## Specifications for Waste Water Pump Stations

### Scope AND INTENT

This section shall apply to all wastewater pump stations that are or will discharge to the City of Clearwater sewage collection system. This includes manholes, gravity mains and force mains. The intent of this section is to ensure that the wastewater pump stations discharging to the City’s collection system meet minimum standards necessary to avoid Sanitary Sewer Overflows (SSO’s) while contributing to a maintainable resilient infrastructure. This section is applicable to new construction and the rehabilitation of existing pump stations. All stations shall be submersible type and the basis of design shall be reviewed and approved by the City of Clearwater Utilities Department.

### Plans Preparation

#### All sanitary wastewater pump stations and associated force mains and appurtenances shall be designed in accordance with Florida Department of Environmental Protection or assigns, and applicable City of Clearwater specifications and standards established herein.

#### Wastewater pump stations that will be owned and operated by the City of Clearwater Utilities Department shall be constructed adjacent to a public right-of-way on property dedicated for such purpose. Site size and conditions shall be as provided within this section. For stations to be owned and operated by the City of Clearwater, the site ownership shall be transferred to the City.

#### Wastewater pump station plans will be reviewed and approved by the City of Clearwater Utilities Department prior to construction.

### Reference documents

Specifications included in the 400 Series of Section IV of the City of Clearwater contract Documents & Specifications apply as applicable for the construction and rehabilitation of wastewater pump stations. These may be accessed at the following link:

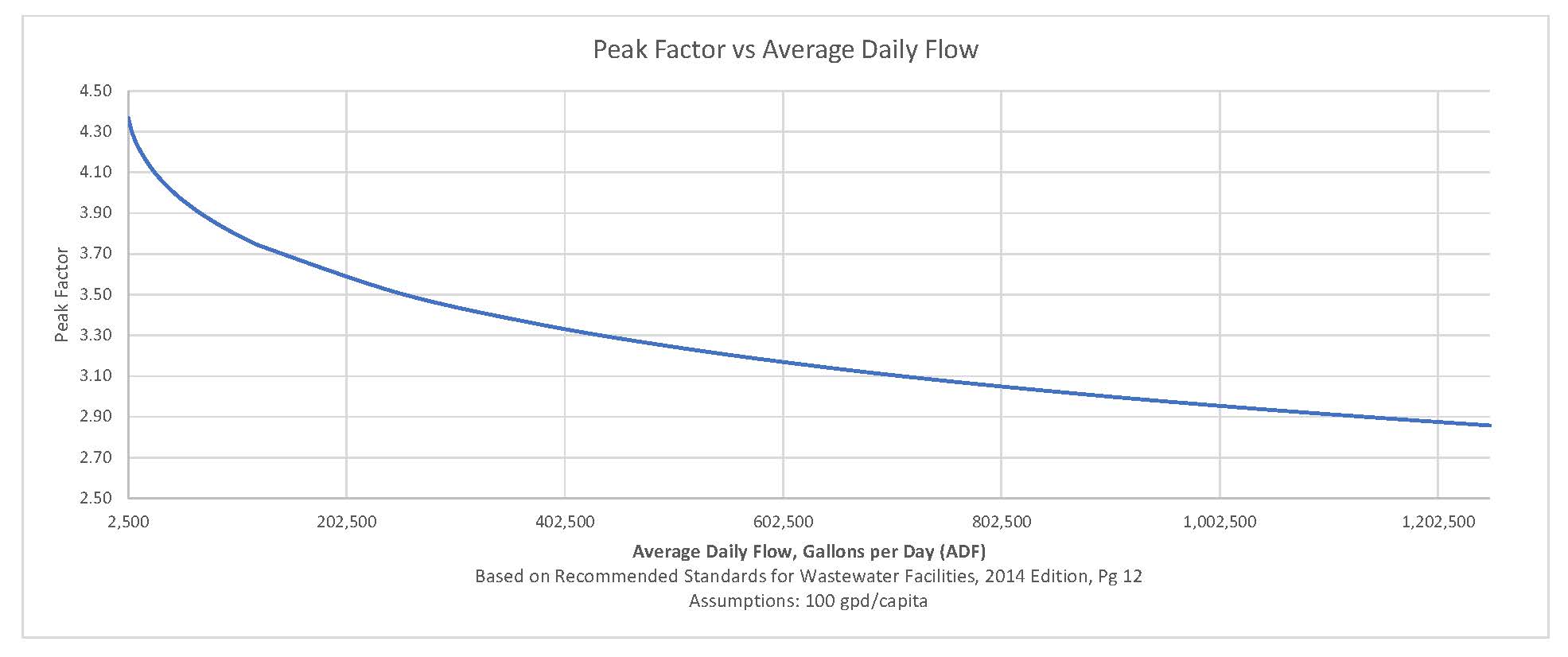
<https://www.myclearwater.com/government/city-departments/engineering/documents-publications/contract-specifications>.

### Design basis

#### Average daily Flow (ADF)

The wastewater pump station shall be designed based on the ultimate developed or projected flow. Average daily wastewater flow shall be calculated by the Equivalent Residential Unit (ERU) as outlined in Table I (Appendix A) of **Chapter 64E-6 F.A.C.** in effect at time of document issuance below. If using fixture units as provided in the currently adopted version of the Florida Building Code the Total ERU= Number of Fixture Units X 1 ERU/12 Fixture Units. Alternate design criteria may be considered on a case by case basis by the City of Clearwater Public Utilities Department.

#### Peak design flow

Wastewater pump stations shall be designed for the ADF times the Wastewater Flow Peaking factor (PF) from the graph below. Peak Design Flow=ADF X PF

#### Design Calculations

##### Request in writing from the City the pressure information at the tie-in location. The request shall include the location of proposed connection point with a sketch showing an address or parcel ID.

##### Signed and Sealed design calculations shall be included for all wastewater pump stations. Calculations shall be included in the pump station design drawings and shall include system curves, pump curves, pump make and model, level transducer/float settings and wet well buoyancy calculations. Buoyancy calculations shall assume no friction between the soil and wet well and include only the weight of the wet well and saturated soil above the wet well base flange. Assume the ground water elevation is equal to the surface elevation.

##### All new wastewater pump stations shall be submersible type stations.

##### The pump station shall be capable of pumping the peak design flow with the largest pump out of service.

##### Pumps shall be capable of operating over the entire pump curve without overloading the motor.

##### Each pump station shall have a minimum of two pumps for peak flows of 1,000 gpm or less. Package grinder pump stations serving a single-family residence may have one installed pump, if approved by the City. Flows exceeding 1,000 gpm shall require three (3) or more pumps. All pumps shall be submersible and shall be removable without entering the wet well. One pump shall operate as an installed “spare” and shall alternate into service to maintain even wear on each pump.

##### Design calculations shall include high head and low head condition system curves taking into account force main pressures, friction losses, and wet well sizing.

#### Elevations.

Wastewater pump stations, including electrical and mechanical equipment shall be protected from physical damage in the event of a 100-year flood. Wastewater pump stations shall remain fully operational and accessible during a 25-year flood. Wet well top elevations and control panels shall be set with a minimum of two (2) feet above the 100-year flood elevation.

#### Site Sizing and Layout.

##### Stations with a capacity of 1,000 gpm or more shall be sited as follows on the site:

###### The concrete pad for the station shall be a minimum of 20 feet to the side and back lot lines and 50 feet away from any residential structures or commercial building envelopes.

###### The front edge of the pump station shall be a minimum of 30 feet from the edge of pavement of the roadway.

###### The site shall be suitably sized to house an on-site emergency generator.

##### Stations with a capacity of less than 1,000 gpm shall be sited as follows on the site:

###### The concrete pad shall be a minimum of 20 feet to the side and back lot lines and a minimum of 30 feet to any residential structures or commercial building envelopes. Accessory structures, including swimming pools, shall be outside of this 30-foot distance.

###### Grinder and post-development stations shall be sited on an inside lot within the subdivision.

##### A to-scale site plan shall be provided in the design drawings, which shall include all lot grading details and elevations.

##### All driveway and site drainage shall be directed away from the pump station.

##### Landscaping shall be indicated on the plans. A Homeowner Association acceptance of responsibility for maintenance shall be provided prior to pump station start-up.

#### Wet Wells

##### Wet Well Volume. The volume of the wet well between start and stop elevations shall be determined based upon the design pump flow rate as follows:

V = *Ɵ*q / 4

Where:

V = Required capacity in gallons (From Low Water Level to High-Water Level)

*Ɵ* = Minimum time of one pumping cycle between successive starts, or speed increases of a pump operating over the control range in minutes

q = Pump capacity in gallons per minute, for one pump, or the incremental pumping capacity for an additional pump, or pump speed.

###### For large pumps and motors (15 HP and larger), *Ɵ* shall be not less than 20 minutes. For smaller pumps, *Ɵ* shall be 15 minutes.

###### The cycle of operation for each pump shall be not less than five minutes. The maximum retention time in the wet well shall not average more than 30 minutes.

###### For very large pumps and motors with variable drives (larger than 88 HP), the system shall operate continuously with pumps alternating in order to maintain equal wear on the pumping units. The wet well volume will be considered on a case by case basis by the City of Clearwater Public Utilities Department.

##### Wet Well Diameter. The diameter of the wet well shall be between 6-feet diameter and 12-feet in diameter, as required to house the pumps and provide adequate circulation without causing vortexing (air binding) or cavitation while pumps are operating. Grinder stations shall be no more than 6-feet in diameter.

##### Wet Well Depth. The maximum depth of the wet well will be less than 20-feet from ground surface to the inside bottom of the wet well. If additional volume is required, the wet well diameter shall be increased or a second wet well will be considered.

##### General Requirements.

###### Control Elevations. Control elevations shall be set as follows: Low Water Level (all pumps off) will be at least three-inches above the top of the pump motors. The high-water alarm will not be above the invert elevation of the influent pipe. For drop inverts the high-water alarm level will not exceed the upper invert elevation.

###### Fillet. The wet well floor shall have a grout fillet with a minimum slope of one to one providing a hopper bottom no larger than necessary for proper operation of the pump suction.

##### Wall penetrations. Wet well wall penetrations for pump discharge piping shall be core drilled or have cast in sleeves to provide a smooth sealing surface. Penetrations shall be sealed by installing a Link-Seal modular elastomeric seal as manufactured by GPT. Openings shall be sized to accommodate the outside diameter of the pipe flange installed on the pump discharge piping.

#### Valve Vaults

##### Valve vaults shall provide adequate access for maintenance entry and removal of all installed piping and appurtenances.

##### Wall penetrations shall be as required for the wet wells.

##### The floor shall slope to the drain which empties into the wet well.

#### Wet Well and Valve Vault Bedding.

Wet wells and valve vaults shall be set on a bed of leveled and compacted #57 stone.

#### Stainless Steel Piping and Appurtenances.

All wet piping and appurtenances with the exception of the of the pump base elbows and any reducers installed on the base elbows shall be manufactured of 316L stainless steel. The stainless steel piping shall extend out of the wet well to the first flanged connection in the valve vault.

#### Access hatches

To include safety grates on wet wells.

Ladders required for valve vaults over 4 feet deep

#### Pre-packaged grinder Pump Stations

##### Shall be owned and maintained by the proper owner or management group responsible for maintenance and payment of power bills.

##### Single pump restrictions: Single pump prepackaged systems shall only be used on single family residences. Multi-family residences and commercial properties shall be serviced by dual pump systems

##### Responsibility for power and payment of utility bills: Electric service for multi-family residences and commercial properties shall be set up such that service shut down to any given residence or commercial space does not prevent pump station operation for the remaining tenants.

#### Submersible Wastewater Pumps

##### Submittals

Shop drawings and product data including pump curves, materials and operating points shall be submitted for submersible sewage pumps. Deviations from specified requirements shall be stated on the submittal cover sheet.

##### Each pump shall be equipped with a submersible electric motor connected for operation as indicated on contract drawings, submersible cable (SUBCAB) suitable for submersible pump applications.

##### The pumps shall be supplied with a mating cast iron discharge connection. The pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with 316SS lifting chain or stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

##### Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be AISI type 316 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

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

##### The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

##### The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

##### The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

##### The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

##### The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

##### The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

##### Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion and abrasion resistant tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion and abrasion resistant tungsten-carbide seal ring.

##### Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.

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

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

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

##### Seal lubricant shall be FDA Approved, nontoxic.

##### Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T.

##### If a shaft material of lower quality than stainless steel – ASTM A479 S43100-T is used, a shaft sleeve of stainless steel – ASTM A479 S43100-T is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided in the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

##### The impeller shall be of gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design having a long throughlet without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Whenever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency; thus, reducing operating costs. Impeller shall be keyed to the shaft, retained with an Allen head bolt and shall be capable of passing a minimum three inch diameter solid.

##### A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass ring insert that is drive fitted to the volute inlet.

##### This pump shall also have a stainless steel impeller wear ring heat shrink fitted onto the suction inlet of the impeller.

##### Pump volute shall be a single-piece grey cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

##### All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125°C (260°F), stop the motor and activate an alarm.

##### A leakage sensor shall be available as an option to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.

##### Pumps shall be Flygt, as manufactured by Xylem, Inc. For purposes of maintaining spare parts, the City has standardized upon Flygt

#### Rail System

All pump stations shall employ twin front load guide rails running from the discharge (base) elbow to a guide rail bracket at the top hatch to allow easy placement and removal of pumps without entering the wet well. All rails and brackets shall be 316L stainless steel.

#### Water Supply

All Wastewater pump stations shall be equipped with a minimum 1-inch potable water service for station washdown. The water service shall be equipped with a reduced pressure principle backflow preventer. The service assembly shall be located inside the station fence in a location to avoid vehicle traffic and tripping hazards. A water service from the City shall be provided. After acceptance by the City, the meter shall be placed within the name of the City.

#### Flow Meters

##### E&H Proline W400 or Tigermag Magnetic Flow Meter

##### Flow meters and transmitters shall be rated for submersion. A remote display shall be located on the deadfront panel inside of the control panel.

##### Flow meter bypass piping with isolation valves to allow removal of the flow meter during station operation shall be included for all stations discharging into a pressurized force main. For stations discharging into a manhole no bypass piping or valves shall be required but a spool piece with the same diameter and lay length as the flow meter shall be affixed inside the valve vault to allow for operation with the flow meter removed

##### Installation shall meet manufacturer’s straight pipe requirements upstream and downstream of the flow meter.

#### Site Enclosure

##### Chain Link Fencing shall be provided surrounding the pump station. The fencing shall be nominally six feet high with gates and privacy screening. The fencing installer shall be a firm experienced in the erection of fencing and accessories. All materials and work shall comply with the provisions and recommendations of the following:

ASTM A153 – Standards Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware

ASTM A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric

ASTM A428 – Standard Test method for Weight (Mass) of Coating on Aluminum Coated Iron or Steel Articles

ASTM A824 – Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence

ASTM F552 – Standard Terminology Relating to Chain-Link Fencing

ASTM F567 – Standard Practice for Installation of Chain-Link Fence

ASTM F626 – Standard Specification for Fence Fittings

ASTM F900 – Standard Specification for Industrial and Commercial Steel Swing Gates

ASTM F1143 – Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework

ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded for Fence Structures

ASTM F1184 – Standard Specification for Industrial and Commercial Horizontal Slide Gates

Federal Specification RR-F-191/1A – Fencing and Wire and Post, and Metal (Chain-Link Fence Fabric)

American Welding Society (AWS)

Chain Link Manufacturer’s Institute for “Galvanized Steel Chain Link Fence Fabric and Accessories”

Chain link fabric shall be ASTM A39 zinc-coated steel, coated prior to weaving, 2.0 ounces per square foot. Wire gauge shall be 9 ga with a 2-inch mesh size. Top and bottom selvages shall be twisted and barbed. Line posts shall be ASTM F1083 pipe, Schedule 40, NPS (nominal pipe size) 1 ½ inches. Corner and terminal posts shall be ASTM F1083 pipe, Schedule 40, NPS 2 inches. Braces and rails shall be ASTM F1083 pipe, Schedule 40, NPS 1 ¼ inches. Tension wires shall be placed at the top and bottom of the fabric and shall be ASTM A824, galvanized steel, Class 3, No. 7. Fence fittings, including post and line caps, rail and brace ends, sleeves – top rail, tie wires and clips, tension and brace bands, tension bars, and truss rods, shall be ASTM F626, steel wire, No. 9. Maximum spacing for posts shall be ten feet on center.

Color: Fence fabric, fittings, posts, rails and accessories shall be Green.

Privacy fabric shall be provided for each fencing system. The material shall be HDPE with UV inhibitors with the same height as the fence with a locking channel to keep in position. The privacy slots shall be woven through the fabric and into the locking channel.

##### Gates: Gates shall be installed as required for access to the pump stations for the installation and removal of pumps and for regular maintenance and repair work. Gates shall be either swing or slide as suitable for each installation.

##### Horizontal Slide Gates: Shall be in compliance with FDOT Indices 802 and 803, shall be sized to match the driveway width plus two feet on each size, shall be in compliance with ASTM F1184, Type II.

##### Gates shall be supplied with a Class 1 External Roller. Horizontal top and bottom steel pipe “track” members to be 2.375 in. OD. Vertical and internal members, 1.900 inches O.D. in compliance with ASTM F1083 schedule 40 galvanized steel pipe. Gate frame to be fabricated by welding, vertical and horizontal members installed no greater than 8 feet apart. Welded joints are to be protected by applying zinc-rich paint in accordance with ASTM Practice A780. Gates shall be designed to open or close by applying an initial pull force no greater 40 lbs. Match chain link fabric to that of the fence system. Positive locking pressed steel latch, galvanized after fabrication. Galvanized steel drop bars provided with double gates. Gateposts, for fences 6-feet in height, shall be 4.000 inches OD schedule 40 pipe per ASTM F1083. Provide safety protective guards for the top and bottom external rollers following ASTM F1184 guidelines.

Swing gates: Shall be a minimum of four-feet wide for pedestrians and ten-feet wide for vehicles (double ten-foot wide with gate stops). Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900 inches OD ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 feet apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. Gatepost diameter shall be as listed in the table below.

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| --- | --- | --- | --- | --- |
| **GATEPOST DIAMETER TABLE** | | | | |
| **Gate fabric height up to and including 6 ft. (1.2m)** | | | |  |
| **Gate leaf width** |  | **Post Outside Diameter** | | **Weight** |
| Up to 4 ft. (1.2 m) |  | 2.375 in. (60.3 mm) |  | 3.65 lb/ft (5.4 kg/m) |
| Over 4 ft. to 10 ft. (1.2 to 3.05 m) | | 2.875 in. (73.0 mm) |  | 5.79 lb/ft (8.6 kg/m) |
| Over 10 ft. to 18 ft. (3.05 to 5.5 m) | | 4.000 in. (101.6 mm) |  | 9.11 lb/ft (13.6 kg/m) |
| **Gate fabric height over 6 ft. to 12 ft. (1.2 to 2.4m)** | | | |  |
| **Gate leaf width** |  | **Post Outside Diameter** |  | **Weight** |
| Up to 6 ft. (1.8 m) |  | 2.875 in. (73.0 mm) |  | 5.79 lb/ft (8.6 kg/m) |
| Over 6 ft. to 12 ft. (1.8 to 3.7 m) | | 4.000 in. (101.6 mm) |  | 9.11 lb/ft (13.6 kg/m) |
| Over 12 ft. to 18 ft. (2.4 to 5.5 m) | | 6.625 in. (168.3 mm) |  | 18.97 lb/ft (28.2 kg/m) |
| Over 18 ft. to 24 ft. (5.5 to 7.3 m) | | 8.625 in. (219.1 mm) |  | 28.58 lb/ft (42.5 kg/m) |

##### Alternate Enclosures may be proposed for review on a case-by-case basis in order to meet the architectural standards within a proposed subdivision.

#### Pressure Gauges shall be installed on all pump discharges downstream of the check valves. Gauges shall include a snubber and isolation ball valve. Valves and pressure gauges shall be 316 stainless steel. Valve dial shall be 2”.

#### Construction Considerations

#### Tools and Spare Parts

406-4.18.1. Tools and spare parts shall be provided as required herein.

406-4.18.2. A spare pump shall be provided for each pump station. The pump shall be the same as the units installed. The pump shall be appropriately packaged and labeled with station number, address, pump make, model, impeller size, serial number, and any other identifying features.

406-4.18.3. All special and/or proprietary tools necessary for the operations and maintenance of all pump station equipment shall be provided prior to acceptance of the station by the City.

406-4.18.4. Prior to acceptance of the station by the City, all spare parts shall be provided to the City at the following location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

406-4.18.5. Spare parts shall include, but are not limited to, the following:

Centrifugal Pumps: Spare pump

One set of ceramic station seal and rotating carbon seal

Two sets of spare gaskets and O-rings including hydraulic sealing flange gasket

Manufacturer specified impeller pullers

Manufacturer specified wrenches for breakdown of pumps

Grinder Pumps: Spare pump

One set of mechanical seals

Manufacturer specified impeller pullers

Manufacturer specified wrenches for breakdown of pumps

Discharge Piping: One stainless steel, silicone-filled pressure gauge and diaphragm seal unit

One spare check valve flapper, flapper bolt and hinge pin

Electrical: Four spare fuses for each size and type used

One spare relay per cabinet for each coil voltage and type

One spare intrinsically safe isolator for pump stations classified as Class I, Group D, Division 1

#### Odor Control

##### Depending on flow conditions and proximity to dwellings and businesses some pump stations may be subject to complaints about nuisance odors. In these situations, odor control systems may be appropriate. In order to provide for future contingency adequate space must be allocated if odor control becomes necessary

##### Proposed (future) odor control system hardware must be specified and be provided with a space allocation on the pump station site plan drawings. Any required ducting or conduit that needs to be cast into the wet well and or slab shall be installed and capped outside/above the slab as appropriate.

##### Adequate electrical capacity shall be reserved in breaker panels for future odor control systems.

##### System hardware specifications shall be included on the site plans within the designated area, if possible, shown as “Future Odor Control System”

#### Signs

##### Pump Station Identification: A sign shall be affixed to the outside of the fence and shall include pump station identification, address and emergency contact information.

##### Arc Flash: Arc Flash Hazard labels shall be affixed to the front on control panels as required by National Electrical Code.

##### Confined Space: Confined space placards “DANGER-Confined Space-Permit Required-DO NOT ENTER” shall be affixed to the inside of the fence nearest to and visible from the wet well.

#### Wastewater Pump Station Electrical and Controls-See Appendix B for Standard Electrical Specifications

### Wet Well rehabilitation and Coating

#### All new wet wells and valve vaults shall be constructed using Xypex Bio-San C500 admixture and will not require additional coating. This requirement shall also apply to new components constructed during rehabilitation work such as wet well tops and valve vaults. All existing wet wells and valve vaults undergoing rehabilitation and maintenance shall receive a protective coating of rigid polyurethane. The coatings shall completely cover all interior concrete surfaces of the wet well including the floor and underside of the wet well cover.

#### References

##### ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens).

##### ASTM C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.

##### ASTM C 348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

##### ASTM C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.

##### ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.

##### ASTM C1012 Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to Sulfate Solution.

##### ASTM C 1202 - Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration.

##### ICRI Guideline No. 03730 - Surface Preparation Guidelines for Repair of Deteriorated Concrete Resulting from Reinforcing Steel Oxidation.

#### Submittals

##### Shop Drawings showing location of proposed repairs, details, anchorage and other information required for review.

##### Manufacturer's data sheets on each product to be used, including: preparation instructions and recommendations, storage and handling requirements, installation methods.

#### Rehabilitation and repair of existing wet wells

##### Existing coatings and liners shall be removed by appropriate mechanical means followed by high pressure water blasting.

##### Leaks in the wet well shall be repaired using a combination of fast setting hydraulic cement, hydrophilic polyurethane grout or chemically activated grout. Voids on the exterior of the wet well shall be filled will chemically activated grout to prevent soil subsidence adjacent to the wet well.

###### Hydraulic cement: Fast setting, single component cement for patching and repair of cracks and holes including defects with flowing water. As manufactured by Xypex, Sika, Quickrete or Engineer approved equal.

###### Hydrophilic polyurethane grout: single component, moisture activated blended polyurethane injection resin. Designed for sealing active water leaks in large cracks or joints in concrete structures, creating an impermeable foam or gel. MasterRoc MP 355 1K as manufactured by BASF, AV-202as manufactured by Avanti or Engineer approved equal.

###### Chemically activated grout: Chemical Grout is used to stop water infiltration into manholes, mainlines, laterals and lateral connections by creating an effective water barrier on the exterior of the structure. It forms a chemically reactive gel that travels anywhere water can travel and cures to form long-lasting water barrier while providing soil stabilization. As manufactured by Avanti or Engineer approved equal.

##### Areas that have exposed reinforcing or spalling over reinforcing shall be repaired as follows

###### Concrete shall be chipped back to expose clean reinforcing on either side of the defect. One-half inch of concrete shall be removed from behind the reinforcing in the damage area to facilitate further cleaning.

###### The reinforcing shall be blast cleaned to SSPC-SP 10 (NACE No.2) near white conditions taking care that the rear side of the reinforcing is appropriately cleaned.

###### If required, install new reinforcing using a 40 bar diameter overlap and tie in place as needed.

###### Apply repair mortar to the damage area to cover the reinforcing and match the existing surface.

Repair Mortar shall be EucoRepair V100 by Euclid Chemical, MasterEmaco N 425 by BASF or Engineer approved equal.

#### Coating of rehabilitated wet wells and valve vaults shall be SprayWall® as manufactured by Sprayroq, Inc.

##### Coatings and primers/underlayments shall be applied by manufacturer trained and certified applicators.

### Startup Testing and Inspection

#### Wet Well

#### Pumps

#### Control Panel/SCADA

#### Transducer/Floats

#### Flow Meter

#### Generator

#### Forms: See Appendix C for Startup and Data forms

| Appendix A  TABLE I  For System Design  ESTIMATED SEWAGE FLOWS | |
| --- | --- |
| TYPE OF ESTABLISHMENT COMMERCIAL: | GALLONS PER DAY |
| Airports, bus terminals, train stations, port & dock facilities, Bathroom waste only |  |
| (a) Per passenger | 4 |
| (b) Add per employee per 8 hour shift | 15 |
| Barber & beauty shops per service chair | 75 |
| Bowling alley bathroom waste only per lane | 50 |
| Country club |  |
| (a) Per resident | 100 |
| (b) Add per member or patron | 25 |
| (c) Add per employee per 8 hour shift | 15 |
| Doctor and Dentist offices |  |
| (a) Per practitioner | 250 |
| (b) Add per employee per 8 hour shift | 15 |
| Factories, exclusive of industrial wastes gallons per employee per 8 hour shift |  |
| (a) No showers provided | 15 |
| (b) Showers provided | 25 |
| Flea Market open 3 or less days per week |  |
| (a) Per non-food service vendor space | 15 |
| (b) Add per food service establishment using single service articles only per 100 Square feet of floor space | 50 |
| (c) Per limited food service establishment | 25 |
| (d) For flea markets open more than 3 days per week estimated flows shall be doubled |  |
| Food operations |  |
| (a) Restaurant operating 16 hours or less per day per seat | 40 |
| (b) Restaurant operating more than 16 hours per day per seat | 60 |
| (c) Restaurant using single service articles only and operating 16 hours or less per day per seat | 20 |
| (d) Restaurant using single service articles only and operating more than 16 hours per day per seat | 35 |
| (e) Bar and cocktail lounge per seat | 20 |
| add per pool table or video game | 15 |
| (f) Drive-in restaurant per car space | 50 |
| (g) Carry out only, including caterers |  |
| 1. Per 100 square feet of floor space | 50 |
| 2. Add per employee per 8 hour shift | 15 |
| (h) Institutions per meal | 5 |
| (i) Food Outlets excluding deli’s, bakery, or meat department per 100 square feet of floor space | 10 |
| 1. Add for deli per 100 square feet of deli floor space | 40 |
| 2. Add for bakery per 100 square feet of bakery floor space | 40 |
| 3. Add for meat department per 100 square feet of meat department floor space | 75 |
| 4. Add per water closet | 200 |
| Hotels & motels |  |
| (a) Regular per room | 100 |
| (b) Resort hotels, camps, cottages per room | 200 |
| (c) Add for establishments with self service laundry facilities per machine | 750 |
| Mobile Home Park |  |
| (a) Per single wide mobile home space, less than 4 single wide spaces connected to a shared onsite system | 250 |
| (b) Per single wide mobile home space, 4 or more single wide spaces are connected to a shared onsite system | 225 |
| (c) Per double wide mobile home space, less than 4 double wide mobile home spaces connected to a shared onsite system | 300 |
| (d) Per double wide mobile home space, 4 or more double wide mobile home spaces connected to a shared onsite system | 275 |
| Office building |  |
| per employee per 8 hour shift, or | 15 |
| per 100 square feet of floor space, whichever is greater | 15 |
| Transient Recreational Vehicle Park |  |
| (a) Recreational vehicle space for overnight stay, without water and sewer hookup per vehicle space | 50 |
| (b) Recreational vehicle space for overnight stay, with water and sewer hookup per vehicle space | 75 |
| Service stations per water closet |  |
| (a) Open 16 hours per day or less | 250 |
| (b) Open more than 16 hours per day | 325 |
| Shopping centers without food or laundry per square foot of floor space | 0.1 |
| Stadiums, race tracks, ball parks per seat | 4 |
| Stores per bathroom | 200 |
| Swimming and bathing facilities, public per person | 10 |
| per person |  |
| Theatres and Auditoriums, per seat | 4 |
| Veterinary Clinic |  |
| (a) Per practitioner | 250 |
| (b) Add per employee per 8 hour shift | 15 |
| (c) Add per kennel, stall or cage | 20 |
| Warehouse |  |
| (a) Add per employee per 8 hour shift | 15 |
| (b) Add per loading bay | 100 |
| (c) Self-storage, per unit (up to 200 units) | 1 |
| add 1 gallon for each 2 units or fraction thereof, for over 200 units, and shall be in addition to employees, offices or living quarters flow rates. | |
| INSTITUTIONAL: |  |
| Churches per seat which includes kitchen | 3 |
| wastewater flows unless meals |  |
| prepared on a routine basis |  |
| If meals served on a regular basis add per meal prepared | 5 |
| Hospitals per bed which does not include | 200 |
| kitchen wastewater flows |  |
| add per meal prepared | 5 |
| Nursing, rest homes, adult congregate living facilities per bed which does not include kitchen wastewater flows | 100 |
| add per meal prepared | 5 |
| Parks, public picnic |  |
| (a) With toilets only per person | 4 |
| (b) With bathhouse, showers & toilets per person | 10 |
| Public institutions other than schools and hospitals per person which does not include kitchen wastewater flows | 100 |
| add per meal prepared | 5 |
| Schools per student |  |
| (a) Day-type | 10 |
| (b) Add for showers | 4 |
| (c) Add for cafeteria | 4 |
| (d) Add for day school workers | 15 |
| (e) Boarding-type | 75 |
| Work/construction camps, semi-permanent per worker | 50 |
| RESIDENTIAL: |  |
| Residences |  |
| (a) Single or multiple family per dwelling Unit |  |
| 1 Bedroom with 750 sq. ft. or less of building area | 100 |
| 2 Bedrooms with 751-1,200 sq. ft. of building area | 200 |
| 3 Bedrooms with 1,201-2,250 sq. ft. of building area | 300 |
| 4 Bedrooms with 2,251-3,300 sq. ft. of building area | 400 |
| For each additional bedroom or each additional 750 square feet of building area or fraction thereof in a dwelling unit, system sizing shall be increased by 60 gallons per dwelling unit. | |
| (b) Other per occupant | 50 |

Appendix B

Standard Electrical Specifications

**SECTION 16050**

**ELECTRICAL – GENERAL PROVISIONS**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

A. Furnish all labor, materials, equipment and incidentals required for the modifications required to the field devices for the rehabilitation or construction of the City of Clearwater’s sewage pump stations as hereinafter specified and shown on the Drawings.

B. The work, apparatus and materials, which shall be furnished under these Specifications and accompanying Drawings, shall include all items listed hereinafter and/or shown on the Drawings. Certain equipment, which will require wiring thereto and/or complete installation, is indicated. All materials necessary for the complete installation shall be furnished and installed by the CONTRACTOR to provide complete power, instrumentation, wiring and control systems as indicated on the Drawings and/or as specified herein.

C. The CONTRACTOR shall furnish and install the necessary cables, protective devices, conductors, supports, raceways, exterior electrical system, etc., to serve loads as indicated on the Drawings and/or as specified.

D. The work shall include complete testing of all equipment and wiring at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; sub-standard work will be rejected.

E. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work, which may be reasonably implied as being incidental to the work of this Section, shall be furnished at no extra cost.

F. Furnish and install a complete system of conduit as herein specified and shown on the drawings.

**1.02 CODES, INSPECTION AND FEES**

A. All material and installation shall be in accordance with the latest edition of the National Electrical Code and all applicable national, local and state codes, laws and ordinances.

B. Pay all fees required for permits and inspections.

**1.03 TESTS**

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

B. The following minimum tests and checks shall be made prior to the energizing of electrical equipment. Test shall be by the CONTRACTOR and a certified test report shall be submitted providing all test results and stating that the equipment meets and operates in accordance with the Manufacturer's and job specifications, and that equipment and installation conforms to all applicable Standards and Specifications:

1. Test all 600-volt wire insulation with a megohm meter after installation. Make tests at not less than 1000 volts. Submit a written test report of the results to the engineer.

2. Mechanical inspection of all circuit breakers to assure proper operation.

C. The Engineer shall be notified forty-eight (48) hours before tests are made to enable the Owner to have designated personnel present.

**1.04 CUTTING AND PATCHING**

A. All cutting and patching shall be done in a thoroughly workmanlike manner.

**1.05 INTERPRETATION OF DRAWINGS**

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

B. All three-phase circuits shall be run in separate conduits unless otherwise shown on the Drawings.

C. Unless otherwise approved by the Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

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

E. The CONTRACTOR shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the CONTRACTOR without additional expense to the Owner. In case interference develops, the Owner's authorized representative is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

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

G. Circuit layouts shown are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the equipment.

H. The ratings of motors and other electrically operated devices together with the size shown for their branch circuit conductors and conduits are approximate only and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment.

I. All connections to equipment shall be made as shown, specified and directed and in accordance with the approved shop drawings, regardless of the number of conductors shown on the Electrical Drawings.

**1.06 RECORD DRAWINGS**

A. As the work progresses, legibly record all field changes on a set of project Contract Drawings. When the project is complete, furnish a complete set of reproducible "As-built" drawings for the Project Record Documents.

**1.07 COMPONENT INTERCONNECTIONS**

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

B. Analyze all systems components and their shop drawings; identify all terminals and prepare drawings or wiring tables necessary for component interconnection.

**1.08 SHOP DRAWINGS**

A. As specified under other Sections, shop drawings shall be submitted for approval for all materials, equipment, apparatus, and other items as required by the Engineer.

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

1. Pump Control Cabinet

2. Disconnect

3. Data Flow Systems Cabinet

4. Natural gas emergency generator

5. Automatic Transfer Switch

6. Generator Docking Station

7. Meter Can

8. Float Switches

9. Pressure Transmitter

10. Flow Meter

11. Rain Gauge

12. Conductors

13. Conduit

14. Conduit Fittings

C. The Manufacturer's name and product designation and catalog cutsheets shall be submitted for the following material:

1. Conduit

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

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

F. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this Section.

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

**1.09 WARRANTY**

A. Provide a warranty for all the electrical equipment in accordance with the requirements of other Sections. Under no circumstances shall the warranty be for less than one year starting from substantial completion.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

END OF SECTION

**SECTION 16100**

**BASIC MATERIALS AND METHODS**

**PART 1 - GENERAL**

* 1. **SCOPE OF WORK**

1. All work shall be executed in a neat and workmanlike manner by experienced and capable electricians so as to present a neat installation upon completion.
   1. **QUALITY ASSURANCE**
2. Electrical work shall be performed in accordance with the current standards of the electrical trades. The provisions of the NEC and existing local requirements shall comprise the minimum acceptable standards of electrical work.
   1. **DELIVERY, STORAGE, HANDLING, & ENVIRONMENTAL REQUIREMENTS**
3. Equipment and material shall be suitably delivered and stored in the original containers, but shall be readily accessible for inspection. All items subject to moisture damage shall be stored in dry spaces. All material and equipment shall be protected against dirt, dust, water and chemical or mechanical injury, vandalism and theft. Upon completion of the work all equipment and materials shall be cleaned thoroughly, polished and finished in a condition satisfactory to the OWNER.

**PART 2 - PRODUCTS**

* 1. **EQUIPMENT**

1. All equipment and materials shall be new and shall bear the manufacturer’s name, trade name, and the UL label. In cases where a standard has been established for a particular material, the material shall be so labeled. The equipment to be furnished shall be essentially the standard product of a manufacturer regularly engaged in the production of the required type of equipment for this type of work and shall be the manufacturer’s latest approved design.
   1. **ACCESSORIES**
2. Clamps, screws, fasteners and support devices shall be of noncorrosive metal.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

1. The electrical drawings are diagrammatic and indicate the general arrangements of the electrical work. The CONTRACTOR shall carefully examine the Drawings and shall ascertain that the equipment and accessories will be properly located and readily accessible.

**3.02 INSTALLATION**

1. Equipment and appurtenances furnished by various manufacturers shall be installed in strict accordance with the manufacturer’s instructions and approved wiring diagrams for type and capacity of each piece of equipment used. These instructions shall be considered as part of these Specifications. Any OWNER-furnished equipment shall be connected by the CONTRACTOR, including all necessary cords and plugs.
2. Dimensions shown on the drawings are based on the information provided by the manufacturer for specific models indicated. The contractor shall be responsible for ensuring proper clearances, coordination with other equipment, etc. for any substitutions to the equipment used as the basis for the design.

END OF SECTION

**SECTION 16110**

**RACEWAYS AND FITTINGS**

**PART 1 - GENERAL**

* 1. **SCOPE OF WORK**

1. All exposed, exterior conduit shall be rigid aluminum, rigid threaded conduit unless otherwise indicated or shown.
2. All conduit installed below grade shall be rigid non-metallic heavy wall conduit.

**PART 2 - PRODUCTS**

* 1. **MATERIALS**

1. Metallic Conduit and Fittings: Electric metallic conduit shall be standard, heavy-wall rigid aluminum conduit conforming to Federal Specifications. The use of dissimilar metals shall be avoided throughout the system. Installation methods of metallic conduit shall be in accordance with Sections 348-4 through 348-13 of the NEC.
2. Rigid Non-metallic Conduit and Fittings: Rigid non-metallic conduit and fittings of heavy wall polyvinyl chloride (PVC) meeting ASTM Specification D 1785, approved by UL for the specific purpose, may be used in locations not prohibited by the NEC Section 347-3. When equipment grounding is required by Article 250 of the NEC, a separate grounding conductor shall be installed in the conduit. Installation methods of rigid non-metallic conduit shall conform to Section 347-5 through 347-15 of the NEC. Supports shall be in accordance with Table 347-8.

**PART 3 - EXECUTION**

* 1. **INSTALLATION:**

1. Exposed conduit shall run parallel. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Conduit shall be continuous and installed in such a manner that the system shall be electrically continuous throughout. Conduit ends shall be capped during construction. The ends of all conduits shall be carefully reamed free from burrs after threading and before installation. All cuts shall be made square. All joints shall be made up tight. Care shall be taken to see that all control and power conduit runs form a permanent and continuous ground connection point.
2. The Contractor shall permanently and effectively ground service neutral and all raceways, devices, and utilized equipment in accordance with the requirements of the NEC, and as shown or required. All grounding electrodes shall have rigid clamp jaws and be UL listed for the application. A separate ground wire shall be provided in all control and power raceways.
3. Conduit stubs shall be located to conform to location of connection boxes on motors and/or other equipment served. Traps in conduit runs shall be avoided.
4. Conductors shall be installed in a workmanlike manner. Damage to insulation or a reduction of the wire size when pulled into the conduit shall be avoided.
5. All areas of the project are considered to be wet locations and construction within these areas shall be moisture and weather resistant. Work below grade, on grade, or beneath slabs shall be waterproof.
6. Electrical work shall not rest upon, be supported by or hung from ductwork, piping or equipment. Adequate supports shall be provided to assure that this is achieved.
7. Boxes, conduit, hangers, panels, etc., shall be fastened to steel by machine bolts and nuts, and by expansion bolts in concrete. Wood or composition plugs shall not be used.
8. Where installations pass through walls, slabs, or other structures, all cutting shall be accomplished without damage to the structure. Boring and cutting shall be done with proper equipment and without delivering excessive vibration or shock to the structure.
9. The contractor shall install long radius 90 degree bends on all changes of direction in conduits. Factory 90 degree bends will not be accepted.
10. Transition from the above-grade rigid metallic conduit, which includes the first 90° elbow, to the below grade nonmetallic conduit shall be accomplished with a threaded adapter.
11. All aluminum surfaces coming into direct contact with concrete shall be coated/protected at the point of contact to prevent corrosion.

END OF SECTION

**SECTION 16120**

**WIRES AND CABLES**

**PART 1 - GENERAL**

* 1. **SCOPE**

1. This section includes the furnishing, installation, and connection of all low voltage and power wiring. This shall include all wires and cables utilized for controls. Conductors specified for low voltage controls shall be coordinated with and approved by equipment manufacturers.
2. Control wiring specified herein shall be installed and connected by the Electrical Contractor to perform the functions specified in other sections of these specifications.
3. REFERENCE STANDARDS: The following specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this specification to the extent indicated by the references thereto. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date of Invitation for Bids shall be applicable. In text such specifications and standards are referred to by basic designation only.
   * + 1. Federal Specifications (Fed. Spec.)

J-C-30A(1) - Cable and Wire Electrical (Power, Fixed Installation)

HH-I-595C - Insulation Tape, Electrical, Pressure Sensitive Adhesive, Plastic

* + - 1. National Fire Protection Association (NFPA) Publications:

No. 70 - National Electrical Code (NEC) WIRES AND CABLES

* + - 1. Underwriter’s Laboratories, Inc (UL) Publications:

No. 83 - Thermoplastic – Insulated Wires

No. 493 - Thermoplastic – Insulated Underground Feeder and Branch Circuit Cables

No. 486 - Wire Connectors and Soldering Lugs

**PART 2 - PRODUCTS**

* 1. **MATERIALS**

1. Conductors shall consist of annealed copper wire having a minimum of 98% conductivity and shall be sized and insulated or isolated in accordance with the NEC for the current and voltage of the individual circuit. All conductors, unless specifically noted, shall have type “THWN”, 75 degrees F, 600 Volt insulation.

**PART 3 - EXECUTION**

* 1. **INSTALLATION**

1. All conductors shall be coded throughout, using different colors for phases, white for neutral (white with other color stripe for neutral of a different voltage system) and green for ground. The same color code for a particular phase or part of a circuit shall be run with the same conductor throughout the job. Colors used for each voltage system shall be different. Conductors No. 8 AWG and larger may be black in color but shall be identified with colored tape in all outlet, junction or pull boxes and at the terminals of the equipment.

Phase 120/240V, 3PH, System

A Black

B Orange

C Blue

Neutral White

Ground Green

1. All wires in cabinets, boxes, panels, pull and junction boxes shall be trained neatly and tied.
2. All wires and cables, larger than No. 12 AWG, shall be continuous from origin to destination without splices unless written permission is given by the ENGINEER.
3. Conductors shall be sized in accordance with NEC requirements. No conductor shall be smaller than No. 12 AWG, except control and signal circuit conductors which may be No. 14 AWG, unless otherwise specified on the drawings.

**3.02 TERMINATIONS AND SPLICES**

A. Power Conductors: Terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling.

B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors per termination. Termination on screw type terminals shall be made with a maximum of two spade connectors.

C. Instrumentation Signal Conductors: Terminations permitted shall be typical of control conductors. Splices are allowed at instrumentation terminal boxes only.

D. Splices (of any type) shall not be allowed. All conductors shall be continuous from termination point to termination point.

END OF SECTION

**SECTION 16170**

**OVERCURRENT PROTECTIVE DEVICES**

**PART 1 ‑ GENERAL**

* 1. **SYSTEM DESCRIPTION**

1. Main Disconnect: A main disconnecting means meeting the requirements of the NEC shall be furnished and installed for the electrical service as shown on the drawings. The main disconnect shall be a fused disconnect.

**PART 2 - PRODUCTS**

* 1. **ACCESSORIES**

1. Circuit Breakers: Circuit breakers for all branch circuits shall be molded-case unit breakers with thermal-magnetic trips designed to open all phases simultaneously under overload and/or fault conditions. Breakers shall be of adequate rating for the actual duty required. The breaker shall have quick-make, quick-break, toggle mechanism, inverse-time trip characteristics, and shall be trip-free on overload or short-circuit. Automatic release is to be secured by a bimetallic thermal element releasing the mechanism latch. In addition, a magnetic armature shall be provided to trip the breaker instantaneously for short circuit currents above the overload range. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. The trip mechanism shall be a combination thermal-magnetic type. Thermal elements shall inverse time characteristics for overload conditions and magnetic trip element shall protect against short circuits by providing instantaneous trip. Main and Emergency circuit breakers shall be mechanically interlocked so that the two breakers may not both be in the “ON” position simultaneously.
2. Safety Switches: All safety switches shall be heavy-duty type “HD”. The blades of switches shall be quick-make, quick-break operating type. All lugs on all switches shall be equal to Burdy’s solderless quick lugs or shall be compression type. Switches shall have the number of poles and be of the size indicated. Enclosures shall be of the NEMA type indicated on the drawings. The switch shall conform to NEMA Standards and shall be UL listed. Switches shall be equal to General Electric, Square-D, or Cutler-Hammer.

**PART 3 - EXECUTION**

* 1. **INSTALLATION**

1. Install overcurrent protective devices as recommended by the manufacturer, required by Code, and as shown on the drawings.

END OF SECTION

**SECTION 16216**

**NATURAL GAS DRIVEN GENERATOR WITH WEATHERPROOF ENCLOSURES**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

A. Furnish all labor, materials, equipment and incidentals required to install, put into operation, and field test the weatherproof natural gas engine driven generator units and appurtenances as shown on the Drawings and specified herein.

B. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, and delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete units as herein specified, whether specifically mentioned in these Specifications or not.

C. For the units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. This installation shall incorporate the highest standards for the type of service shown on the Drawings. The CONTRACTOR is responsible for field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

**1.02 DESCRIPTION OF SYSTEM**

A. The engine‑generator sets shall be mounted as shown on the Drawings and shall be arranged for automatic starting and stopping, and load transfer upon failure of the normal source of power. The unit controls shall provide for automatic exercising on a weekly basis.

**1.03 QUALIFICATIONS**

A. The engine-generator sets shall be the standard product, as modified by these specifications, of a MANUFACTURER regularly engaged in the production of this type of equipment. The unit to be furnished shall be of proven ability and shall be designed, constructed, and installed in accordance with best practices and methods. To qualify as a MANUFACTURER, the engine must be the principal item manufactured and the completed engine generator sets shall be supplied by the MANUFACTURER's authorized dealer only. The dealer shall have a minimum of ten (10) years experience in the field of power generation.

B. It is the intent of this specification to secure a generator system that has been prototype tested, factory built, production tested, site tested and of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the NEC, along with all applicable local codes and regulations. All equipment shall be new, of current production of a national firm which manufactures the engine/generators and controls, and assembles the generator system as a matched unit so that there is one-source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.

C. The units must be of such physical dimensions as to make a good installation in the opinion of the ENGINEER, in the space provided as indicated on the Drawings.

D. The units shall be assembled in the U.S. with over 50% of the components such as the engine, generator, auxiliary equipment, etc., manufactured in the U.S. by a MANUFACTURER currently engaged in the production of such equipment.

E. Each unit shall be shipped to the jobsite by an authorized engine dealer having a parts and service facility within a 250 mile radius of the jobsite. In addition, and in order not to penalize the OWNER for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacement parts locally available at all times. Certified proof of this requirement shall be furnished to the ENGINEER upon request.

F. All materials and parts comprising the unit shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections. Workmanship shall conform to the best modern practices. Only new and current models will be considered. The units offered under these Specifications shall be the product of a firm regularly engaged in the production of engine‑generator equipment and shall meet the requirements of the Specifications set forth herein. Major exceptions to Specifications will be considered sufficient cause for rejection of the machines.

G. The generator sets shall be listed to UL 2200.

**1.04 SUBMITTALS**

A. Submittals shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required for interconnection between the generator set and the transfer switch included elsewhere in these specifications.

B. The successful bidder shall submit to the ENGINEER for review in accordance with other sections, complete sets of installation drawings, schematics, and wiring diagrams which shall show details of installation and connections to the work of other Sections, including foundation drawings showing location and size of foundation bolts for the spring type vibration isolators and brochures covering each item of equipment.

C. In the event that it is impossible to conform with certain details of the Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

D. The submittal data for each engine/generator set and sound attenuated, weatherproof enclosure shall include, but not necessarily be limited to, the following:

1. Installation drawings showing plan and elevations of the complete generator unit; foundation plan; exhaust silencer; starting battery; battery charger; and sound attenuated, weatherproof enclosure.

2. Engine Data:

1. Manufacturer
2. Model
3. Number of cylinders
4. RPM
5. Bore x stroke
6. BMEP at full rated load
7. Make and model and descriptive literature of electric governor
8. Fuel consumption rate curves at various loads
9. Engine continuous pump drive duty rating (without fan) HP
10. Gross engine horsepower to produce generator standby rating (including fan and all parasitic loads) HP

3. Generator Data:

a. Manufacturer

b. Model

c. Rated KVA

d. Rated SKVA

e. Rated KW

f. Voltage

g. Temperature rise above 40° C ambient

i) Stator by thermometer

ii) Field by resistance

1. Class of insulation
2. Generator efficiency, including excitation losses, at 80% power factor
   1. Full load
   2. ¾ load
   3. ½ load

4. Generator Unit Control Data :

a. Actual electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided. Standard preprinted sheets are not acceptable.

b. Legends for all devices on all diagrams.

c. Sequence of operation explanations for all portions of all schematic wiring diagrams.

5. Engine/Generator Units and Sound Attenuated, Weatherproof Enclosures: Dimensional data shall be given for each Engine/Generator set and for the weatherproof enclosures.

a. Weight of skid mounted unit

b. Overall length

c. Overall width

d. Overall height

e. Exhaust pipe size

f. CFM of air required for combustion and ventilation

g. Heat rejected to jacket water and lubricating oil - BTU/hr.

h. Heat rejected to room by engine and generator - BTU/hr.

i. Weatherproof enclosure details and certification of manufacturing method per specifications.

j. Data on all miscellaneous items supplied.

6. Furnish the number of copies required of the MANUFACTURER'S certified shop test record of the complete engine driven generator unit.

7. Warranty information.

8. Submit to the ENGINEER operating and maintenance data.

9. Submit to the ENGINEER the equipment MANUFACTURER'S Certificate of Installation, Testing, and Instruction.

10. Submit to the ENGINEER the written warranty as required below.

**1.05 TESTING:**

A. To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.

B. Design Prototype Tests: Components of the system such as the engine/generator set and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes and preproduction models, which will not be sold, shall have been used for the following tests. Prototype test programs shall include the requirements of NFPA 110 and the following:

1. Maximum power (KW).

2. Maximum motor starting (KVA) instantaneous voltage dip.

3. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-2240 and 16.40.

4. Governor speed regulation under steady-state and transient conditions.

5. Voltage regulation and generator transient response.

6. Fuel consumption at 1/4, ½, 3/4, and full load.

7. Harmonic analysis, voltage waveform deviation, and telephone influence factor.

8. Three-phase short circuit tests.

9. Alternator cooling air flow.

10. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.

11. Endurance testing.

C. Final Production Tests: Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:

1. Single-step load pickup.

2. Transient and steady-state governing.

3. Safety shutdown device testing.

4. Voltage regulation.

5. Rated power.

6. Maximum power.

7. Upon request, arrangements to either witness this test will be made, or a certified test record will be sent prior to shipment.

D. Site Tests: An installation check, start-up and load test shall be performed by the manufacturer's local representative. The Engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:

1. Fuel, lubricating oil, an antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.

2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery charger, generator strip heaters, annunciator, etc.

3. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage, and phase rotation.

4. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test. An external load bank shall be connected to the system if sufficient load is unavailable to load the generator to the nameplate KW rating.

**1.06 SPECIAL TOOLS AND SPARE PARTS**

A. Furnish one (1) set of all special tools required for normal operation and maintenance of the equipment being furnished. Furnish suitable steel tool chests complete with locks and duplicate keys.

B. The MANUFACTURER shall furnish two (2) complete spare replacement sets of all filter elements required for each generator unit supplied.

C. The MANUFACTURER shall furnish one (1) complete set of belts required for each generator unit supplied.

**PART 2 ‑ PRODUCTS**

**2.01 RATINGS**

A. The standby rating of the generator sets shall not exceed the MANUFACTURER's published prime rating by more than 10%. The gross engine horsepower required to produce the standby rating shall not exceed the MANUFACTURER's published continuous duty rating by more than 150 percent. Continuous duty rating shall be as defined in BS649 or DIN6270 but in no case shall it exceed the MANUFACTURER's published continuous duty rating for the engine as used in continuous rated pump drive applications. The gross engine horsepower required for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, radiator fan (for fan cooled models) and all accessories necessary to the unit's proper operation while operating at rated load and at a rotative speed not to exceed 1800 rpm.

B. The natural gas engine driven generator sets shall be capable of producing the specified standby kw rating for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the MANUFACTURER for the actual unit supplied.

C. The Natural Gas Engine/Generator Units shall have the KW ratings as indicated on the drawings, (240 volts, 3‑Phase, 4-wire, 60 Hertz) at 0.8 power factor with fan.

**2.02 ENGINES**

A. The engines shall be full compression ignition, four cycle, single acting, solid injection engine, either vertical or "V" type. Speed shall not exceed 1800 revolutions per minute at normal full load operation. Multi block engines are not allowed. The engine governor shall be electronic type with a +/- 0.5 percent accuracy.

B. Each engine shall be capable of satisfactory performance on natural gas.

C. The engines shall be capable of operating at light loads for extended periods of time and shall provide a means to reduce carbonization. Periodic cleaning of exhaust ports shall not be required.

D. The engines shall be equipped with fuel filters, lube oil filters, intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, engine driven water pump, and unit mounted instruments. Unit mounted instruments shall include a fuel pressure gauge, water temperature gauge, and lubrication oil pressure gauge. The engine shall be provided with low oil pressure, high water temperature, low coolant level and overspeed safety shutdowns of the manual reset type. Additional instruments and safety shutdowns shall be provided as noted herein.

E. Injection pumps and injection valves shall be a type not requiring adjustment in service and shall be of a design allowing quick replacement by ordinary mechanics without special natural gas experience. The engine shall have an individual mechanical injection pump and injection valve for each cylinder, any one of which may be removed and replaced from parts stock. Fuel injection pumps shall be positive action, constant‑stroke pumps, activated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pumps and valves shall be of heavy seamless tubing.

F. The fuel system shall be equipped with fuel filters having replaceable elements. Filter elements shall be easily removable from their housing for replacing without breaking any fuel line connections, or disturbing the fuel pump, or any other part of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps so that the fuel will have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies. The engine shall be equipped with a built‑in gear‑type, engine‑driven fuel transfer pump, capable of supplying fuel through the filters to the injection pump at constant pressure.

G. In addition to the standard fuel filters provided by the engine MANUFACTURER, there shall also be installed a primary fuel filter and a water separator in the fuel inlet line to the engine.

H. The engines shall be provided with removable wet‑type cylinder liners of close grained alloy iron, heat treated for proper hardness as required for maximum liner life. The cylinder block shall be a one piece stress relieved gray iron casting.

I. The engines shall have a gear‑type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and governor. Effective lubricating oil filters shall be provided and so located and connected that all oil being circulated is continuously filtered and cleaned. Filters shall be accessible, easily removed and cleaned and shall be equipped with a spring‑loaded by‑pass valve as an insurance against stopping of lubricating oil circulation in the event the filters become clogged. The engines shall have a suitable water cooled lubricating oil cooler.

J. The engines shall be provided with one or more engine mounted dry type air cleaners of sufficient capacity to protect effectively the working parts of the engine from dust and grit.

K. During each initial start of each engine, a system shall be provided to pre‑lube at low idle speed. When the internal oil pressure reaches a predetermined safe value, the engine will then increase to generator set operation speed.

L. Mounting: Each unit shall be mounted on a structural steel sub-base and shall be provided with spring type vibration isolators.

M. The engines shall be EPA certified.

**2.03 COOLING SYSTEMS**

A. The engines shall be furnished with a unit mounted radiator‑type cooling system having sufficient capacity for cooling the engine when the natural gas generator set is delivering full rated load in an ambient temperature not to exceed 110 degrees F. The engines shall be provided with a thermostatic valve placed in the jacket water outlet between the engine and the cooling source. This valve shall maintain the proper jacket water temperature under all load conditions. Total air restriction from the radiator shall not exceed 0.5 inches of water at both inlet and outlet. A flexible connecting section shall be provided between the radiator and discharge louver frame.

B. Closed circuit jacket water system shall be treated with a rust inhibiter as recommended by the engine MANUFACTURER.

C. The expansion tank of the radiators shall be fitted with a low water level switch and wired into the safety shutdown system of the unit.

**2.04 GENERATOR, EXCITER AND ACCESSORIES**

A. Rating: Each generator’s KW ratings shall be as indicated in these specifications, 0.8 p.f., 1800 RPM, 3 phase, 4-wire, 60 Hertz, 240 volts, 12 leads, with a maximum temperature rise of 130 degrees C (both armature and field) by resistance at full rated load in ambient air of 40 degrees C. The generator shall conform to NEMA Standard MG‑1.

B. Performance: The instantaneous voltage dip shall not exceed 15 percent of rated voltage when any load is applied. Recovery of stable operation shall occur within 5 seconds. Steady state modulation shall not exceed + ½ percent.

C. Construction:

1. The generators and exciters shall be dripproof, with split sleeve, or ball race bearings. A shaft‑mounted brushless exciter shall be a part of the assembly. The stator cores shall be built up of high grade silicon steel laminations precision punched, and individually insulated. Armature lamination followers and frame ribs shall be welded integral with the frames for support of the stator core. A directional blower shall be mounted on the unit to draw cooling air from the exciter and over the rotor poles and through louvered openings on the opposite end.

2. The exciters shall be a fast response type, with a rotating 3‑phase full‑wave bridge. The exciters shall have a low time constant and large capacity to minimize voltage transients under severe load changes.

3. The alternators shall be salient-pole, brushless, 12-lead reconnectable, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed stator for smooth voltage waveform. The insulation shall meet the NEMA standard (MG1-33.40) for Class H and be insulated with epoxy varnish to be fungus resistant per MIL 1-24092. Temperature rise of the rotors and stators shall be limited to 130° C. The excitation systems shall be of brushless construction controlled by a solid-state voltage regulator capable of maintaining voltage within +/- 0.25% at any constant load from 0% to 100% of rating. The regulators must be isolated to prevent tracking when connected to SCR loads, and provide individual adjustments for voltage range, stability and volts-per-hertz operations; and be protected from the environment by conformal coating.

4. Generator rotor poles shall be built up of individually insulated silicon steel punchings. Poles shall be wound and bonded with high strength epoxy resin. Cage connections to the amortisseur rings shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to the rotor shaft with bolts sized for the centrifugal forces on the rotor. Generator windings shall be braced for full line to ground fault currents, with solidly grounded neutral system.

D. Accessories and Attachments

1. Low Voltage Terminal Boxes: The generators shall have separate AC and DC low voltage terminal boxes with suitably numbered terminal strip for required connections.

2. Engine Block Heaters: Thermostatically controlled and sized to maintain the manufacturer’s recommended engine coolant temperature to meet start-up requirements of NFPA-99 and NFPA-110, Level 1. Power supply shall be 120 volts single phase.

3. Alternator Heater: Sized to prevent the accumulation of moisture or dampness in the alternator windings. Power supply shall be 120 volts single phase.

E. Generator Associated Controls:

1. Voltage Regulator:

i) The generator MANUFACTURER shall furnish a hermetically sealed, silicon controlled rectifier type voltage regulator employing a zener reference with a +1 percent regulation for the generator. The regulators shall include 3-phase voltage sensing, automatic short circuit protection and shall include automatic underfrequency protection to allow the generator to operate at no load at less than synchronous speed for engine start‑up and shutdown procedures. Switches and/or fuses shall not be used to provide this protection. An over‑voltage sensing module with manual reset shall be furnished with the regulator. A volts per Hz., sensing module shall be provided as part of the regulation system.

ii) A voltage adjustment rheostat for 5 percent voltage adjustment on the unit shall be provided.

iii) High voltage step‑down potential transformers shall be provided for the voltage regulator power input and sensing circuits if required.

2. Sustained Short Circuit: A permanent magnetic exciter shall be provided on the unit for sustaining a current of 300 percent during a short circuit, permitting the generator breaker to trip on overload. To prevent possible overheating of the armature windings, appropriate relaying shall be supplied to limit the fault to ten seconds. All current transformers required shall be supplied by the switchgear MANUFACTURER.

**2.05 SOUND ATTENUATED, WEATHER-PROTECTIVE ENCLOSURES**

A. The intent of this Specification is to provide the OWNER with sound attenuated, weatherproof type generator set enclosures complete in every detail and requiring no additional in-field modifications or assembly, except where specifically allows by these Specifications. The enclosures are to be accurately dimensioned so as to be in compliance with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) for clearance of all specified items included therein, and all applicable fire codes for a structure and application of this type.

B. The enclosures shall be of steel construction. The design and construction shall be modular in that the side panels, doors, and louvers shall be a minimum thickness of 14 gauge for all component parts. The roof of the enclosures shall meet or exceed the minimum gauge requirements specified but, in addition, shall be strengthened in such a manner as to support the largest commercially available exhaust silencer recommended by the MANUFACTURER for the applications.

1. Construction - All steel used in the construction of the enclosures shall be galvanized with painted finish. This sequence of metal forming, and final assembly of the enclosures must be noted on the drawings submitted for approval and a factory certification of this manufacturing process shall accompany the "as-built" drawings provided to the OWNER. Walls shall be minimum 14 gauge and the roof shall be minimum 12 gauge.

2. Doors - All doors on the enclosure shall be strategically located in areas as to allow ease of maintenance on the generator set and allow good access to and visibility of instruments, controls, engine gauges, etc. The doors shall be fitted with bolt-on, stainless steel hinges constructed with stainless steel hinge pins of a diameter not less than 0.25-inch (1/4-inch). Each door shall be fitted with flush-mounted, adjustable, key-lock latches. Enclosure shall be rated for 140 MPH constant wind. Certified calculations shall be provided.

3. Louvers - All louvers fixed and drainable with bird screen and shall be designed to prevent the entrance of driving rainwater, but shall have sufficient free area to allow for 120% of the total engine/generator cooling air requirements used in this application. Maximum air velocity shall be 700 CFM. MANUFACTURER shall submit air flow calculations to engineer for review.

4. Components - All components of the enclosures shall be assembled utilizing 0.375-inch minimum stainless steel bolts, nuts, and lock washers. In addition, watertight neoprene flat washers shall be used on all roof bolts.

5. The MANUFACTURER of the enclosures shall provide mounting brackets for the exhaust silencer specified. In addition, a tail pipe extension shall be provided, terminating in a horizontal plane and cut at a 45o angle to prevent the entrance of water. Stainless steel, seamless flexible exhaust tube and all necessary bolts, flanges, and gaskets to mate with the engine and the exhaust silencer shall be provided. The length of the flexible tubing shall be such that additional solid metal nipples or sections shall not be required to be provided as spacers between the engine exhaust port or the exhaust silencer.

6. Oil and Water Drains - All necessary fittings, hoses, shut-off valves, etc., shall be provided by the MANUFACTURER of the enclosure to facilitate lube oil and water drain at the exterior of the enclosures. In addition, engines equipped with crank-case breather tubes shall have this tube terminate at the exterior of the enclosure directly under the radiator air discharge louver.

7. Enclosure - The enclosures shall be rigidly mounted to generator support rails.

8. Under no circumstances shall the floor area or any of its parts be considered for cooling air intake or discharge requirements of the generator set or their associated equipment, nor shall its properties as a "heat-sink" or heat dissipating medium be utilized in any manner whatsoever in this application.

9. All items specified herein shall be supplied and prewired and/or preinstalled including, but not limited to the following:

i) Rain dress for exhaust pipe and tail pipe extensions. Rain dress shall prevent the entrance of rain and allow for the expansion and vibration of the exhaust piping without stress to the exhaust system. Rain dress shall be stainless steel and provided by the enclosure supplier.

ii) Coordination between CONTRACTOR and Supplier is mandatory and the equipment Supplier's instructions will be adhered to without exception.

10. The enclosures shall have acoustic installation that shall meet UL94 HF1 flame resistance standards.

11. The enclosures shall offer a -25 dB(A) sound reduction at 7 meters (23 ft.) using acoustic insulation.

12. Emergency Stop Pushbutton: Provide a NEMA 4X SS, Red, Mushroom-head emergency pushbutton that will immediately stop the generator upon activation. Provide a placard above the pushbutton to read “Generator Emergency Shut Down”. Refer to drawings for pushbutton and placard location and details.

**2.06 EXHAUST SYSTEMS**

A. Exhaust Silencers - A critical type, side inlet, end outlet, Maxim M-51, or Silex JB silencer and a flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the MANUFACTURER's recommendation. Mounting shall be provided by the CONTRACTOR as required. The silencers shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine MANUFACTURER. So called "spiral" or truck mufflers are disallowed and will not be considered as equal to the industrial quality silencers specified above.

B. The silencers shall be fitted with a tail pipe extension terminating at a 45o angle to prevent the entrance of rainwater. It shall also be fitted with an expanded metal bird screen.

C. Rain Skirt - At the point where the exhaust pipe flexible tubing penetrates the roof of the enclosure, a suitable "rain skirt" and collar shall be provided by the MANUFACTURER. It shall be designed to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system. This detail must appear on the drawings submitted for approval.

**2.07 AUTOMATIC STARTING SYSTEM**

A. Starting Motors - A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be 12 volts.

B. Automatic Control - Fully automatic engine start-stop controls in the generator control panels shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and loss of engine coolant. Alarms for approaching high water temperature and impending low oil pressure shall also be included. Controls shall include a 45-second single cranking cycle limit with lockout or a cyclic crank system with lockout and overcrank protection.

C. Batteries - A lead-acid storage battery set of the heavy duty natural gas starting type shall be provided. Battery voltage shall be 12 volts, and the battery set shall be rated no less than 225 ampere hours. Necessary cables and clamps shall be provided.

D. Battery Trays - battery trays shall be provided for the batteries and shall conform to NEC 480-7(b). It shall be constructed of fiberglass and so treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over of battery electrolyte shall be contained within the tray to prevent a direct path to ground.

E. Battery Chargers - A current-limiting, automatic 12 volt DC charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than ten (10) amperes. Chargers shall be wall mounting type in NEMA 1 enclosure, and U.L. listed as an industrial control panel. The chargers shall be as manufactured by LaMarche per NFPA 110 and U.L. 508. The chargers shall be mounted and wired within the enclosure for the generator set by enclosure manufacturer.

**2.08 MAIN LINE CIRCUIT BREAKERS**

1. Type - Main line, 600 volt, 100% rated, molded case circuit breaker mounted upon and sized to the output of the generator shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions.

Note: The manufacturer may size the main line circuit breaker based on the controller’s protective scheme (when said controller meets UL requirements). However, in all cases, the breaker shall operate in a manner to protect both the output conductors and the transfer switch.

B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electric Manufacturers Association, and National Electrical Code.

C. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

D. Circuit breaker shall have battery voltage operated shunt trip wired to safety shutdowns to open the breaker in the event of engine failure.

E. The circuit breakers shall be equipped with an auxiliary contact for remote annunciation of breaker position.

F. The rating of the circuit breakers shall allow the starting of full generator SKVA.

G. The circuit breaker enclosure, together with all specified circuit breakers, shall be designed for the specific generator set specified and be equipped with an isolated neutral conductor bus, rear copper stabs, or load cable lugs and be finish painted to match the generator set.

**2.09 GENERATOR CONTROL PANELS**

A. Type - A generator-mounted, NEMA 1 type, vibration isolated, 14-gauge steel control panel shall be provided for the generator set. The panel must be capable of facing any direction when mounted upon the generator set. Panel shall contain, but not be limited to, the following equipment:

1. Frequency meter, 4-1/2", dial type, 55-65 hertz.

2. Voltmeter, 4-1/2", 2% accuracy.

3. Ammeter, 4-1/2", 2% accuracy.

4. Ammeter (4 position) and voltmeter phase selector switches (individual).

5. Automatic starting controls as previously specified.

6. Voltage level adjustment rheostat with locking knob.

7. Dry contacts for remote alarms wired to terminal strips.\

8. Five (5) individual fault indicator lights for low oil pressure, over temperature, overspeed, battery charger low, and low coolant level. All lights to be pressed-to-test type, 1" diameter.

9. Four (4) position function switch marked "auto", "manual", "off/reset", and stop".

10. Battery charging voltmeter, running time meter, electric oil pressure gauge, and electric water temperature gauge, all 2" size (nominal).

11. Auxiliary relay, 3PDT, operating each time generator runs, 10 amp contacts brought out to terminal strip.

12. Two (2) alarms and indicators for approaching low oil pressure and high water temperature. Each light to be press-to-test type, 1" diameter.

13. Alarm horn and silence switch with cleared-fault resound circuitry. Alarm shall sound on impending shutdown.

14. Governor motor control switch with cleared-fault resound circuitry.

15. Panel illumination lights and switch.

16. An engraved, identification plate listing dealer's name, address, phone number, etc., as well as unit model and serial number shall be mounted on the panel face in a prominent location and be of a size easily read by maintenance personnel.

B. Digital or solid state meters or metering devices shall be acceptable as a substitute for the electromechanical devices specified.

C. Engraved, screw-on type nameplates will identify each function indicated without abbreviation of function description. So-called international symbols will not be acceptable substitutes for this mandatory requirement.

D. Timing Functions - All control panel timing functions shall be accomplished by metal encased, solid-state, plug-in timing relays with 2PDT output contacts rated for ten (10) amperes. All solid-state time delay relays shall be reverse polarity protected and shall not function or be damaged by the application of improper polarity. Open printed circuit board type time delay circuits will not be accepted.

E. Control Relays - All control relays shall be the 3PDT plug-in type with .187QC blade terminals rated for (10) amperes. Each relay shall be equipped with a manual push to operate check button, L.E.D. or neon visual indicator, and see-thru dust cover for contact inspection and protection. Exposed contact and octal base plug-in relays are not acceptable.

F. Relay Sockets - All relay sockets shall be of the molded thermoplastic type, suitable for snap mounting on standard D.I.N. rail. Relay sockets will have wire clamp type terminals for secure wire connections, and one (1) piece bus bar connectors between the actual relay blade and wire clamp terminal. Relay sockets shall be rated for fifteen (15) amperes at 300V. Printed circuit board type relay sockets and relay sockets with push-on quick connect terminals are not acceptable.

G. It shall be possible to adjust alternator output voltage at the control panel.

* 1. **FUEL SYSTEMS**

A. Refer to Mechanical specifications for natural gas delivery requirements.

**2.11 AUTOMATIC TRANSFER SWITCHES**

A. The rating of the automatic load transfer switches (ATS) shall be as indicated on the drawings. The ATS’s shall be 3-pole with a solid neutral. The ATS’s shall be NEMA 3R stainless steel construction. The withstand and closing ratings with any overcurrent device shall be 10,000 RMS symmetrical amperes minimum.

B. The automatic transfer switches shall be mechanically held on both the emergency and the normal side, and rated for continuous duty in the above described enclosure. The switches shall be solid-state, electronically controlled, double throw with the main contacts rigidly and mechanically interlocked to ensure positive positioning of power switches. A manual operator must be provided to enable one (1) hand manual operation which, when utilized, can provide a neutral position for servicing operations.

C. The automatic transfer switches shall be a single motor operated circuit breaker type with interpole barriers and arc chutes. So-called linear actuated or solenoid operated switches are approved only when manufactured by the Generator MANUFACTURER. All elements of the drive system must be replaceable from the front of the switch, and the power switching devices must be replaceable without removal of the connecting cables.

D. The transfer switches shall be listed under U.L. 1008, in a NEMA 3R stainless steel enclosure and shall be from the same manufacturer as the generator set provided under this contract.

E. Accessories - The automatic load transfer switches specified shall include the following accessories:

1. Full phase protection. Solid-state phase monitor shall be field adjustable, close differential type, with 85-100% pick-up and 75-98% drop-out. A single adjustment shall set all phases.
2. Solid-state voltage and frequency monitor on generator output to prevent transfer prior to proper output parameters, adjustable 85-100% of generator rated voltage and frequency, with adjustable drop-out of 75-85% of pick-up setting.

3. Adjustable, solid-state, 0.5 to 6 seconds time delay on engine starting to override momentary outages and nuisance voltage dips.

4 Adjustable, solid-state, 2 to 30 minutes time delay on retransfer of load to normal.

5. Adjustable, solid-state, 2 to 30 minutes cool-down timer wherein the generator set runs unloaded after retransfer to line.

6. Motor load decay time delay, adjustable for 1.5 to 15 seconds and operating on transfer to either source.

7. Adjustable, solid-state, 0.5 seconds to 5 minutes time delay on transfer to emergency source after verification of emergency source voltage and frequency.

8. Test switch to simulate normal power failure, heavy duty, oil tight, pushbutton type with momentary contacts and override circuitry to revert to normal power if emergency source should fail during test.

9. Motor circuit disconnect switch.

10. Three (3) pilot lights, to indicate the normal and emergency position of the transfer switch, and mode selector switch in "off" position.

11. Engine starting contacts to provide for generator starting.

12. One (1) auxiliary S.P.D.T. contact for indication of emergency position and one (1) S.P.D.T. auxiliary contact on normal position.

13. Plant exerciser to start and run the generator set with or without load (in-field switchable) each 168 hours for a 30 minute interval.

14. Four (4) position mode selector switch marked "test", "auto", "off", and "engine start".

15. Equipment grounding lug.

16. Cable connection lugs, cu/al type for all conductors.

F. Nameplates: Nameplates shall be rigid laminated phenolic with black surface and white core. Each nameplate shall be fastened to the compartment door with two (2) screws. The unit nameplates shall be 1” x 3” minimum with 1/8” high characters. Abbreviations are not acceptable.

**PART 3 ‑ EXECUTION**

**3.01 SERVICES**

A. Furnish the services of a competent and experienced MANUFACTURER'S field service technician who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than two (2) days in two separate visits to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed.

B. At least one (1) of the two (2) days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the OWNER and shall take place during plant start‑up and acceptance by the OWNER.

C. Three final copies of operation and maintenance manuals specified must be delivered to the ENGINEER prior to scheduling the instruction period with the OWNER.

**3.02 PAINTING**

A. The engine generator set and associated equipment shall be shop primed and finish coated in accordance with the MANUFACTURER's standard practice prior to shipment. An adequate supply of touch‑up paint shall be supplied by the MANUFACTURER.

**3.03 TESTING**

A. The engine‑generator sets shall be given the MANUFACTURER'S standard factory load test prior to shipment.

B. Prior to final acceptance of the generator set, all equipment furnished under this Section shall be field tested per NFPA 110 to show it is free of any defects and the generator set can operate satisfactorily under full load test using resistance type load banks (brine tanks not acceptable). Test shall be for four (4) continuous hours. Any defects which become evident at this time shall be corrected before acceptance.

C. An all‑in‑place static alignment check of all rotating components shall be made prior to first start‑up, after unit is secured in place and all final connections are made.

D. A final alignment check and/or adjustment shall be made after the machines have run four (4) to six (6) hours with its normal connected load.

**3.05 SYSTEM SERVICE CONTRACT**

A. The supplier of the standby power systems must provide a copy of and make available to the OWNER his standard service contract which, at the OWNER'S option, may be accepted or refused. This contract will accompany documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc., submitted for approval to the designing ENGINEER. The contract shall be for the complete services rendered over a period of one (1) year. The first year’s service shall be included in the contract price.

**3.06 WARRANTY**

A. Equipment furnished under this Section shall be guaranteed against defective parts and workmanship under terms of the MANUFACTURER'S and dealer's warranty. But, in no event, shall it be for a period of less than five (5) years (comprehensive) from date of initial start‑up of the system and shall include labor, parts and travel time for necessary repairs at the job site. Running hours shall not be a limiting factor for the system warranty either by the MANUFACTURER or the supplying dealer. Submittal data received without written warranties as specified will be rejected in their entirety.

END OF SECTION

**SECTION 16941**

**PUMP STATION ELECTRICAL PROVISIONS**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

A. Furnish all labor, materials, equipment and incidentals required for complete electrical system for the rehabilitation or construction of the City of Clearwater’s sewage pump stations as hereinafter specified and shown on the Drawings.

**1.02 CODES**

A. All material and installation shall be in accordance with the 2017 edition of the National Electrical Code (N.E.C.), and NFPA 70 code articles that are applicable to the minimum electrical installation requirements for sewer lift stations.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

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

B. Materials and equipment used shall be Underwriters Laboratories, Inc. listed and conform with applicable standards of NEMA and ANSI.

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

**2.02 RACEWAYS AND FITTINGS**

1. All raceways installed above grade shall be rigid aluminum conduit.
2. All raceways installed below grade shall be rigid PVC conduit.
3. Raceways containing pump cables, float cables and pressure transducer cable entering the wet well shall be rigid PVC conduit.
4. Raceways installed below grade for antenna coaxial cable shall be PVC schedule 80 conduit.
5. Where conduit is cut, the inside edge shall be reamed smooth to prevent injury to conductors.

**2.03 CONDUCTORS**

A. Conductors shall be copper. Power circuits shall have 600 volt insulation (Underwriters' approved Type THWN). Conductors shall be color coded in accordance with the NEC.

B. All motor controls, remote indicating lights, alarm circuits and metering loops shall be wired with #12 stranded copper conductors. Insulation shall be THHN. An overall PVC jacket shall be provided for multi-conductor cables where required by the drawings.

**2.04 MISCELLANEOUS EQUIPMENT**

A. Boxes and Fittings:

1. Junction box utilized for termination of pump cables, float cables and pressure transducer cable shall be stainless steel as manufactured by Crouse‑Hinds Co., Appleton Electric Co., or approved equal.

2. Conduit hubs shall be used for all outdoor conduit terminations and shall be as manufactured by Meyers Electric Products, Inc., Raco Div., Appleton Electric Co., or approved equal.

3. Conduit sealing bushings shall be O.Z./Gedney Type CSB or approved equal.

**2.05 PUMP CONTROL SYSTEM**

A. Panel Construction:

1. The electrical control equipment shall be mounted within a NEMA Type 4X, dead front enclosure, constructed of not less than #14 gauge stainless steel. Enclosure shall be provided with aluminum sunshields on sides and top of enclosure. The enclosure shall be equipped with an inner aluminum door and shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Outer panel door shall be equipped with door stop.

B. Panel Components:

1. Enclosure: Enclosure shall be NEMA 4X by Hoffman or approved equivalent with a heavy-duty padlock hasp. Enclosure shall be 316 Stainless Steel.

2. Inner Safety Door: Panel shall include one aluminum inner safety door, 12 gauge nominal thickness (minimum) with 3/4-inch, 90 degree break bend on all edges for rigidity; full length aluminum hinge; positive twist lock handle; safety latch to keep door open during maintenance.

3. Main Circuit Breaker: The panel shall include main circuit breaker sized as indicated for main power disconnect. The breaker shall be mounted on the subpanel with handle through the inner door.

4. Emergency Circuit Breaker: The panel shall include an emergency circuit breaker sized as indicated for disconnecting emergency source. The breaker shall be mounted on the subpanel with handle through the inner door.

5. Alarm System: The panel shall include a vapor-proof red light mounted on the exterior of the cabinet as shown on the drawings for alarm visual indication and a weatherproof horn mounted on the exterior of the cabinet. The alarm light and horn shall be prewired to the DataFlow TCU to operate on alarm conditions via signals from both the TCU and associated cabinet relays. An alarm silence push button labeled “Alarm Silence” shall be mounted on the outside of the enclosure and shall be wired to the DataFlow TCU which will silence the horn under all conditions, and automatically reset when the alarm condition is corrected. The alarm system shall be manually reset.

NOTE: Alarm light to be designed and positioned to provide unobstructed access for changing light bulb.

6. Convenience Receptacle: The panel shall have GFI (ground fault interrupter) type convenience receptacle mounted on the inner door to provide plug-in 120V power with ground fault protection.

7. Seal Failure Indicator: The panel shall have a seal failure (leak detector) indicator pilot light for each pump. These pilot lights shall be operated by moisture sensing monitors which are signaled by probes supplied in each pump. Momentary test switches to simulate seal failure to be included and so marked with permanent weatherproof nameplates.

8. All motor branch circuit breakers, motor starter and control relays shall be of highest industrial quality, securely fastened to the removal back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

9. A magnetic air circuit breaker, Type FA as manufactured by Square D Company, or approved equal, shall be furnished for the pump motor. Circuit breaker shall be adequately sized to meet the pump motor and station operating conditions.

10. A mechanical disconnect mechanism shall be installed on each circuit breaker to provide a means of disconnecting power to the pump motor. These may protrude through inner aluminum door.

11. Pump starters shall be full voltage type rated for 3-phase operation. Overloads shall be provided and be class 20 bi-metallic. Two (2) auxiliary contacts and line and load termination points shall be provided. The starter ratings shall be as indicated on the drawings, however, if the final selection of the pump motor provided exceeds the capacity of the starter size indicated on the drawings the contractor shall provide the next higher starter size at no additional cost. The contractor shall indicate the proper selection of the starter size (based on pump motor submitted and operation on a 208V, 3-phase power source) during the shop drawing process. The starters shall be Allen-Bradley, Square D or approved equal.

12. Relays shall be 3PDT with 10 ampere contacts. Coil voltages as per the drawings. Relays shall be Square-D Class 9001 Type KU13 with appropriate voltage code.

13. Motor Ground Fault Relays shall be 120V with auto reset. Bender Cat#RCM465Y.

14. Phase Monitor shall be 208V, adjustable, DPDT. Diversified Electronics Cat# SLA-230-ALE.

15. Intrinsically Safe Relays for float switches shall be 24V AC, Diversified Electronics Cat# ISO-24-AFN.

C. Operating Controls and Instruments:

1. All operating controls and instruments shall be securely mounted on the control compartment door. All controls and instruments shall be clearly labeled to indicate function.

2. Indicator lamps shall be mounted in oil-tight modules, as manufactured by Allen-Bradley, Square D or approved equal. Lamp modules shall be equipped to operate at 120 volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing lamp module from its mounted position.

3. Control and installation schematics are shown on the drawings. It is the intent of these specifications that the existing Data Flow TCU units will be reused.

F. Manufacturer:

1. Control Panel shall be manufactured by Xylem, Unitron Controls, C2i Controls or approved equal.

G. Installation:

1. Unless otherwise noted on the Drawings, top of cabinets shall be mounted six feet above grade, properly aligned and adequately supported independently of the connecting raceways.

2. All wiring in the control panel shall be neatly formed, grouped, and identified to provide a neat and orderly appearance.

3. All nameplates shall be properly secured.

**2.06 SUBMERSIBLE PRESSURE TRANSDUCER**

A. The level sensor for controlling the sewage level in wet wells shall consist of a submersible pressure-sensing element, encased in a plastic body watertight case. It shall be supplied with 40 feet of cable that shall have a ropellant jacket with a breather system.

B. The submersible pressure transducer shall have a 4-20mA output and have a range of 0-23.1 feet (10 psi).

C. The submersible pressure transducer shall be model SLX130-M-10-40R-B as manufactured by Contegra.

**2.07 FLOATS**

1. Levels shall be sensed by polypropylene weighted floats. The floats shall be heavy-duty type, with hermitically sealed non-mercury switches inside. Weights shall be 20 ounces minimum. The floats shall be secured at the top of the wetwell via a stainless steel wall mount bracket designed specifically for float installation. The floats shall be B/W 7000 Series or approved equal.

**2.08 RAIN GAUGE**

A. Provide tipping bucket rain gauge constructed of high impact UV-protected plastic. For each 0.01 inch or 0.25 mm of rainfall through the rain gauge’s orifice, the rain gauge’s sensor mechanism shall activate a sealed reed switch that produces a contact closure. Provide rain gauge with Provide rain gauge with 4-20mA output.

B. Rain gauge shall be Global Water model RG200 with RG700 Pulse to Current Converter Module (4-20 mA Output).

**2.10 ANALOG LOOP SUPPLY AND INTRINSICALLY SAFE RELAY**

1. The submersible pressure transducer shall be provided with a regulated power supply from the DataFlow TCU.
2. The pressure transmitter shall be isolated from the hazardous area by an intrinsically safe relay, Stahl catalog # 9001/012-80-110-10.

**2.11 SURGE PROTECTION DEVICE (SPD)**

A. The pump control panel shall be protected by a surge protection device compatible with a 208V, 3-phase, 4-wire system. The SPD shall have a NEMA 4X enclosure. The SPD shall be an Advanced Protection Technologies (APT) Cat# TE/2XF/4X.

**PART 3 - EXECUTION**

**3.01 CONDUIT INSTALLATION**

A. Where conduits enter or leave all outlet boxes, cabinets safety switches, tap boxes, motor controllers, etc., threaded hubs shall be used. Bushings 1-inch and larger shall be of an approved insulated type. Unless otherwise indicated, conduit 2-inches shall be supported at intervals not exceeding ten (10) feet.

B. During construction, all installed raceways shall be temporarily plugged or otherwise protected from the entrance of moisture, dirt, trash, plaster, moisture, etc., through neglect of the CONTRACTOR to so protect them, shall be replaced by the CONTRACTOR without additional expense to the Owner. No kinked, clogged or deformed raceways will be permitted on the job. Raceways shall be cut to proper length so that ends will fit accurately in the outlets. Where raceways cross building expansion joints, a suitable raceway expansion fitting shall be used.

C. Size of raceway shall not be less than NEC requirements, but in no case shall be less than indicated on the Drawings. Combining of circuits, other than detailed, will not be permitted. The CONTRACTOR shall install larger size raceways than detailed where there is excessive length of unbroken run or excessive number of bends.

D. Bends in metallic raceways shall be made while "cold" and in no case shall the raceways be heated. Raceways shall not be bent through more than 90º. The radius of bends shall not be less than six (6) times the internal diameter of the raceway. Not more than four (4) (equivalent 90º) bends will be permitted between outlets, the bends at the outlets being counted.

E. Raceways shall be properly aligned, grouped and supported. Exposed raceways shall be installed at the right angles to or parallel to the principal structural members. Concealed raceways, unless otherwise indicated, may take the most direct route between outlets. Raceways shall be firmly held in place. Raceways shall run to avoid trapping wherever possible. Where areas are indicated for future openings, foundations, etc., all raceways shall be run around such areas. The CONTRACTOR shall provide necessary inserts in poured concrete areas and shall furnish and install all necessary sleeves through walls, floors and roofs for passage of raceways. Sleeves through roofs and/or exterior walls shall be properly sealed by the CONTRACTOR against entrance of moisture, etc., into the building. Where necessary repairs to the building structure using material in no way inferior to that originally installed and using labor skilled in the trades involved.

**3.02 CONDUCTORS**

A. Taps and attachments of fittings and lugs shall be electrically and mechanically secure. Approved solderless lugs and connectors shall be sued for all conductors with 2-bolt type being used for sized No. 4/0 and larger. There shall be plenty of slack cable in boxes, outlets and cabinets to ensure that there is no binding at the bushings. All lugs shall be of the correct sizes for the conductor in order to fit the conductor into a lug.

B. No splices of any type will be allowed. Conductors shall be continuous from termination point to termination point.

**3.03 GROUNDING**

A. The entire electrical system shall be completely and effectively grounded as required by the NEC and as specified hereinafter.

B. All metallic raceways shall be mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment. Metallic raceways entering the motor control center control panels or other electrical boxes shall be grounded to the appropriate ground bus. All metallic raceways shall be electrically continuous throughout the entire conduit system. Bond wires shall be used in exterior concrete pull boxes.

**3.04 SUPPORTS**

A. The CONTRACTOR shall furnish and install all necessary supports for properly mounting all electrical equipment and raceways. Such supports shall be fabricated and installed in a neat and workmanlike manner, and care shall be taken that at no time shall any portion of the building structure be overloaded. Should the building structure sustain damage through carelessness or through failure of the CONTRACTOR to properly support and install the electrical equipment, the CONTRACTOR shall bear all costs involved in repairing or replacing such installation.

B. All steel shapes exposed to the weather shall be galvanized after all cutting, drilling, and/or welding is done. All shop connections shall be welded or riveted and all field connections shall be bolted on all outdoor structures. Where the field cutting or drilling of galvanized steel is necessary, the CONTRACTOR shall apply one (1) coat of priming paint and one (1) finish coat of aluminum and oil paint.

**3.05 TESTS AND CHECKS**

A. The following minimum tests and checks shall be made prior to the termination of any field wiring.

1. Megger terminals and buses after disconnecting devices sensitive to megger voltage.

2. A 1,000V DC megger shall be used for these tests.

3. The first test shall be made with main circuit breaker closed and all remaining breakers open. A second test shall be made with all circuit breakers closed.

4. The test results shall be recorded and forwarded to the Engineer for his review. Minimum megger readings shall be 100 megohms in both tests.

B. The following shall be done before energizing any motor control center or control panel.

1. Remove all current transformer shunts after completing the secondary circuit.

2. Install overload relay heaters based on actual motor nameplate current.

3. Vacuum clean all interior equipment.

**3.06 SPARE PARTS**

A. Spare parts shall be furnished to permit convenient and quick service restoration upon failure of a particular unit and shall include the following: One set of spare parts for each pump station.

1. One (1) TAC Pack Telemetry Control Unit (TCU)

2. One (1) power supply with battery

4. One (1) box of fuses of each type

5. One spare surge suppressor.

6. One spare seal failure relay.

7. One spare float.

8. Four spare overload relays.

B. The spare parts shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity, and temperature.

**3.07 WARRANTY**

A. Warranty - The SYSTEM SUPPLIER shall warrant all hardware and software provided under this contract against all defects in material and workmanship for a period of one year. The system supplier shall warrant the telemetry software to be free of defects for as long as it is operational in the county. The SYSTEM SUPPLIER shall also provide free updates to this software for the life of the system. The function modules utilized in the remote terminal units shall carry an additional two year return‑to‑factory warranty. The two year return‑to‑factory warranty shall also cover damage due to lightning.

**3.08 SERVICE**

A. Service - The SYSTEM SUPPLIER shall offer full factory support of the installed system through the use of factory employees. Service representatives who are not direct employees of the SYSTEM SUPPLIER, or who are not specifically trained in the service of radio telemetry systems shall be unacceptable. The customer shall have 24 hour per day access to service personnel through the use of a pager. The SYSTEM SUPPLIER shall keep a fully‑configured replacement CPU at their premises at all times. This unit shall be made available as a temporary replacement in the event of the system computer failure. Supplier must be able to install replacement computer within 24 hours of notification of failure. This emergency spare computer shall be offered at no charge during the warranty period and shall be offered for only transportation and labor charges after the warranty has expired. The Owner agrees to take all necessary steps to assure prompt repair of the failed.

**3.9 TRAINING**

A. Training - The following tabulation indicates the required minimum training required from the successful bidder. Two full (8 hour) days at the Owner’s facility during the time of system start‑up. One full (8 hour) day 2 to 3 weeks after system start‑up.

**3.10 ARC FLASH LABELING**

1. The Contractor shall be responsible for providing an Arc Flash Label as required for each piece of equipment as defined by the latest adopted edition of NFPA 70E. The Contractor shall employ a subcontractor or subconsultant if required to gather the required information to ascertain the Arc Flash label parameters.

END OF SECTION

Appendix C

**Pump Station Start Up Report**

Pump Station Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Address: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Site

Pump station properly located on site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Grading per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Driveway per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Fencing per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hose bibb w/BFP properly installed with BFP inspection: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Landscaping per plans and in good condition: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Site Comments: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Structural**

Valve vault per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Access cover per plans and load rated for traffic areas: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Valve vault wall and pipe seals water tight: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Valve vault Coatings per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Valve vault drains where required: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wet well diameter and depth per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wet well access cover per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wet well wall and pipe seals water tight: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wet well coating per plans and includes floor and under top slab: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Vent screen installed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Influent/effluent lines are correct size, location and elevation per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wet well conduits are sealed with duct seal in wet well junction box: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural Comments: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Mechanical**

Piping and valves installed per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bypass connections are the proper size and configuration: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Buried valves have valve boxes, pads and ID tags: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Guide rails (straight, plumb, braced): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cables/chains properly stowed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pull pumps from wet well:

Proper rail/pump operation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pump No. 1:

Manufacturer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Model: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Serial Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Phase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HP: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check for impeller free rotation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check Impeller Rotation (cw/ccw): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pump No. 2:

Manufacturer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Model: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Serial Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Phase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HP: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check for impeller free rotation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check Impeller Rotation (cw/ccw): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pump No. 3:

Manufacturer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Model: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Serial Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Phase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HP: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check for impeller free rotation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check Impeller Rotation (cw/ccw): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reset pumps in wet well. Check for proper seating: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Electrical**

Control panels per plans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Interior of panels clean and dry: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Does liquid level ever drop below top of pump: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

All connections tight: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check level controls for proper operation (transducer): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check emergency float operation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Check alarms/Does alarm signal transmit over SCADA: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Electrical Comments: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

See pump startup report by pump manufacturer for detailed pump information

**Drawdown Calculations**

Wet well diameter D (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

L1-Measure down top of cover to center of volute (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

L2-Measure down top of set well cover to centerline of gauges (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pump No. 1

Start-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Finish-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Time pumping (minutes): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pressure gauge while pumping: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_PSI

Volume=7.48 gal/ft3 X 3.1416 X D2/4 X (Finish-Start) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Gallons

Rate= Volume (gallons)/Time pumping (minutes)= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gallons/minute

Static Head = L1 – L2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Static head in feet

Pressure in feet = Gauge pressure (psi) X 2.31 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gauge pressure in feet

TDH total dynamic head = static head + gauge pressure in feet = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TDH feet

Pump No. 2

Start-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Finish-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Time pumping (minutes): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pressure gauge while pumping: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_PSI

Volume=7.48 gal/ft3 X 3.1416 X D2/4 X (Finish-Start) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Gallons

Rate= Volume (gallons)/Time pumping (minutes)= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gallons/minute

Static Head = L1 – L2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Static head in feet

Pressure in feet = Gauge pressure (psi) X 2.31 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gauge pressure in feet

TDH total dynamic head = static head + gauge pressure in feet = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TDH feet

Pump No. 3

Start-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Finish-Measure down top of cover to top of liquid (ft): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Time pumping (minutes): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pressure gauge while pumping: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_PSI

Volume=7.48 gal/ft3 X 3.1416 X D2/4 X (Finish-Start) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Gallons

Rate= Volume (gallons)/Time pumping (minutes)= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gallons/minute

Static Head = L1 – L2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Static head in feet

Pressure in feet = Gauge pressure (psi) X 2.31 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gauge pressure in feet

TDH total dynamic head = static head + gauge pressure in feet = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TDH feet

Pump Startup Report

Flygt