

## MOORE COUNTY PUBLIC WORKS DEPARTMENT

### Replace Sanitary Sewer Lift Station 3-3 Project

#### TECHNICAL SPECIFICATIONS

**Project Drawings:** "Lift Stations 3-3 and 15-1 Replacements" as sealed by C. Brian Patnode, PE, and Randall W. Sturgill, PE.

**Standards and Specifications:** Moore County standards and specifications are available on the Moore County website at the following address:

*Moorecountync.gov/Departments/Public Works/Engineering under Policies and Specifications*

Pay particular attention to the following sections:

- General Conditions
- General Construction
- Wastewater Gravity System
- Wastewater Lift Stations and Force Mains

These documents are included as a part of the contract documents for this project.

**Wastewater Prefabricated Pumping Station:** Refer to specification section below.

**Wet Well:** Wet Well shall be 6 ft diameter precast concrete and shall meet the specifications in the Wastewater Gravity System standard under "Wet Well Requirements and Design", which includes but is not limited to the following Structure:

- Epoxy Coat wetwell walls and piping
- Reinforced concrete cover constructed to accommodate the above ground station pump station components and enclosure, reinforced around openings as shown on the drawings.
- Semi-circle access cover and pump frames shall be double leaf aluminum diamond pattern floor hatch certified for H 20 loading. Leaves shall open 90 degrees attached with Stainless steel hinges that lock in the open position and vinyl grip handles to release lock for closing.
- Safety landing grating constructed of stainless steel with coated orange or safety yellow by "Retro-grate" or equal.

**Pump Station Appurtenances:** Furnish and install all pump station components and appurtenances as shown and specified in Moore County's "Wastewater Lift Stations and Force Mains" standard including but not limited to the following as:

- Ventilation Equipment
- Auto-dialer (remove and reinstall the existing Auto-dialer)
- Flow monitoring equipment (not required for this size station)
- Alarm light and horn
- Standby Power

**Mobilization:** Includes the mobilizing on-site of equipment and storage and placement of materials for the project in the project area or other approved area. This bid item shall be no more than 3% of the total price bid.

**Demolition:** The Demolition Work bid item includes the removal and disposal of the existing pump station, piping electrical components and incidentals as shown and specified. The intent of the demolition work is to remove the existing facilities as needed to provide the proposed facilities shown.

**Water Service Relocation:** Contractor shall relocate the existing water service as needed to perform the Work.

**By-pass Pumping:** The Contractor shall provide temporary bypass pumping during the duration of the project.

**Damage to Existing Facilities:** Contractor shall repair all damage caused by him to the satisfaction of the Owner as specified in the General Conditions.

**Painting:** Performed by Contractor per Moore County Standard Specifications. Color shall meet industry standards.

**Submittals:** Submit shop drawings of materials to be used to perform the Work. Submit a dimensional layout drawing precisely labeling the dimensions of all materials with allowance for gaskets, etc.

**Hardware:** All hardware and gaskets shall be as specified in the Moore County Public Works standards (available at *Moorecountync.gov/departments/public works/engineering/Policies and Specifications-Water Distribution*).

# MOORE COUNTY PUBLIC WORKS DEPARTMENT

## Replace Sanitary Sewer Lift Station 3-3 Project

### TECHNICAL SPECIFICATIONS WASTEWATER PREFABRICATED PUMPING STATION

#### 1. SYSTEM DESCRIPTION

- A. Contractor shall furnish and install one factory built above ground, automatic pump station at each pump station site to replace the existing pump station, wetwell, controls and appurtenances as shown on the drawings. The station shall be complete with all equipment specified herein; factory assembled in a fiberglass reinforced polyester resin enclosure.
- B. In addition to the station enclosure, principal items of equipment shall include two horizontal, self-priming, centrifugal sewage pumps, V-belt drives, motors, internal piping, valves, motor control panel, automatic liquid level control system, and internal wiring.
- C. Factory built pump station design, including materials of construction, pump features, valves and piping, and motor controls shall be in accordance with requirements specified herein

#### 2. REFERENCES

Publications listed below form part of this specification to extent referenced in the text by basic designation only. Consult latest edition of publication unless otherwise noted.

1. American National Std. Institute (ANSI) / American Water Works Assoc. (AWWA)
  - a. ANSI B16.1 Cast iron pipe flanges and flanged fittings.
  - b. ANSI/AWWA C115/A21.51 Cast/ductile iron pipe with threaded flanges.
  - c. ANSI 253.1 Safety Color Code for Marking Physical Hazards.
  - d. ANSI B40.1 Gages, Pressure and Vacuum.
  - e. AWWA C508 Single Swing Check Valves.
2. American Society for Testing and Materials (ASTM)
  - a. ASTM A48 Gray Iron Castings.
  - b. ASTM A126 Valves, Flanges, and Pipe Fittings.
  - c. ASTM A307 Carbon Steel Bolts and Studs.
  - d. ASTM A36 Structural Steel.
3. Institute of Electrical and Electronics Engineers (IEEE)
  - a. ANSI/IEEE Std 100 Standard Dictionary of Electrical Terms.
  - b. ANSI/IEEE Std 112 Test Procedure for Polyphase Induction
  - c. IEEE Std 242 Protection of Industrial and Control Power Systems.
4. National Electric Code (NEC) / National Electrical Manufacturers Assoc. (NEMA)
  - a. NEC National Electric Code.
  - b. NEC 701 National Electric Code article 701.
  - c. NEMA Std MG1 Motors and Generators.

5. Miscellaneous References
  - a. Ten-State Standards Recommended Standards for Sewage Works.
  - b. Hydraulic Institute Std for Centrifugal, Rotary and Reciprocating Pumps.
  - c. NMTBA and JIC Std National Machine Tool Builders Association and Joint Industrial Council Standards
  - d. ISO 9001 International Organization for Standardization.

### 3. EXISTING PUMPING STATIONS

- A. The existing pump stations are pneumatic stations. The existing electrical service shall be replaced as shown on the drawings.

### 4. PERFORMANCE CRITERIA

- A. Pumps shall be designed to handle raw, unscreened, domestic sanitary sewage. Pumps shall have 4" suction connection, and 3" discharge connection. Each pump shall be selected to perform under following operating conditions:

Pump Station 3-3

1. Capacity (GPM)	180
2. Total Dynamic Head (FT)	116
3. Static Suction Lift (FT)	18
4. Motor Horsepower	25
5. Motor Speed (RPM)	1800

- B. Site power furnished to pump station shall be 3 phase, 60 hertz, 208 volts and 4 wire maintained within industry standards. The available fault current provided at the pump station control panel is 10 kA rms symmetrical. Voltage tolerance shall be plus or minus 10 percent. Phase-to-phase unbalance shall not exceed 1% average voltage as set forth in NEMA Standard MG-1. Control voltage shall not exceed 132 volts.

### 5. SUBMITTALS

#### A. PRODUCT DATA

1. Prior to fabrication, pump station manufacturer shall submit an electronic copy of submittal data for review and approval.
2. Submittal shall include shop drawings, electrical ladder logic drawings, and support data as follows: Catalog cut sheets reflecting characteristics for major items of equipment, materials of construction, major dimensions, motor and v-belt drive data, pump characteristic curves showing the design duty point capacity (GPM), head (FT), net positive suction head required (NPSH<sub>r</sub>), and hydraulic brake horsepower (BHP). Electrical components used in the motor branch and liquid level control shall be fully described.
3. Shop drawings shall provide layout of mechanical equipment and anchor bolt locations for station. Pipe penetrations and station access clearances shall be dimensioned relative to the station centerline. The electrical ladder logic drawings shall illustrate motor branch

and liquid level control circuits to extent necessary to validate function and integration of circuits to form a complete working system.

## B. OPERATIONS AND MAINTENANCE MANUALS

1. Operation shall be in accordance with written instructions provided by the pump station manufacturer. Comprehensive instructions supplied at time of shipment shall enable personnel to properly operate and maintain all equipment supplied. Content and instructions shall assume operating personnel are familiar with pumps, motors, piping and valves, but lack experience on exact equipment supplied.
2. Documentation shall be specific to the pump station supplied and collated in functional sections. Each section shall combine to form a complete system manual covering all aspects of equipment supplied by the station manufacturer. Support data for any equipment supplied by others, even if mounted or included in overall station design, shall be provided by those supplying the equipment. Instructions shall include the following as a minimum:
  - a. Functional description of each major component, complete with operating instructions.
  - b. Instructions for operating pumps and pump controls in all modes of operation.
  - c. Calibration and adjustment of equipment for initial start-up, Replacements of level control components, or as required for routine maintenance.
  - d. Support data for commercially available components not produced by the station manufacturer, but supplied in accordance with the specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices.
  - e. Electrical schematic diagram of the pump station circuits shall be in accordance with NFPA 79. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included. Details for such parts shall not be substituted for an overall system schematic. Partial schematics block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.
  - f. Mechanical layout drawing of the pump station and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping.
3. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

## 6. QUALITY ASSURANCE

- A. The pumps and pump station manufacturer must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.
- B. Upon request from the Engineer, the pump station manufacturer shall prove financial stability and ability to produce the station within the specified delivery schedules. Evidence of facilities, equipment and expertise shall demonstrate the manufacturer's commitment to long term customer service and product support.
- C. To unify responsibility for proper operation, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source) and that source shall be the pump manufacturer. The pumps must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted.
- D. Manufacturer must show proof of original product design and testing. Products violating intellectual property regulations shall not be allowed, as they may violate international law and expose the user or Engineer to unintended liabilities. "Reverse-engineered" products fabricated to substantially duplicate the design of original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design, which may contribute to product failure.
- E. The term "pump manufacturer" or "pump station manufacturer" shall be defined as the entity which designs, machines, assembles, hydraulically tests, and warranties the final product. Any entity that does not meet this definition will not be considered a "pump manufacturer" or "pump station manufacturer" and is not an acceptable supplier. For quality control reasons and future pump and parts availability, all major castings of the pump shall be sourced and machined in North America.

#### F. PUMP PERFORMANCE CERTIFICATIONS

- 1. All internal passages, impeller vanes, and recirculation ports shall pass a 3" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the Engineer, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.
- 2. Reprime Performance
  - a. Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.
  - b. During unattended operation, the pump shall retain adequate liquid in the casing to ensure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

- c. Pump must be capable of repriming 25 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:
  - 1) A check valve to be installed down stream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.
  - 2) A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
  - 3) The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90° elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
  - 4) Impeller clearances shall be set as recommended in the pump service manual.
  - 5) Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
  - 6) Liquid to be used for repriming test shall be water.
- 3. Upon request from the Engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional Engineer, shall be submitted for approval prior to shipment.

#### G. FACTORY SYSTEM TEST

- 1. All internal components including the pumps, motors, valves, piping, and controls will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed, and horsepower. Factory operational test shall simulate actual performance anticipated for the complete station.
- 2. Upon request from the Engineer, the operational test may be witnessed by the Engineer, and/or representatives of his choice, at the manufacturer's facility.

H. The manufacturer's technical representative shall inspect the completed installation, correct or supervise the correction of any defect or malfunction, and instruct operating personnel in the proper operation and maintenance of the equipment as described in Part 3 of this section.

#### 7. MANUFACTURER'S WARRANTY

- A. The pump station manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.
  - 1. In addition to defects in material and workmanship, fiberglass reinforced polyester station enclosures are warranted for sixty (60) months to be resistant to rust, corrosion, corrosive soils, effects of airborne contamination or physical failures occurring in normal service for the period of the pump station warranty.
  - 2. All other equipment, apparatus, and parts furnished shall be warranted for sixty (60) months, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, O-rings, etc. The pump station manufacturer shall be solely responsible for warranty of the station and all components.
- B. Components failing to perform as specified by the Engineer, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer.
- C. It is not intended that the station manufacturer assume liability for consequential damages or contingent liabilities arising from failure of any vendor supplied product or part which fails to properly operate, however caused. Consequential damages resulting from defects in design or delays in delivery are also beyond the manufacturer's scope of liability.
- D. Equipment supplied by others and incorporated into a pump station or enclosure is not covered by this limited warranty. Any warranty applicable to equipment selected or supplied by others will be limited solely to the warranty, if any, provided by the manufacturer of the equipment.
- E. This limited warranty shall be valid only when installation is made and use and maintenance is performed in accordance with manufacturer recommendations. A start-up report completed by an authorized manufacturer's representative must be received by manufacturer within thirty (30) days of the initial date the unit is placed into service. The warranty shall become effective on the date of acceptance by the purchaser or the purchaser's authorized agent, or sixty (60) days after installation, or ninety (90) days after shipment from the factory, whichever occurs first.

## **8. MANUFACTURER**

- A. To unify responsibility for proper operation of the complete pumping station, it is the intent of these Specifications that all system components are furnished by a single supplier (unitary source). The pumping station must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted. The pump station system integrator must be ISO 9001:2000 revisions certified, with scope of registration including design control and service after sales activities.
- B. **SUBSTITUTIONS:** The Contractor shall prepare his bid based on the specified equipment or other approved equipment. The submit substitute equipment, submit shop drawings and detailed information demonstrating the alternate equipment's use on the site. Any changes to the design drawings shall also be included for review by the Engineer.

- C. In event the Contractor obtains Engineer's approval for equipment substitution, the Contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping, or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the Engineer prior to acceptance.
- D. It will be assumed that if the cost to the Contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

## 9. STATION ENCLOSURE

- A. The station enclosure shall provide sufficient inside area for maintenance personnel to perform normal operation and maintenance inside, sheltered, and free from foul weather. The enclosure shall consist of a base to support the pumps and a cover. Minimum dimensions of the enclosure shall be eight feet by twelve feet and nine feet in height.
- B. The station enclosure shall be manufactured of molded fiberglass reinforced orthophthalic polyester resins with a minimum of 30% fiberglass, and a maximum of 70% resin. Glass fibers shall have a minimum average length of 1¼ inches. Resin fillers or extenders shall not be used. Major design considerations shall be given to structural stability, corrosion resistance, and water-tight properties. The polyester laminates shall provide a balance of mechanical, chemical, and electrical properties to insure long maintenance free life. They must be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases which can reasonably be expected to be present in the environment surrounding the wet well. Wood core type enclosures shall not be considered acceptable and shall be basis for equipment rejection. See manufacturer's requirements for enclosure warranty in these specifications.
- C. All interior surfaces of the housing shall be gel coated with a polyester resin. It shall be of suitable thickness and formulated to provide:
  - 1. Maintenance-free service
  - 2. Abrasion resistance
  - 3. Protection from sewage, greases, oils, gasoline, and other common chemicals.
  - 4. Color fastness
  - 5. Gloss retention
- D. Interior surfaces of the enclosure cover shall be white for maximum light reflectivity. The base shall be of a darker color to de-emphasize the presence of dirt, grease, etc. Colors used for both portions shall result in a pleasing looking structure.
- E. The pump station shall be furnished with 1" thick foam insulation which shall be applied to the walls, door, and roof to achieve an R-6 insulation factor. A gasketed seal around the door shall also be included.
- F. The outside of the enclosure shall be coated with a suitable pigmented resin compound to insure long, maintenance-free life. The fiberglass enclosure shall be a regular product of the pump station manufacturer.
- G. Station base shall be constructed of pre-cast, reinforced concrete encapsulated in a fiberglass mold. The design shall resist deformation of the structure during shipping, lifting, or handling. Base shall incorporate drainage provisions, and an opening sized to permit installation of piping

and service connections to the wet well. After installation, the opening shall serve as a grout dam to be utilized by the Contractor. The base shall incorporate anchor bolt recesses for securing the complete station to a concrete pad (supplied by the Contractor) in accordance with the project plans.

- H. Holes through the base shall be provided for suction and discharge lines, air release lines, and level control line. Holes for the suction and discharge lines shall be provided with a grout dam incorporated in a grout retention cavity which the Contractor shall fill at installation with suitable grout to seal each pipe-to-base joint against the entrance of hazardous gases from the wet well.
- I. Station base shall incorporate a suitable flange designed for securing the pump station to the concrete pad in accordance with the station plans.
- J. The enclosure cover shall be provided with a hinged fiberglass reinforced access door. Minimum dimensions of the door shall be 36 inches wide by 78 inches high for access by maintenance personnel to station interior. Door shall be a minimum 1 7/8 inch thick and shall be hinged with a minimum of two heavy-duty stainless-steel hinges to the enclosure cover. Door shall be furnished with a handle with padlock connected to a latching mechanism. Latch shall engage door casing or maximum security against vandalism. All mounting hardware for door casing and door must be concealed or of such type as to prevent vandalism with ordinary tools.
- K. Removable panels shall be supplied on two sides of the enclosure for additional access to equipment. Location and size shall permit access for routine maintenance functions such as pump and motor inspection, drive belt adjustment, and pump clean-out. Non-hinged panels shall be secured with stainless steel tamper-proof hardware
- L. A duplex ground fault indicating utility receptacle providing 115 volts, single phase, 60 hertz shall be mounted inside the pump station. Receptacle shall be NEMA 5-15r configuration, heavy duty, specification grade and fitted with a weatherproof cover. The receptacle shall be protected by normal duty circuit breaker.
- M. A shuttered exhaust fan with a minimum capacity of 500 CFM to change the air in the enclosure once every minute, shall be mounted in the end wall approximately opposite the hinged door opening. An air intake vent shall be mounted in the hinged door assembly. Both intake and exhaust opening shall be equipped with a screen and cowl suitably designed to prevent the entrance of rain, snow, rocks, and other foreign material. The thermostatically controlled exhaust fan shall energize automatically at approximately 70 degrees F and turned off at 55 degrees F. Fan circuit shall be protected by a normal duty circuit breaker.
- N. Two enclosed and gasketed 80-watt fluorescent light fixtures shall be provided. The fixtures shall be NEMA 4, suitable for wet location. The fixtures shall be located to provide adequate light to all parts of the station and shall not constitute a physical hazard to inspection or service personnel. Light circuit shall be protected by a normal duty circuit breaker and shall be provided with a disconnect switch.
- O. A 4 KW three-phase wall mounted forced air heater shall be provided for protection of the pump station equipment. The heater shall maintain an inside/outside temperature differential of 60 degrees F while operating on the primary electrical power available to the station. The

heater shall be controlled by a thermostat and contactor and protected by a heavy-duty circuit breaker.

## 10. PUMPS

- A. Pump shall be horizontal, self-priming centrifugal type, designed specifically for handling raw unscreened domestic sanitary sewage or industrial waste. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this section. The manufacturer of the pumps must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.
- B. Pump shall be vertically staged incorporating a lower and upper volute casing united by a ductile iron transition chamber, allowing for a direct and smooth flow path to the impeller in the upper casing.
- C. Pump suction and discharge connections of the lower casing shall be vertically in-line with one another.
- D. The cover plates and rotating assemblies shall be interchangeable between both casings.
- E. The discharge port of the upper casing shall be capable of being rotated to allow for multiple pipe connection orientations.
- F. MATERIALS AND CONSTRUCTION FEATURES
  1. Pump casings shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:
    - a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
    - b. Fill port cover plate, 3 1/2" diameter, shall be opened after loosening a positive lock clamp bar assembly. In consideration for safety, cap-screw threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A non-metallic gasket shall prevent adhesion of the fill port cover to the casing while assuring a reliable seal.
    - c. Lower casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.
    - d. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this section.
  2. Cover plates shall be cast iron Class 30. Design must incorporate the following maintenance features:

- a. Retained by hand nuts for complete access to pump interior. Cover plate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wear plate or check valve without removing suction or discharge piping.
  - b. Replaceable wear plate secured to the cover plate by weld studs and nuts shall be AISI 1015 HRS. Wear plates shall be self-cleaning design ensuring that debris is cleared away and does not collect on the impeller vanes.
  - c. In consideration for safety, a pressure relief valve shall be supplied in each cover plate. Relief valve shall open at 75-200 PSI.
  - d. Two O-rings of Buna-N material shall seal each cover plate to pump casings.
  - e. Pusher bolt capability to assist in removal of cover plates. Pusher bolt threaded holes shall be sized to accept same retaining cap-screws as used in rotating assemblies.
  - f. An easy-grip handle shall be mounted to the face of each cover plate.
3. Each rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate the following features:
  - a. Seal plates and bearing housings shall be cast iron Class 30. Anti-rotation ribs shall be cast into the seal plates to reduce internal wear and maximize component life. Separate oil filled cavities, vented to atmosphere, and shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.
    - 1) Each bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
    - 2) Each seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.
    - 3) Double lip seals shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
  - b. Impellers shall be ductile iron, two vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impellers shall be statically or dynamically

balanced. Impeller shall thread onto the pump shaft and be secured with a lock screw and conical washer.

- c. Shafts shall be AISI 4140 alloy steel unless otherwise specified by the Engineer, in which case AISI 17-4 pH stainless steel shall be supplied.
- d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.
- e. Each shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design. An external O-ring secures the stationary seat to the seal plate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton; cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seals shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.
- f. Pusher bolt capability to assist in removal of rotating assemblies. Pusher bolt threaded holes shall be sized to accept same cap-screws as used for retaining rotating assemblies.

4. Adjustment of the impeller face clearances (distance between impeller and wear plate) shall be accomplished by external means.

- a. Clearances shall be maintained by a four-point external shimless cover plate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four-point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Cover plates shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.
- b. There shall be provisions for additional clearance adjustments in the event that adjustment tolerances have been depleted from the cover plate side of the pump. The removal of stainless-steel tabbed spacers from the rotating assembly side of the pump shall allow for further adjustment as described above.

- c. Clearance adjustments which require movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.
- 5. An externally removable suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casings from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished from the top of the lower pump casing without disturbing the suction piping or completely draining both casings. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
- 6. Pump shall include flange kit consisting of two ASA spool flanges that shall be one-piece cast iron class 30 suitable for attachment to suction and discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

#### G. SERVICEABILITY

- 1. The pump manufacturer shall demonstrate to the Engineer's satisfaction that consideration has been given to reducing maintenance costs.
- 2. No special tools shall be required for Replacements of any components within the pump.

#### H. DRAIN KIT

- 1. Pumps to be supplied with a drain kit for ease of maintenance. The kit to contain 10' length of reinforced plastic hose with a female quick connect fitting at one end, and factory installed drain fittings in each pump. Fittings include a stainless steel pipe nipple, stainless steel bushing, stainless steel ball valve and aluminum male quick connect fitting.

#### I. SPARE PARTS KIT

- 1. The following minimum spare parts shall be furnished with the pump station:
  - a. One spare pump mechanical seal (complete with shaft sleeve)
  - b. One cover plate O-Ring
  - c. One rotating assembly O-Ring
  - d. One set of rotating assembly spacers
  - e. One complete rotating assembly which includes impeller, shaft, bearings, bearing housing, or-rings, and impeller adjustment shims.

### 11. VALVES AND PIPING

- A. Each pump shall be equipped with a full flow type check valve capable of passing a 3" spherical solid. Valve shall be constructed with flanged ends and fitted with an external lever and

torsional spring. Valve seat shall be constructed of stainless steel, secured to the body to ensure concentricity, sealed by an O-ring, and shall be replaceable. The valve body shall be cast iron incorporating a clean-out port large enough to allow removal and/or Replacements of the valve clapper without removing valve or piping from the line. Valve clapper shall have a molded Buna seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings. Shaft nut shall have double O-rings which shall be easily replaceable without requiring access to interior of valve body. All internal hardware shall be stainless steel. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable.

- B. Plug valves shall be of the non-lubricated, tapered type. Valve body shall be semi-steel with flanged end connection drilled to ANSI 125 lb. Standard. Valves shall have ports designed to pass spherical solids equal to the pump's capability. Valves shall be furnished with a drip-tight shutoff plug mounted in stainless steel or Teflon over phenolic bearings and shall have a resilient facing bonded to the sealing surface.
- C. An automatic air release valve shall be furnished for each pump designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming cycle or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visual indication of valve closure and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms, if used, shall be of fabric-reinforced neoprene or similar inert material.
- D. A gauge kit shall be supplied for each pump. Suction pressure must be monitored by a glycerin-filled compound gauge, and discharge pressure by a glycerin-filled pressure gauge. Gauges to be at least 4 inches in diameter, graduated in feet water column. Rated accuracy shall be 1% of full-scale reading. Compound gauge shall be graduated -34 to +34 feet water column minimum. Pressure gauge to be graduated 0 to 230 feet water column minimum. Gauges to be factory mounted on a resilient panel with frame assembly secured to pumps or piping. Gauge installations shall be complete with all hoses and stainless-steel fittings, including a shutoff valve for each gauge line at the point of connection to suction and discharge pipes.

#### E. PIPING

- 1. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.
- 2. Flanges shall be cast iron class 125 and comply with ANSI B16.1.
- 3. Pipe and flanges shall be threaded, and suitable thread sealant applied before assembling flange to pipe.
- 4. Bolt holes shall be in angular alignment within 1/2° between flanges. Flanges shall be faced with a gasket finish.

F. Contractor must ensure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping. Pump station discharge force main piping shall be anchored with thrust blocks where shown on the contract drawings.

## 12. DRIVE UNIT

A. Motors (Note: Maximum motor frame size is 405T open drip-proof.)

1. Pump motors shall be 3 phase, 60 hertz of horsepower and voltage specified above, horizontal ODP, NEMA design B with cast iron frame with copper windings, induction type, with Class F insulation and 1.15 service factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.
2. Motors shall be tested in accordance with provisions of ANSI/IEEE Std 112.

## 13. DRIVE TRANSMISSION

A. Power to pumps shall be transmitted through V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.

B. Each drive assembly shall utilize at least two V-belts providing minimum a combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5 are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer.

C. Precise alignment tolerances of the drive assemblies shall be achieved by means of a belt/sheave laser alignment system resulting in the reduction of vibration, accelerated wear, and premature failure.

D. The pump manufacturer shall submit power transmission calculations which document the following:

1. Ratio of pump/motor speed.
2. Pitch diameter of driver and driven sheaves.
3. Number of belts required per drive.
4. Theoretical horsepower transmitted per belt, based on vendor's data.
5. Center distance between pump and motor shafts.
6. Arc-length correction factor applied to theoretical horsepower transmitted.
7. Service factor applied to established design horsepower.
8. Safety factor ratio of power transmitted/brake horsepower required.

E. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed 1/2 inch.

1. Guards must be completely removable without interference from any unit component, and shall be securely fastened and braced to the unit base.

2. Metal to be free from burrs and sharp edges. Structural joints shall be continuously welded. Rivet spacing on panels shall not exceed five inches. Tack welds shall not exceed four inch spacing.
3. The guard shall be finished in accordance with Section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

## **14. COATING**

Pumps, piping, and exposed steel framework shall be cleaned prior to painting. Exposed surfaces to be coated with one coat gray W.R. non-lift primer and one coat white acrylic alkyd W.R. enamel. Paint shall be low VOC, alkyd based, high solids, semi-gloss white enamel for optimum illumination enhancement, incorporating rust inhibitive additives. The finish coat shall be 1.0 to 1.2 MIL dry film thickness (minimum), resistant to oil mist exposure, solvent contact, and salt spray. The factory finish shall allow for over-coating and touch up after final installation.

## **15. ELECTRICAL CONTROL COMPONENTS**

- A. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.
- B. Electrical control equipment shall be mounted within a common NEMA 1 stainless steel, dead front type control enclosures. Doors shall be hinged and sealed with a neoprene gasket and equipped with captive closing hardware. Control components shall be mounted on removable steel back panels secured to enclosure with collar studs. All control devices and instruments shall be secured to the sub-plate with machine screws and lockwashers. Mounting holes shall be drilled and tapped; self-tapping screws shall not be used to mount any component. All control devices shall be clearly labeled to indicate function.
- C. Pump station components and controls shall conform to third party safety certification. The station shall bear a UL label listed for "Packaged Pumping System". The panel shall bear a serialized UL label listed for "Enclosed Industrial Control Panels". The pump station components, panel enclosure, and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures.
- D. All Motor branch and power circuit components shall be of highest industrial quality. The short circuit current rating of all power circuit devices shall be a tested combination or evaluated per the National Electric Code Article 409. The lowest rated power circuit component shall be the overall control panel short circuit rating and shall not be less than the fault current available. The minimum control panel rating shall not be less than 10 kA, rms symmetrical. Control assemblies operating at 120 volts nominal or less may be provided with transformers which limit the fault current and may be rated less than the minimum required short circuit rating.
  1. A properly sized heavy duty circuit breaker shall be furnished for each pump motor. The circuit breakers must be sealed by the manufacturer after calibration to prevent tampering. An operating mechanism installed on each motor circuit breaker shall penetrate the control panel door. An operator with padlock and handle shall be secured on the exterior surface.

Interlocks must prevent opening the door until circuit breakers are in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.

2. Starter: A reduced voltage, solid state motor starter shall be furnished for each pump motor. The starter construction shall be modular with separately replaceable power and control sections. The power section shall consist of six back-to-back SCR's rated 208 to 480 volts, 50/60 hertz. The SCR's shall have a minimum repetitive peak inverse voltage rating of 1400 volts at 480 volts. The enclosed operating temperature range shall be 0 to 40 degrees C at altitudes up to 2000 meters without derating.
  - a. Starting Modes: Starting modes shall be selectable soft start, current limit, or full voltage. Soft starting the pump shall include an adjustable initial torque value of 0 to 90 %. The acceleration ramp shall be adjustable from 0 to 30 seconds. The starter shall include a selectable kick start providing a current pulse at start. Kick start level shall be adjustable from 0 to 90% of locked rotor torque. Kick start time shall be adjustable from 0 to 2 seconds. Current limit mode shall provide means for limiting the starting current to a programmable value between 50 and 600% of full load current. Full voltage start shall provide across the line starting with a ramp time of less than 0.25 seconds.
  - b. Pump Control Mode: Ramp time will be dependent on pump torque requirements. The starter shall provide smooth acceleration and deceleration, which approximates the flow rate of a centrifugal pump. The starter's microcomputer shall analyze motor variables and generate control commands, which will minimize surges in the system. Pump stop time shall be adjustable from 0 to 120 seconds. Pump control provides reduced hydraulic shock.
  - c. Bypass: When the start ramp time is complete, the starter shall energize an integral bypass contactor. When in the bypass mode, the bypass contactor shall carry the motor load to minimize internal heating in the electrical enclosure.
  - d. Protection: The starter shall include protective features: Communication fault, control temperature, excess starts/hour, stall, jam, line fault, open gate, overload, overvoltage, phase reversal, power loss, underload, undervoltage, shorted SCR, open bypass and voltage unbalance.
    - 1) An integral electronic overload relay equipped with thermal memory shall be included and shall utilize three phase current sensing. Adjustments shall include trip current, service factor and 10, 15, 20 or 30 trip class.
    - 2) Jam trip shall be adjustable 0-1,000% of the nominal motor current with a delay time adjustment of 0-99 seconds.
    - 3) Stall protection senses that the motor is not up-to-speed at end of ramp and will shut down after a user-selected delay time has elapsed. Stall delay shall be adjustable from 0-10 seconds.
    - 4) Fault diagnostics shall be displayed on the starter and shall include temperature fault, line fault, open gate and power loss.

- e. Display: The starter shall include a keypad and display on the front of the control module. The display is equipped with a built-in four line, 16 character backlit LCD. The LCD displays metering, faults and parameter settings in English. Faults will display in English and fault code. A fault buffer will store the last five faults. Metering capabilities shall include: Three phase current, three phase voltage, power factor, motor thermal usage, wattmeter, kilowatt hours, and elapsed time meter. Digital parameter adjustments shall be made using the keypad.
- f. Door Mounted Display: Each starter shall be furnished with a display and keypad mounted to the door of the control panel. The door mounted display will duplicate the functions of the starter display and allow the operator to monitor or change parameters without opening the control panel door.

3. The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, high voltage, low voltage, and voltage unbalance. An adjustable time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart, following an adjustable time delay, when power conditions return to normal.
4. The control panel shall be equipped with a transient voltage surge suppressor to minimize damage to the pump motor and control from transient voltage surges. The suppressor shall utilize thermally protected silicon-oxide varistors encapsulated in a non-conductive housing. Mechanical indicators shall be provided on each phase to indicate protection has been lost. The suppressor shall have a surge current rating of 100,000 Amps per phase and a 100 kA interrupting rating.

#### E. CONTROL CIRCUIT

1. A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.
2. Pump mode selector switches shall permit manual start or stop of each pump individually or permit automatic operation under control of the liquid level control system. Manual operation shall override all shutdown systems, except the motor overload relays. Selector switches to be oil-tight design with contacts rated NEMA A300 minimum.
3. Pump alternation shall be integral to the liquid level controller. Provisions for automatic alternation or manual selection shall also be integral to the liquid level controller.
4. Six digit elapsed time meter (non-reset type) shall be connected to each motor starter to indicate total running time of each pump in "hours" and "tenths of hours". Separate pilot lights shall be provided to indicate which motor is energized and should be running.
5. A high pump temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump from excessive temperature. A thermostat shall be mounted on each pump casing. If casing temperature rises to a level sufficient to cause pump damage, the high pump temperature protection circuit shall interrupt power to the pump motor. A visible indicator, mounted through the control panel door shall indicate motor stopped due to high pump temperature. The motor shall remain locked out until the pump has cooled and circuit has been manually reset. Automatic reset of this circuit is not acceptable.

6. A duplex ground fault receptacle providing 115 VAC, 60 Hz, single phase current, will be mounted on the side of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal-magnetic circuit breaker.
7. The lift station shall be equipped with a 5 KVA step-down transformer to supply 115 volt, AC, single phase for the control and auxiliary equipment. The primary and secondary side of the transformer shall be protected by a thermal magnetic circuit breakers, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door and a padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until primary circuit breaker is in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.
8. **Wiring**
  - a. The pump station, as furnished by the manufacturer, shall be completely wired, except for power feed lines to the main entrance terminal blocks and final connections to remote alarm devices.
  - b. All wiring, workmanship, and schematic wiring diagrams shall comply with applicable standards and specifications of the National Electric Code (NEC).
  - c. All user serviceable wiring shall be type MTW or THW, 600 volts, color coded as follows:

1) Line and Load Circuits, AC or DC power.....	Black
2) AC Control Circuit Less Than Line Voltage.....	Red
3) DC Control Circuit.....	Blue
4) Interlock Control Circuit, from External Source.....	Yellow
5) Equipment Grounding Conductor.....	Green
6) Current Carrying Ground.....	White
7) Hot With Circuit Breaker Open.....	Orange
  - d. Control circuit wiring inside the panel, with exception of internal wiring of individual components, shall be 16 gauge minimum, type MTW or THW, 600 volts. Power wiring to be 14 gauge minimum. Motor branch wiring shall be 10 gauge minimum.
  - e. Motor branch and other power conductors shall not be loaded above the temperature of the connected termination. Wires must be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall be ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied. All wires extending from components mounted on door shall terminate at a terminal block mounted on the back panel. All wiring outside the panel shall be routed through conduit.
  - f. Control wires connected to door mounted components must be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.
9. Factory installed conduit shall conform to following requirements:
  - a. All conduit and fittings to be UL listed.
  - b. Liquid tight flexible metal conduit to be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight polyvinyl chloride cover.

- c. Conduit to be supported in accordance with articles 346, 347, and 350 of the National Electric Code.
  - d. Conduit shall be sized according to the National Electric Code.
- 10. Station manufacturer shall ground all electrical equipment inside the pump station to the control panel back plate. All paint must be removed from the grounding mounting surface before making final connection. The Contractor shall provide an earth driven ground connection to the pump station at the main grounding lug in accordance with the National Electric Code (NEC).
- 11. Equipment Marking
  - a. Permanent corrosion resistant name plate(s) shall be attached to the control and include following information:
    - 1) Equipment serial number
    - 2) Control panel short circuit rating
    - 3) Supply voltage, phase and frequency
    - 4) Current rating of the minimum main conductor
    - 5) Electrical wiring diagram number
    - 6) Motor horsepower and full load current
    - 7) Motor overload heater element
    - 8) Motor circuit breaker trip current rating
    - 9) Name and location of equipment manufacturer
  - b. Control components shall be permanently marked using the same identification keys shown on the electrical diagram. Labels shall be mounted adjacent to device being identified.
  - c. Switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function, position, etc. Labels shall be mounted adjacent to, or above the device.

## **16. LIQUID LEVEL CONTROL**

- A. The manufacturer of the liquid level control system must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.
- B. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein. The level controller to provide an analog signal to the variable frequency drives to modulate pump speed upon rise and fall of wet well level.
- C. The level control system shall operate as an air bubbler type level control system.
- D. The level control system shall utilize alternation to select first one pump, then the second pump, then the third pump (if required), to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.
- E. The level control system shall utilize an electronic pressure switch which shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this

pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the electronic pressure switch shall start the second and/or third pump (if required) when the liquid reaches the "lag pump start level", or "standby pump start level" so that all pumps are operating. These levels shall be adjustable as described below.

1. The electronic pressure switch shall include integral components to perform all pressure sensing, signal conditioning, EMI and RFI suppression, DC power supply and 120-volt outputs. Comparators shall be solid state and shall be integrated with other components to perform as described below.
2. The electronic pressure switch shall be capable of operating on a supply voltage from 12-24VDC in an ambient temperature range of -10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Control range shall be 0 to 12.0 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be non-volatile.
3. The electronic pressure switch shall consist of the following integral components: pressure sensor, display, electronic comparators and output relays.
  - a. The internal pressure sensor shall be a strain gauge transducer and shall receive an input pressure from the air bubbler system. The transducer shall convert the input to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-15 PSI, temperature compensated from -40 degrees C (-40 degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 0.25% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.
  - b. The electronic pressure switch shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and the preset start and stop level for both lead and lag pump. The display shall include twenty (20), 0.19" high alpha-numeric characters calibrated to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full-scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.
  - c. Level adjustments shall be electronic comparator set-points to control the levels at which the pumps start and stop. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.
  - d. Each output relay in the electronic pressure switch shall be solid state. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. The "ON" state of each relay shall be indicated by illumination of a light emitting diode. The output of each relay shall be individually fused providing overload and short circuit protection. Each output relay shall have an inductive load rating equivalent to one NEMA size 4 contactor. A pilot relay shall be incorporated for loads greater than a size 4 contactor.

4. The electronic pressure switch shall be equipped with an output board which shall include LED status indicators and a connector with cable for connection to the main unit.
5. The electronic pressure switch shall be equipped with pump start delay(s) preset at a fixed delay time of five (5) seconds.
6. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.
7. The electronic pressure switch shall be equipped with a simulator system capable of performing system cycle testing functions.
8. The electronic pressure switch shall have internal capability of providing automatic alternation, manual selection of pump sequence operation, and alternation in the event of 1-199 hours excessive run time.
9. The electronic pressure switch shall be equipped with a security access code to prevent accidental set-up changes and provide liquid level set-point lock-out.
10. The electronic pressure switch shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5VDC, 0-10VDC, or 4-20mA, and one (1) 4-20mA scalable output. Output is powered by 10-24VDC supply. Load resistance for 4-20mA output shall be 100-1000 ohms.
11. The electronic pressure switch shall include a DC power supply to convert 120VAC control power to 12 or 24VDC EPS power. The power supply shall be 500mA (6W) minimum and be UL listed Class II power limited power supply.
12. The electronic pressure switch shall be equipped with an electronic comparator and solid-state output relay to alert maintenance personnel to a high liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.

F. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically. The pushbutton shall be oil tight design with contacts rated NEMA A300 minimum.

G. A back-up float control shall be provided with four floats and intrinsically safe relays to provide for a complete back-up to the air bubbler control. The float switch back-up control shall initiate when the level in wet well rises above high water alarm float switch. Once engaged the back-up float control shall remain active until the level control system is manually reset with a “float reset” pushbutton.

H. AIR BUBLER SYSTEM

1. The level control system shall be the air bubbler type, containing air bubbler piping which extends into the wet well. A pressure sensor contained within the electronic pressure switch

shall sense the air pressure in this piping to provide wet well level signals for the remainder of the level control system.

2. Two vibrating reed, industrial rated, air pumps shall be furnished to deliver free air at a rate of approximately 5 cubic feet per hour and a pressure not to exceed 7 psi. Liquid level control systems utilizing air compressors delivering greater quantities of air at higher pressures, requiring pressure reducing valves, air storage reservoirs, and other maintenance nuisance items will not be acceptable. A selector switch shall be furnished to provide manual alternation of the air pumps. The switch shall be connected in such a manner that either pump may be selected to operate continuously. The selector switch shall be oil-tight design with contacts rated NEMA A300 minimum.
3. An air bell constructed of Sch. 80 PVC, 3 inches in diameter shall be provided for installation at the outlet of the air bubbler line in the wet well. The air bell shall have a 3/8" NPT tapped fitting for connection to the bubbler line.
4. An air flow indicator gauge shall be provided and connected to the air bubbler piping to provide a visual indication of rate of flow in standard cubic feet per hour.

## **17. INSTALLATION**

- A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Station manufacturer shall provide written instruction for proper handling. Immediately after off-loading, Contractor shall inspect complete pump station and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all station serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.
- B. Install, level, align, and lubricate pump station as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.
- C. Suction pipe connections must be vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump station piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.
- D. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.
- E. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.
- F. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

## **18. FIELD QUALITY CONTROL**

A. OPERATIONAL TEST

1. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
2. After construction debris and foreign material has been removed from the wet well, Contractor shall supply water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gauge readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems.

B. Co-ordinate station start-up with manufacturer's technical representative. The representative or factory service technician will inspect the completed installation. The technician will calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

C. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Remove from the job site all tools, surplus materials, scrap and debris.

D. The pump station should be placed into service immediately. If operation is delayed, station is to be stored and maintained per manufacturer's written instructions.

**TABLE OF CONTENTS**

1. 16000 Electrical-General
2. 16900 Engine-Generator Systems

## SECTION 16000

### ELECTRICAL - GENERAL

#### PART 1 GENERAL

##### 1.1 DESCRIPTION

This section of the specifications includes the furnishing and installation of all labor, materials, tools, equipment, and operations necessary for the proper execution and completion of all electrical work indicated on the drawings and specified herein.

The Contractor shall furnish and install all conduit, cable, systems for power, and shall furnish and install raceways for special systems as specified herein and as indicated on the electrical drawings, complete and ready to operate in every respect, including connection of Owner furnished equipment, if applicable.

##### 1.2 CODES & ORDINANCES

All electrical work and materials shall comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), American Society for Testing and Material (ASTM), Insulated Cable Engineers Association (ICEA), National Electrical Manufacturers Association (NEMA), National Fire Protection Association (NFPA), Underwriters' Laboratories (UL) and applicable local codes and regulations.

All electrical equipment shall be third party listed as required by the State of North Carolina.

If discrepancies occur between laws, codes, ordinances, rules and regulations, and the specifications or drawings, each discrepancy shall be called to the attention of the Engineer in writing before the bids are submitted. That work which is shown or specified in violation of these rules and regulations shall be done in compliance with the regulations, and no claim for additional cost required to make implied systems complete will be accepted.

##### 1.3 UTILITY COORDINATION, PERMITS AND FEES

The Contractor shall coordinate power service modifications with the Energy United and provide equipment in full conformance with their requirements.

The Contractor shall notify the utility to provide new services indicated on the drawings.

The Contractor shall obtain all permits and inspections required for the completion of this contract.

##### 1.4 WORKMANSHIP

Workmanship in the fabrication, preparation, and installation of materials and equipment shall conform to the best standards of practice of the trades involved. Experienced and skilled electricians and mechanics under the supervision of a competent foreman shall perform work. Substandard workmanship will be cause for rejection of work and replacement by Contractor.

##### 1.5 DRAWINGS AND SPECIFICATIONS

Lift Station 3-3 & 15-1  
Moore County NC

The drawings show the location and arrangement of conduits, ducts, and equipment, together with details of connections of certain principal items. The layout shown shall be followed as closely as circumstances will permit, but the Contractor shall lay out his work so as to avoid conflict with other contractors and trades, and to avoid any unnecessary cutting or damage to walls, floors, and supporting structural members. The Contractor shall install at the proper time all necessary sleeves, hangers and inserts that will be required for the completion of his work and shall be solely responsible for the accurate and proper location of the above items.

The Contractor shall refer to the general drawings and cooperate fully with other contractors and trades while installing electrical equipment because of close space limits. In case of conflict, the Engineer shall be notified before proceeding with installation.

The drawings and specifications complement each other and together are intended to give a complete description of the work. Any item of equipment or note of work to be done as shown on plans and not mentioned in the specifications, or mentioned in specifications and not shown on plans, shall be furnished the same as if mentioned or shown in both places. If conflicts exist, then the most stringent method shown or described should apply.

Any discrepancy, omission, or conflict found in plans or specifications shall be called to the immediate attention of the Engineer, prior to receipt of bids.

The drawings are not intended to show complete details. It is the Contractor's responsibility to comply with the evident intent for centering and symmetric arrangement. The Contractor shall take all field measurements and be responsible therefore. Exact locations are to be defined in the field.

#### 1.6 CUTTING AND PATCHING

The Contractor shall do any cutting of walls or structures required for the installation of work under this section. Holes through walls for passage of conduits shall be properly and neatly sleeved and grouted. Sleeves through exterior walls shall be effectively sealed against passage of water. All disturbed areas shall be refinished and left in a finished and matching condition and shall meet the approval of the Engineer.

#### 1.7 ALLOWANCE FOR ADDITIONAL WORK

Before proceeding with any work for which compensation may be claimed or the Owner may claim credit, a detailed estimate shall be submitted and approved in writing. No claim for addition to the contract will be valid unless so ordered and approved by the Owner and Engineer.

#### 1.8 AS INSTALLED PRINTS

The Contractor shall maintain a set of prints, showing exact location of all relocated equipment, concealed equipment, service accesses, hand holes, underground duct banks, and all other changes to the plans. This set of prints shall be kept current and turned over to the Engineer upon completion of the job. Dimensions shall be shown to locate all underground conduit duct banks from permanent reference points.

#### 1.9 INCIDENTAL CONSTRUCTION WORK

The Contractor shall provide all openings as required for the electrical work. The Contractor shall do all cutting and fitting of his work and of other work that may be required to make the several parts come together properly and to fit his work to receive or be received by the work of other Contractors as shown upon, or reasonably implied by the drawings and specifications. He shall properly complete and finish up his work

Lift Station 3-3 & 15-1  
Moore County NC

after other contractors have finished as the Engineer may direct. All excavating required for the installation of the system shall be done by the Contractor. Backfill shall be accomplished as specified in the appropriate section of the specifications.

#### 1.10 CLEANING AND PAINTING

The Contractor shall at all times keep the Owner's premises, adjoining driveways and streets clean of rubbish caused by the Contractor's operations and at the completion of the work shall remove all the rubbish from and about the premises, all his tools, equipment, temporary work, surplus material and shall leave the area clean and ready for use.

The Contractor shall be required to perform touch-up painting on factory-finished equipment installed under this contract where necessary to repair damaged areas. All metal exposed to weather shall be properly painted. Any equipment installed where exposed to weather shall have all damaged areas cleaned, primed, and painted by the Contractor.

#### 1.11 GUARANTEE

The Contractor shall guarantee all materials, equipment, and workmanship in this contract against defects and failures of any nature for a period of one year from date on which the system is accepted. Apparatus furnished by the Contractor shall be guaranteed to be satisfactory when operated under rated conditions in accordance with manufacturer's instructions and to be of size, function, and capacity as indicated on the drawings or in the specifications. Upon notice from the Engineer or Owner, the Contractor shall immediately check the system, make necessary repairs or adjustments as required due to faulty workmanship, materials, faults, operation, or equipment, without cost to the Owner, and instruct the Owner in proper operation, adjustment, and care of the systems.

#### 1.12 IDENTIFICATION

All equipment shall be identified and properly marked. All marking must meet the Engineer's approval. All markers shall be of appropriate size. Each panel, transformer, contactor, starter, and other piece of electrical equipment shall be identified as to their service.

All disconnect switches, junction boxes, motor controllers, and other equipment requiring electrical owner connection shall be marked with voltage present, as appropriate to designate 120, 208, 240, 277, or 480 volts and single or three-phase, as applicable.

#### 1.13 MAINTENANCE AND OPERATING INSTRUCTIONS

The Contractor shall furnish to the Engineer five (5) complete sets of applicable drawings, instructions and parts lists on all equipment furnished, providing names and addresses of manufacturers or subcontractors and suppliers. Two (2) copies of manufacturer's warranties on all equipment shall be provided to the Owner and one (1) copy to the Engineer.

The one-year warranty period on all equipment and systems installed by this Contractor shall start upon final approval and acceptance following the installation and commissioning of the equipment.

#### 1.14 SHOP DRAWINGS

Upon award of the contract, the Contractor shall submit to the Engineer for approval, a list of all proposed subcontractors and materials he proposes to utilize and five (5) sets of shop drawings consisting of detailed

Lift Station 3-3 & 15-1  
Moore County NC

drawings or manufacturer's cuts of all manufactured equipment he proposes to use on the job. The drawings or cuts shall show details of construction and arrangement of all pertinent data pertaining to equipment proposed to be furnished. Where manufacturer's cut sheets include more than one option or model number, the Contractor must clearly indicate the proposed option or model number. The approval of the Engineer shall be obtained before equipment is ordered for delivery. It will be the duty of the Contractor to verify quantities, dimensions, and details, and determine suitability of equipment for installation in space provided. Approval of shop drawings by the Engineer does not relieve the Contractor of the responsibility for coordination, dimensions, quantities or conformance with contract documents.

The Contractor shall check and initial shop drawings making such notations and corrections as may be appropriate or necessary to comply with contract documents before submission to the Engineer.

#### 1.15 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

The Contractor shall be responsible for furnishing suitable shelter and protection for all materials and equipment stored on the job. Equipment shall be protected from damage from any source both during storage and after installation until completion of the job. No damaged equipment will be accepted. Existing equipment removed from service shall be protected from damage and loss of parts until turned over to the owner.

### PART 2 MATERIALS

#### 2.1 ELECTRICAL MATERIALS AND METHODS

Materials and workmanship on all work installed under this contract shall be new and of the best quality and shall conform to the best practice for such work and be installed in accordance with manufacturer's recommendations and instructions, including all hardware and accessories recommended or appropriate. Any work or materials not specifically mentioned in these plans and specifications, but required to make this job a complete and workable system shall be furnished and installed by the Contractor.

Substitution for equipment specified must be equal in every respect and the Contractor shall base his proposal on the quality of materials and equipment covered in these specifications and shown on the drawings.

Where substitutions alter the design or space requirements indicated on the plans, the Contractor shall include all items of cost for the revised design and construction, including the cost of any changes or modifications in structural or mechanical details and electric service resulting from substitution of electrical equipment, and the cost of all allied trades involved.

All manufactured and fabricated assemblies of electrically operated equipment furnished under this contract shall have Underwriter's Laboratories approval or UL Re-examination listing in every case where such approval has been established for the particular type of materials or devices in question.

#### 2.2 CONDUITS AND RACEWAYS

All wiring shall be in conduit or other approved raceways except as shown on the drawings or otherwise specified, and shall be concealed unless otherwise noted. Conduit shall be one of the types listed below.

##### 2.2.1 Conduit Types:

PVC-Coated Rigid Steel Conduit. The conduit shall be rigid steel, hot-dip galvanized, with a 40 mil thick PVC coating on the pipe outer diameter and a 2-mil thick PVC coating on the pipe inner

Lift Station 3-3 & 15-1  
Moore County NC

diameter. PVC coated rigid steel conduit shall be as manufactured by Ocal, Perma-Cote, or Robroy Industries.

Rigid Steel Conduit. Rigid steel conduit shall be heavy wall, hot-dip galvanized, and shall conform to Fed Spec WW-C-581, ANSI C80.1, and UL 6.

Rigid PVC Conduit. The conduit shall be Schedule 80 PVC, 90 deg C rated conforming to NEMA TC-3 and UL514, 651. Conduit shall be as manufactured by Carlon, Indian head, Robroy, Ocal or equal.

Rigid Aluminum Conduit (RAC). Rigid aluminum conduit and fittings shall be manufactured of 6063-T1 alloy. Rigid aluminum conduit shall be UL approved and shall conform to Fed Spec WW-C-540 and ANSI C80.5.

Liquid Tight Flexible Metal Conduit. Liquid tight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moisture proof polyvinyl chloride jacket, and shall be UL labeled.

2.2.2 Conduit Installation:

Rigid steel conduit shall be installed in masonry walls, concrete slabs, and cast-in-place walls.

Intermediate and rigid steel conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts. Terminations and connections shall be taper threaded. Conduits shall be reamed, free of burrs, and terminated with conduit bushings.

PVC-coated rigid steel conduit shall be installed in exposed outdoor locations and where indicated on the drawings. PVC-coated mounting hardware and framing materials shall rigidly support conduit. Nuts and bolts shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer. Threading tools used for steel conduit shall not be used to thread PVC-coated rigid steel conduit.

Liquid tight flexible metal conduit with watertight connectors shall be installed for final connections to dry type transformers, motors, equipment with moving parts, and where indicated on the drawings. Conduit shall be installed without sharp bends and in minimum lengths required for the application but not longer than 4'-0", unless acceptable to the Engineer.

Unless otherwise noted or required by Code, direct buried underground conduit shall be PVC schedule 80 upsized as required. Turn-ups outdoors shall be PVC coated rigid steel. Conduit in classified locations shall be PVC coated rigid steel.

Underground conduits shall be concrete encased under roadways and where indicated on the drawings.

Locknuts inside and outside shall securely fasten conduit connections to sheet metal enclosures. Conduits shall be installed between the reinforcing steel in walls or slabs that have reinforcement in both faces. In slabs that have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

Lift Station 3-3 & 15-1  
Moore County NC

All conduits that enter enclosures shall be terminated by fittings that ensure that the NEMA rating of the enclosure is not affected or changed. A corrosion-resistant coating shall be applied to all conduits that turn out of concrete, masonry, or earth indoors. The coating shall consist of a heavy coat of thixotropic coal tar paint extending six inches on each side of the point of turnout.

Concrete encased conduit shall have minimum concrete thickness of 2 inches between conduits, six inches above and below conduits. Underground conduit bend radius shall be not less than 2 feet at vertical risers or less than 3 feet elsewhere. Underground conduits and conduit banks shall have 2-feet minimum earth cover except where indicated otherwise. Underground conduits shall be sloped to drain to the handholes.

After cable has been installed and connected, conduit ends shall be sealed by non-hardening duct sealing compound forced into conduits to a minimum depth equal to the conduit diameter. This shall apply for all conduits at handholes and building entrance junction boxes, and for all conduit connections to equipment.

All exposed conduit runs shall be so located that pull or junction boxes will not be made inaccessible due to inadequate clearance with piping or equipment.

All conduits used for service entrance feeders from supply point to first overcurrent device shall be bonded with suitable bonding locknuts and/or bonding insulating bushings, or by separate copper bonding conductor.

## 2.3 CONDUCTORS

### 2.3.1 General:

The Contractor shall furnish and install all wire and cable necessary to complete the work herein outlined and as shown on drawings, except such items as are specifically noted as being furnished by others. All wiring in the entire system must be color-coded and all conductors shall have their size, voltage, manufacturer, and type clearly marked on the outer covering. All wire and cable shall be as herein specified or as shown on the drawings. Wire and cable shall be as manufactured by Okonite, Belden, Anaconda, Rome, General Cable, or equal.

### 2.3.2 Power Conductors:

Conductors shall consist of annealed copper wire of size indicated on drawings or as may be specified herein. No conductors smaller than #12 AWG copper shall be used unless otherwise indicated on the drawings. All conductors #12 AWG and larger shall be of Class B concentric stranded construction, unless specified otherwise herein or on drawings.

All wire and cable unless otherwise specified shall be single conductor type THWN or THHN 600-volt insulation. Service entrance conductors shall be RHH/RHW-USE type insulation. Conductors shall be color coded as follows:

- black, blue, red, white, and green on 120/208 volt wye systems
- black, orange, red, white, and green on 120/240 volt delta systems
- brown, orange, yellow, gray, and green on 277/480 volt wye systems.

### 2.3.3 Installation:

Lift Station 3-3 & 15-1  
Moore County NC

The Engineer reserves the right to inspect any and all joints in wiring. If the joint is already taped, the Contractor shall properly re-tape after inspection. Conductors shall be continuous without joints or splices in runs between outlet boxes. All splices shall be made at boxes only.

2.3.4 Splices and Terminations:

Splices shall be made by use of mechanical connectors of the following manufacturers' types, T & B Sta-Kon, Burndy Crimpit, Minnesota Mining and Manufacturing Company Scotchlock, and Ideal Wire-Nut. Conductors size #8 AWG and larger shall be spliced and connected with suitable, solderless, mechanical lugs and connectors. All splices, taps, and connections shall be insulated with Scotch electrical tape as made by Minnesota Mining & Manufacturing Company as applicable to installation.

2.3.5 Instrument Cable.

Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Cable shall be used where indicated on the drawings.

2.4 SUPPORTING DEVICES

2.4.1 General:

All secondary electrical devices such as outlet boxes, poles, bases, switches, and receptacles shall be located generally as shown on the drawings. No device utilized by the handicapped shall be located higher than 4'-0" from the finished floor level to the top of the device.

2.4.2 Outlet and Switch Boxes:

Boxes exposed, in masonry walls and cast-in-place walls shall be cast metal, malleable, with conduit hubs, Crouse Hinds, Appleton or equal. Intermediate oversize type cover plates shall be used where standard cover plates will not cover opening. All adjacent plates shall match in material, size, design, and color.

All exterior mounted boxes shall have approved weather-proof plates and in-use covers.

2.4.3 Outlet Locations:

All outlets for receptacles or switches shall be installed in the location indicated on the drawings. When necessary, the Contractor shall relocate outlets to coordinate with other equipment.

Unless otherwise indicated on the drawings, electrical devices shall be placed at the following distances from finished floors:

- Light Switches – center of switch 45" above finished floor (45" AFF).
- Duplex receptacles – center of receptacle 18" above finished floor (18" AFF).
- Power Panelboards - top of cabinet 6'-6" above finished floor.
- Safety switches and/or circuit breakers - handle not over 6'-6" above finished floor.

Lift Station 3-3 & 15-1  
Moore County NC

The Electrical Contractor is cautioned to review general drawings to confirm location of equipment and to adjust the exact installed location of receptacles and devices accordingly to avoid interference between electrical devices and equipment. Responsibility for locating devices in the field is the Contractor's. The Engineer should be contacted for clarification before installation.

2.4.4 Structural Steel:

The Contractor shall provide miscellaneous structural steel necessary to mount electrical equipment to walls, beams and joists. All structural steel furnished shall be standard shapes and sizes and shall be stainless steel. All interior steel shall be firmly and rigidly welded or bolted in place. All structural steel shall be structural quality conforming to ASTM A7-497.

2.4.5 Tap and Pull Boxes:

Boxes shall be of code gauge galvanized sheet steel but not less than 14-gauge metal. Holes for raceways shall be drilled on the job. Where necessary for boxes to be supported away from the ceiling or beams, strap iron or threaded rod shall be used for supports. Outdoor boxes shall be Nema 4X stainless steel unless otherwise noted.

Boxes shall have covers fastened on with screws. Sizes of boxes shall be determined by NEC requirements.

2.4.6 Secondary Systems:

The Contractor shall furnish and install all conduit, junction boxes, outlet boxes, and plates for conduit systems as indicated on the drawings.

2.5 GROUNDING

All electrical systems and equipment connected under this contract shall be grounded in strict accordance with the National Electrical Code and state and local regulations. Provide a green insulated equipment grounding conductor in all conduits. It is intended that equipment grounding is not dependent on conduit connections.

Metal raceways, metal enclosures or electrical devices, switchgear enclosures, transformer frames, and other equipment shall be completely grounded in an approved manner prescribed by the NEC. All necessary conduit, conductors, clamps and connectors for the grounding system shall be furnished, installed and connected by the Electrical Contractor. The service shall be grounded as indicated on the drawings and as required by the NEC. Ground connections to water pipes shall consist of a ground fitting that bonds both conduit and conductor to the pipe.

All grounding conductors shall be bare or green insulated in accordance with the National Electrical Code, soft drawn copper cable or bar, not smaller than 12 AWG. Ground cable splices and joints which will be inaccessible upon completion of construction shall meet the requirements of IEEE Standard 837, and shall be Cadweld "Exothermic" or Burndy "Hyground" type. Ground cable near the base of a structure shall be in earth and as far from the structure as the excavation permits but not closer than 6 inches.

Ground connections to equipment and ground buses shall be by copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be by clamp type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures or by grounding locknuts or bushings.

Lift Station 3-3 & 15-1  
Moore County NC

Ground rods not described elsewhere shall be 5/8-inch diameter by 8 feet long, with a copper jacket bonded to a steel core.

**2.6 SWITCHES**

Wall switches specification grade and shall be 20 amperes, 120/277 volts, Hubbell, Leviton, Eagle or equal and shall be mounted 3'-6" AFF unless otherwise indicated on the drawings.

**2.7 RECEPTACLES**

Receptacles shall be specification grade, duplex, three-wire, grounding, 20 amperes, 125 volts, Hubbell, Leviton, Eagle or equal for 120-volt circuits. Ground fault receptacles shall be duplex, 20 amperes, 125 volts, Hubbell, Leviton, Eagle or equal, or equal. Receptacles shall be mounted 48 inches AFG unless otherwise indicated on the drawings.

**2.8 CIRCUIT BREAKER TYPE DISCONNECT SWITCHES**

Unless otherwise specified, each circuit breaker type disconnect switch shall be 3 phase, heavy-duty, with a voltage and continuous current rating as indicated on the drawings.

Each disconnect switch shall have an enclosure rating as indicated on the drawings.

The disconnect switch for the primary service shall be service entrance rated.

The disconnect switch for the generator shall be provided with insulated neutral terminals.

Circuit breakers shall be 3 phase, 480 volt, molded-case circuit breakers of not less than 22,000 amperes interrupting rating at 208 volts ac, complete with thermal and instantaneous trip elements. Breakers shall be manually operated with quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Circuit breakers shall have "On", "Off", and "Tripped" indication and padlockable handles.

Disconnect switches shall have nameplates identifying related equipment, and unit numbers where applicable. Nameplates shall be laminated black-over-white plastic, with 1/8-inch engraved letters, and shall be securely fastened to the enclosure.

**2.9 POWER PANELS (PP) 120/208Vac, 3 Phase**

Unless otherwise specified, each power panel with neutral shall be dead-front, circuit breaker, 3 phase, panel-board type in accordance with the drawings and the following.

The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA type enclosure designation as required by the location where it will be installed. The enclosure shall have a door with latch and lock. A directory inside the door shall have a panel and all circuit identities neatly typewritten at completion of the contract.

A ground stud bolt shall be provided through the cabinet, with a removable 2/0 AWG bond to the panel ground bus and an external clamp connector for a station ground cable.

Lift Station 3-3 & 15-1  
Moore County NC

Circuit breakers shall be thermal magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple pole shall be common trip. Breakers shall be rated 600 volts with interrupting ratings not less than 22,000 amperes at 208 volts. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (minimum of two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, poles, and ampere ratings indicated.

The panel shall have 3 phase buses, a neutral bus insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere and voltage ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, and clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

Panels shall have nameplates identifying the panel, and unit numbers where applicable. Nameplates shall be laminated black-over-white plastic, with 1/8-inch engraved letters, and shall be securely fastened to the enclosure.

TVSS shall be provided at each panel shall be suitable for use on a 120/208 Vac, 3-phase 4-wire grounded wye system. Maximum Suppressed Voltage Rating (SVR) per UL1449 2nd Edition shall not exceed 500 volts for L-N, N-G, & L-G and 1500 volts for L-L. The TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage. The total surge current based on an 8 x 20 microsecond waveform that the device is capable of surviving shall not be less than 100kA per mode.

TVSS minimum life shall be 2000 current surges of 5,000 amperes on a 10 x 20 microsecond waveshape, and the subsequent power-follow current, per mode.

TVSS shall be integral to the panel, listed for installation in the panel, and connected through a disconnecting means to the bus. Overcurrent protection shall be as recommended by the manufacturer.

TVSS shall have visual and audible status indication plus form "C" relay contacts that change state when the TVSS has been damaged or is no longer providing protection. TVSS shall be UL1449 Second Edition listed.

-- END OF SECTION --

## SECTION 16900

### ENGINE – GENERATOR SYSTEM

#### PART 1 GENERAL

##### 1.1 DESCRIPTION

Contractor shall provide all labor, materials, and equipment to furnish, install, and place in operation the engine generator systems in accordance with the contract documents and manufacturer's drawings and installation instructions. All equipment shall be new, factory tested, and delivered ready for field installation.

The responsibility for performance to this specification shall not be divided among individual component manufacturers but must be assumed solely by the primary manufacturer. This includes generating system design, manufacture, test, and having a local supplier responsible for service, parts, and warranty for the total system.

Generator set mounted subassemblies such as cooling system, base, air intake system, exhaust outlet fittings, subbase fuel tank, and generator set mounted controls shall also be designed, built, and assembled as a complete unit by the engine/generator manufacturer.

##### 1.2 APPROVED MANUFACTURERS

The engine and generator shall be the product of an ISO 9001 certified manufacturer. System shall be manufactured by Caterpillar, Kohler, Cummins-Onan, MTU, Generac, or prior approved equal.

##### 1.3 SYSTEM RATINGS

###### Lift Statin 3-3

The Pumping Station electric power generating system including engine-mounted radiator shall have a site capability of:

- 60 kW standby (minimum)
- 75 kVA @ 0.8 PF, continuous standby rating (minimum)
- 120/208 Volts AC, Wye connected, 3 Phase, 60 Hertz
- 700 Altitude (Feet)
- 110 Maximum Outside ambient temperature (degrees F)
- -10 Minimum Outside temperature (degrees F)
- Maximum voltage drop of 25 percent.

System shall start and operate the following loads in the order listed:

- 5 Kw miscellaneous load
- One (1) 25 hp pump motor on solid-state starter at 400 percent
- One (1) 25 hp pump motor on solid-state starter at 400 percent

Lift Station 3-3 & 15-1  
Moore County NC

### Lift Station 15-1

The Pumping Station electric power generating system including engine-mounted radiator shall have a site capability of:

- 40 kW standby (minimum)
- 75 kVA @ 0.8 PF, continuous standby rating (minimum)
- 120/208 Volts AC, Wye connected, 3 Phase, 60 Hertz
- 700 Altitude (Feet)
- 110 Maximum Outside ambient temperature (degrees F)
- -10 Minimum Outside temperature (degrees F)
- Maximum voltage drop of 25 percent.

System shall start and operate the following loads in the order listed:

- 5 Kw miscellaneous load
- One (1) 15 hp pump motor on solid-state starter at 400 percent
- One (1) 15 hp pump motor on solid-state starter at 400 percent

## 1.4 SUBMITTALS

Submittals for approval shall include but not be limited to:

- Certification of Prototype Testing.
- Component List: A breakdown of all components and options.
- Technical Data: Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator and including relevant component design and performance data.
- Auxiliary Equipment: Specification or data sheets, including switchgear, transfer switch, vibration isolators, and day tank.
- Drawings: General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
- Wiring Diagrams: Wiring diagrams, schematics and control panel outline drawings published by the manufacturer for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.
- Warranty Statements: Warranty verification published by the manufacturer.

## 1.5 PRODUCTION TESTS

The system manufacturer shall perform production tests on the complete generator set supplied at the generator set manufacturers facility. A certified report of these tests shall be available when requested at the time of the generator set order. These tests and controls shall include but not be limited to:

- Operation at rated kVA
- Transient and steady state governing
- Transient and steady state voltage regulation
- Operation of all alarm and shutdown devices
- Single step load pickup of rated kW

## 1.6 PROTOTYPE TESTS

The system manufacturer must certify that engine, generator, controls, and switchgear have been tested as complete system of representative engineering models (not on equipment sold). Prototype testing shall include:

- Fuel consumption at 1/4, 1/2, 3/4, and full load
- Exhaust emissions
- Mechanical and exhaust noise
- Governor speed regulation at 1/4, 1/2, 3/4, and full load; and during transients
- Motor starting kVA
- Generator temperature rise in accordance with NEMA MG1-22.40
- Voltage regulation at 1/4, 1/2, 3/4, and full load; and during transients.
- Generator short circuit capability
- Cooling system performance

## 1.7 WARRANTY/SERVICE

The manufacturer's and dealer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty. Running hours shall not be a limiting factor for the system warranty by either the manufacturer or servicing dealer. Submittals received without written warranties as specified will be rejected in their entirety.

The generator set supplier shall have factory trained service representatives and tooling necessary to install, test, maintain, and repair all provided equipment and shall be located within 100 miles of the customer site.

The generator set supplier shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any required parts and shall guarantee 100% parts availability within 48 hours from the time an order is entered with the dealer.

# PART 2 PRODUCTS

## 2.1 SYSTEM PERFORMANCE

The power generating system shall conform to the following performance criteria at the site conditions:

- Rating: Engine brake horsepower shall be sufficient to deliver full rated generator set kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators.
- Start Time and Load Acceptance: Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained.

- With the power generating system at normal operating temperature, it shall accept a 100% block load, less applicable derating factors, in accordance with NFPA 110.
- Steady state frequency regulation shall be +/- 0.33% with no load to full load speed droop less than 3%.
- Voltage regulation shall +/- 0.5% for any steady state load between no load and full load.

## 2.2 ENGINE

The engine shall be a stationary, liquid cooled, 1800 rpm, four-cycle design, single block assembly with one-piece crankshaft and dry exhaust manifolds.

Electronic governor frequency regulation shall be isynchronous, regulated to within +/- 0.25% from no load to full load.

## 2.3 ENGINE ACCESSORY EQUIPMENT

- Electric starting motors and control circuit capable of four complete starting cycles without overheating.
- Mechanical, positive displacement lube oil pump with replaceable full flow filter, oil cooler, and dipstick.
- Mechanical, positive displacement fuel transfer pump with replaceable full flow filter.
- Manually operated fuel-priming pump.
- Replaceable dry element air filter.
- Engine mounted electrically powered, thermostatically controlled jacket water heater sized to ensure proper starting. Shall include isolation valves and adjustable thermostat.
- Flexible, stainless steel exhaust connector.
- Flexible fuel lines.
- Battery charger.

## 2.4 GENERATOR

- Each alternator shall be four pole, revolving field, with self-ventilated, drip-proof construction. Insulation shall meet NEMA MG-1-22.4 and NEMA MG1-1.65 standards. Alternator insulation shall be Class F. Rotor and stator insulation shall be Class H and be vacuum impregnated with epoxy varnish.
- Temperature Rise. The temperature rise of the alternator windings, when operated at rated load and under standby duty conditions with cooling air inlet temperature of 40C, shall not exceed 130C when measured by the resistance method.
- The excitation system shall be brushless and controlled by a solid-state voltage regulator with adjustable volts per hertz operation capable of maintaining voltage within + 2% at any constant load from 0 to 100% of rating. Frequency regulation shall be + 0.2% hertz from no load to rated load.
- The instantaneous voltage dip shall not exceed 25% and recover to +2% in one second for any load up to rated load. The generator shall be capable of sustaining at least 250% rated current for at least 10 seconds under fault conditions.
- The alternator shall be directly connected to the flywheel housing, and the rotor shall be driven through a semi flexible driving flange to ensure permanent alignment.

## 2.5 CONTROL PANEL

- Each engine-generator system shall be provided with a microprocessor-based control panel mounted inside the enclosure. Control panel shall be vibration isolated as required and powered from system batteries. The control panel shall include the following as a minimum:
  1. Engine water temperature gauge.
  2. Engine oil temperature gauge
  3. Running time meter.
  4. Voltmeter for all line-to-line and line-to-neutral voltages.
  5. Frequency meter
  6. Shutdown logic and reset pushbutton for high engine water temperature, low oil pressure, high engine oil temperature.
  7. Indicating lights and contacts for remote monitoring for the following:
  8. Not in "AUTO"
  9. Overcrank
  10. Emergency Stop
  11. High Engine Temperature/Low Coolant Level
  12. Overspeed
  13. Low Oil Pressure
  14. Battery Charger Malfunction
  15. Low Battery Voltage
  16. Low Fuel
  17. System Ready
  18. Pre-alarm High Engine Temperature
  19. Pre-alarm Low Oil Pressure
  20. Low Coolant Temperature
  21. Low fuel temperature
  22. Test switch for indicating lights.
  23. Auto-Off-On selector switch. In Auto, the engine-generator system will operate from main switchgear.
  24. Alarm horn with silencer switch.
  25. Ammeter.
  26. Oil pressure gauge.
  27. Voltage adjust rheostat.
  28. Battery charging meter.
  29. Overvoltage protection that will shut down the unit after one second of 15% or more voltage.
  30. Emergency stop pushbutton.
  31. Overcrank protection.
  32. Solid state cranking system controls with individually adjustable "On" and "Off" cranking periods, 2 to 30 seconds with cranking reset button.
  33. Engine cool down timer factory set at 5 minutes.
  34. Provisions for a remote emergency stop switch.
  35. Governor speed control.
  36. Tachometer.
  37. Two spare contacts that will close when engine is running.
  38. Two spare contacts that will open when engine-generator is in alarm.
  39. Speed switch to ensure the engine cannot restart until the engine has come to a complete stop.

## 2.6 MANUALS

Supplier shall submit complete instruction manuals, including parts lists for the generators and all equipment devices furnished with the generator. The manuals shall give complete and detailed instructions for installation, maintenance, operation, and adjustments.

## 2.7 TEST REPORTS

A certified test report for all specified tests shall be provided with each unit.

## 2.8 BATTERY SYSTEM

A dual rate 10-ampere battery charger shall be provided which shall accept 120-volt AC input and DC output, incorporate current limiting circuitry, and include a DC ammeter and voltmeter. The use of a crank disconnect relay to protect the charger during starting is not acceptable. The charger shall be housed in a NEMA 1 enclosure. The charger shall include LED annunciation for low battery voltage, high battery voltage, battery charger malfunction, and AC failure; and dry contacts for battery charger malfunction and low battery voltage; as required by NFPA-110.

Lead acid type starting batteries; sized as recommended by the generator set manufacturer to comply with the starting and temperature specifications; battery cables, and base mounted battery rack shall be provided.

## 2.9 MAIN LINE CIRCUIT BREAKER

Systems shall be provided with a main line circuit breaker as recommended by the system manufacturer and as required by the application. Circuit breakers shall be rated 3 Pole, each maximum. Circuit breakers shall be suitable for termination of conductors indicated on the drawings.

## 2.10 ENCLOSURE

Weatherproof enclosure shall be designed to provide maximum weather protection against driving rain, snow, or other weather elements. Layout of enclosure shall permit operation and servicing from inside of enclosure unless otherwise specified. The enclosure shall house all components not less generator set and electrical components etc. Enclosure will meet local and state building codes. Wind loading shall be per location, 110 mph minimum.

Enclosure shall be sound attenuated to less than 75 dBA at 25 feet.

**Intake and Discharge Louvers:** Intake louvers constructed of aluminum with rodent screen for intake sized to allow combustion and cooling air to enter the enclosure at a face velocity to create a static pressure drop over the entire system not to exceed 0.25-inch H2O. Radiator discharge will utilize a gravity type aluminum damper.

U.L. Listed Sub-Base Fuel Tank with Secondary Containment (UL listed):

- Tanks shall be designed for storage of diesel fuel at atmospheric pressure. Tanks are intended for stationary installation in accordance with the standard for flammable and combustible liquid code of national fire protection association, NFPA #30. The standard

- for installation and use of stationary combustion engine and gas turbines, NFPA #37 and the standard for emergency and standby power systems, NFPA #110.
- Fuel consumption will vary depending on generator supplier. Tank will be supplied with a fuel tank sized for 72 hours at full capacity.
- Vent sizes will be calculated using 100% of the wetted surface area of the four sides and in accordance with U.L.142 specifications.
- The vent openings shall be identified and be in addition to filling, withdrawal, or monitoring openings.
- 120 VAC fuel solenoid valve on fuel inlet from main tank
- Fuel connections for inlet and return from main tank sized per manufacturers recommendations.

**Drains and Fumes Disposal:** The package will be provided with oil and water drains to exterior of enclosure with a bronze body ball valve installed on engine and plumbed to exterior coupling with high quality hose. Fumes disposal will be extended to radiator discharge using an oil resistant high-quality hose.

## 2.11 EXHAUST SILENCER

A critical exhaust silencer shall be sized and supplied by the engine supplier. The silencer and associated piping shall not impose more than 27 in H<sub>2</sub>O restriction. Exhaust noise shall be limited 85 dba as measured at 10 feet in a free-field environment. (Note: Silencers mounted on the roof of the enclosure shall be 304 stainless steel construction.) Exterior silencers shall utilize stainless steel construction to prevent rusting and shall be mounted near the engine to minimize noise and condensation. A provision for draining moisture shall be included. Silencer and piping shall be fully floating with respect to internal growth due to thermal expansion and fully insulated within the building structure.

## 2.12 AUTOMATIC TRANSFER SWITCH, ATS

An Automatic Transfer Switch shall be provided as indicated on the drawings and as specified herein. The ATS shall consist of enclosed contact assemblies, a solid-state logic controller, a digital control panel, auxiliary control relays, and other hardware for a completely operational system.

The transfer switch shall be 100% equipment rated for continuous duty and shall conform to the applicable requirements of UL1008 for emergency total system load. The ATS shall bear the UL label and shall withstand a fault current of 22,000 amperes at 208 VAC. All power contacts shall be rated for multiple fault interruptions per UL 1087.

Control power shall be derived from the line side of the source to which the load is transferred. The ATS shall be capable of being operated manually and automatically under full load conditions. A permanently affixed manual operator shall accomplish manual operation. The manual operator shall provide the same contact-to-contact transfer time as provided under automatic operation. The ATS shall be positively interlocked, electrically and mechanically, to prevent simultaneous closing of both sources under automatic or manual operation. The ATS shall have a manual neutral position for load circuit maintenance. A contact position indicator shall be visible from the front of the switch. The ATS shall have an adjustable time delay in neutral to allow motors to stop prior to energizing circuit.

The ATS shall be provided with a digital control panel to allow the operator to view the status and control the operation of the transfer switch. The ATS shall contain a digital display capable of providing the following functions and capabilities:

- Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
- Display source status, to indicate source is connected or not connected.
- Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.

The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:

- Set nominal voltage and frequency for the transfer switch.
- Adjust voltage and frequency sensor operation set points.
- Set up time clock functions.
- Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
- Display Real-Time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
- Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
- Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, controller low DC voltage, ATS fail to close on transfer; ATS fail to close on retransfer, battery charger malfunction.

Transfer switch voltage sensors shall provide source availability information to the control system based on the following functions:

- Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
- Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
- Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
- Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
- Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
- Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
- Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

In addition, the automatic transfer switch (ATS) shall include the following minimum features:

- Engine starting contacts.
- Switch position contacts and indicating lights.
- Source status contacts and indicating lights.
- Time delay engine start adjustable 0.5 to 120 seconds.
- Time delay normal to emergency, adjustable 1 second to 20 minutes.
- Time delay emergency to normal, adjustable 1 second to 20 minutes.
- Time delay engine cool down, adjustable 10 seconds to 20 minutes.
- Test-Auto-Engine Start-Off selector switch.
- Weekly system exerciser, adjustable exercise time from 5 minutes to 4 hours.
- Spare contacts (Form C) for: ATS on utility, ATS on generator, generator overload, generator status, and generator alarm for remote indication.

## PART 3 EXECUTION

### 3.1 CONTRACT COMPLETION

#### Installation/On Site Testing:

The installation shall be performed in accordance with shop drawing, specifications, and the manufacturer's instructions; and shall comply with applicable state and local codes.

The generator set shall be tested as defined below by the manufacturer's authorized dealer to show it is free of any defects and will start automatically and carry full load. This testing is to be performed at the jobsite. Testing shall be completed in the presence of the owner's engineer or his appointed representative. The bidder shall furnish all consumables necessary for testing. The bidders at his/her own expense shall correct any defects, which become evident during the test. Fuel for testing and start-up to be at the expense of the Contractor.

Proper operation of the following shall be demonstrated:

- All auxiliary equipment supplied to this specification.
- Starting and charging system components.
- All controls, engine shutdowns, and safety devices
- Cold start test: The unit shall demonstrate the ability to start from a "cold" standby condition (i.e. normal standby mode with engine coolant temperature at normal temperature established by properly functioning jacket water heater).

#### 3.1.1 Load Bank Testing:

The unit shall be tested per NFPA 110 with the following minimums. The unit shall be operated at 80% of full load rating for one hour followed by two hours operation at 100% full load, using load bank test equipment. After the first half-hour stabilization period at full load, the following shall be recorded at fifteen-minute intervals:

- Voltage and amperage (3 phase), frequency
- Fuel pressure, oil pressure and water temperature
- Exhaust gas temperature at engine exhaust outlet
- Ambient temperature

3.1.2 Service Manuals and Parts Books:

The system manufacturer's authorized local dealer shall furnish one copy each of the manuals and books listed below for each unit under this contract:

- Operating Instructions: With description and illustration of all switchgear controls and indicators; and engine and generator controls and indicators.
- Parts Books: That illustrates and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
- Preventative Maintenance Instructions: on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
- Routine Test Procedures: For all electronic and electrical circuits and for the main AC generator.
- Troubleshooting Chart: Covering the complete generator set showing description of trouble, probable cause, and suggested remedy.
- Recommended Spare Parts List: Showing all consumables anticipated being required during routine maintenance and test.
- Wiring Diagrams and Schematics: Showing function of all electrical components.
- Preventative Maintenance Contract: Include a written PM agreement.

3.1.3 Training:

Provide a minimum of 8 hours of customer training onsite to include demonstration and testing of all equipment.

--End of Section--