

## SECTION 13

### **SEWAGE PUMPING STATION** **(Submerged Pump Type)**

#### **13.01 SCOPE:**

These Specifications form a part of the Contract Documents and shall govern for the construction of sewage pumping stations. The Work covered by this Section includes the furnishing of all parts, labor, equipment, appliances and materials, and performing all operations in connection with the construction and installation of sewage pumping stations complete with pumps, piping, wet well, controls, electrical work and all necessary auxiliary equipment. The station shall be complete and in strict accordance with this Section of Specifications and the applicable Plans and subject to the terms and conditions of the Contract. See Appendix D and E for Standard Details pertaining to this Section.

Where variable speed pumping is specified, all additional considerations relative thereto shall be provided including but not limited to pumps, controls, buildings, shelters, and accessories. Contract Drawings included in Appendix D and E are intended to reflect single speed pumping and shall be considered only as a general guide where variable pumping is specified.

#### **13.02 MATERIALS:**

Materials of this Section shall be as specified herein.

#### **13.03 INTENT OF PLANS AND SPECIFICATIONS:**

The intent of the Plans and Specifications associated with this Section is to provide a completed sewage pumping station which will function as intended and is ready for operation.

It shall be the responsibility of the Contractor as a part of this Work through careful quality control and coordination with the Engineer to avoid all conflicts occurring during construction such as available space, routings, mis-matched or otherwise incompatible component selection, incomplete systems, substitutions, etc.

Where inter-system components, devices, adaptors, etc., are not specified or noted in the design, but required to complete the system, it shall be the

responsibility of the Contractor to provide such items and material as a part of this work.

Unless otherwise noted, items specified herein by manufacturer or trade name shall be used as a guide to quality and inherent features and such reference shall not be intended to restrict the Project to such listing.

The Plans and Specifications included herein and Appendix D and E reflect single speed pumping. Where variable speed pumping is specified, all additional requirements associated therewith shall be met by the Contractor. Special Drawings and Specifications shall be submitted by the Contractor for the Engineer's evaluation covering all equipment, controls, material, and construction procedures for variable speed pumping.

The actual field installation shall reflect only that material and equipment submitted and approved by the Engineer. Any work performed without an approved submittal and considered not acceptable by the Engineer shall be removed and reworked at the Contractor's expense.

#### **13.04 SUBMITTALS AND TESTS:**

##### **A. Submittals:**

Prior to installation of any material or equipment, the Contractor shall submit for approval of the Engineer, five sets of required submittal material indicating item identification, manufacturer, type, size, ratings, and other descriptive information required for adequate evaluation. Wiring diagrams shall be submitted where item function description necessitates, and as required by the Engineer. Submittals shall be conspicuously marked to denote departures from the design references shown on Plans or specified. Incomplete or otherwise indiscernible submittals will not be evaluated.

Submittals shall bear a stamp or specific written indication that the Contractor has satisfied his responsibilities under the

Contract with respect to the Contractor's review of the submission.

Omissions and/or design revisions made in submittals shall not relieve the Contractor from the responsibility of providing the omitted item or required material as a part of this Work. Approval by the Engineer shall not constitute acceptance of an erroneous or incomplete system submittal.

The Contractor, at his option, may submit for evaluation two copies of submittal material, one of which will be marked and returned. The required number of copies, corrected as marked, will then be submitted for approval stamping to the Engineer.

1. Material submittals shall be manufacturer's catalog sheets or similarly published data marked to denote only the item or items covered by the submittal. Materials of unique production shall have special submittal attention to give complete identification of the materials being proposed.
2. Equipment submittals shall present the equipment for evaluation as a unit piece including all component parts by manufacturer's designation. Submittals shall be marked to denote only the equipment being proposed and shall be complete including electrical, physical, and operational data. Additional supporting data shall be provided where necessary.
3. Fabrications, assemblies, and special productions shall have submittals of unique preparation to present the finished item completely identified. Such Shop Drawings shall include all material, components, and assembly work.
4. Systems composed of multiple component parts or subsystems shall have submittals to denote the system as a completed composite. All component parts and subsystems shall be identified.

5. Documentation of the finished installation shall be made as a part of final acceptance and shall include corrected submittals, operation and maintenance publications, and other data necessary to accurately define the final field installation.

**B. Tests, Instructions and Reports:**

The following listed items shall be required in addition to other special requirements within these Specifications.

1. Written conductor insulation resistance test.
2. Written ground rod resistance test.
3. Local public electrical inspector's certificate.
4. Operational demonstration test.

**13.05 CLEARING:**

In general, clearing shall consist of the removal and disposal of all undergrowth, brush, logs, trash and other objectionable obstructions. All materials cleared from the site shall be disposed of off the site by the Contractor. It is the intent that the entire area within the limits of the sewage pumping stations as shown on the Plans shall be cleared.

**13.06 EXCAVATION FOR PIPES AND STRUCTURES:**

**A. General:**

The Contractor shall perform excavation of every description regardless of the nature of the materials encountered. Trenches or foundations for pipes or structures shall be excavated to the lines, grades, and elevations shown on the Plans. Trench and structure excavations shall be of sufficient size to permit the placing of pipes and forms.

**B. Overcuts:**

If at any point in excavating for structures material is excavated beyond the neat lines upon or against which concrete is to be placed, the overcut shall be filled with reef shell, crushed slag or crushed stone fill

properly compacted, or with concrete, as directed by the Engineer. The proposed elevations and positions for the different structures are shown on the Plans; however, the Engineer reserves the right to make such modifications as in his opinion are necessary to carry out the intent of the Plans or Specifications. No payment will be made for overcuts or reef shell, crushed slag or crushed stone fill in overcuts. Reef shell, crushed slag or crushed stone shall be as specified in Section 16 entitled "Erosion Control."

C. Dewatering:

Should lowering of ground water be necessary for the installation of concrete structures, piping, etc., or to prevent lateral movement of material under concrete already placed, such lowering shall be accomplished in accordance with Section 10 entitled "Special Provisions", paragraph entitled "Dewatering," at no additional cost to the Owner.

**13.07 CONCRETE:**

The minimum compressive strength required at 28 days is 3000 pounds per square inch. Field specimens and laboratory tests shall be made in accordance with the standards of the American Society of Testing Materials. The minimum amount of water shall be used to produce a workable mix and shall not exceed 6 U.S. gallons per sack of cement.

**13.08 WET-WELL:**

The foundation of the wet-well shall consist of a reinforced concrete slab poured on undisturbed earth in accordance with details shown on the Plans. See Appendix D.

The barrel of the wet-well shall be constructed of sections of reinforced concrete pipe conforming to ASTM 3 Specification Designation C76, Class II. Concrete for pipe shall be Type II Portland Cement with 100 percent calcareous aggregate.

The diameter, height, opening and other details shall be as shown on the Plans. See Appendix D.

Joints shall be made with rubber gaskets or an approved equal.

**13.09 CERAMIC EPOXY LINING FOR WET-WELL:**

Materials:

- A. General – All Materials incorporated in the Work shall be delivered to the Work site in new, unopened containers bearing the label of the supplier. The containers shall be handled and stored in compliance with the supplier's recommendations, and in such a way as to protect adequately the contents from damage, deterioration, and contamination.
- B. Lining Compound – The materials, installation, and testing used for lining shall be as specified in Section 12 entitled "Sanitary Sewers", paragraph entitled "Ceramic Epoxy Lining for Concrete Pipe".

**13.10 BACKFILL FOR PIPES AND STRUCTURES:**

Backfill requirements for pipes and structures of this Section shall be in accordance with Section 15 entitled "Backfilling," paragraph entitled "Backfilling for Pumping Stations."

**13.11 TOPSOIL:**

The final top 4 inches of soils at the sewage pumping station site shall be a good quality topsoil in accordance with Section 16 entitled "Erosion Control", paragraph entitled "Topsoil".

**13.12 SOLID SOD:**

All areas shown on the drawings to be grassed shall receive solid sod in accordance with Section 16 entitled "Erosion Control", paragraph entitled "Solid Sod".

**13.13 FENCE:**

A. Chain Link Fence:

The fence fabric shall be zinc-coated Class II steel chain link per ASTM Specification A392, 2-inch mesh, number 9 gauge with three strands of galvanized barbed wire (4 barbs, No. 12-1/2 wire size minimum) on 45 degree angle arms at top of galvanized steel line posts, or H Columns with nominal weight of not less than 4.1 pounds per foot. All corner, end, and pull posts shall be 2-7/8

inches O.D. (minimum) standard galvanized steel pipe or 3-1/2 inches by 3-1/2 inches rolled formed sections with integral fabric loops, 5.14 pounds minimum per foot. Corner posts shall be braced in both directions and gate posts shall be braced to the nearest line or corner post. Pipe posts shall have tops which exclude moisture.

Top rails shall be a minimum of 1-1/4 inch (6.11 inch O.D.) standard weight galvanized steel pipe. Total height of fence shall be 7 feet with the wire fabric being 6 feet. Spacing of line posts shall be uniform and shall not exceed 10 feet. Line posts shall be set in concrete bases 36 inches deep and 10 inches in diameter, minimum. All corner, gate and brace posts shall be set in a foundation 36 inches deep, minimum, and 14 inches in diameter, minimum.

Traffic gate shall be double-leaf, swing type for a 12-foot opening for heavy duty service matching the fence. A brass weatherproof padlock shall be furnished for the gate, of the 4-pin tumbler type (minimum), and the Owner shall be provided with keys as noted in Section 10 entitled "Special Provisions."

Posts, rails, hardware and fittings shall have a minimum zinc coating not less than required by ASTM Specifications A120, A123, or A153, whichever is applicable.

**B. Wood Fence:**

The fence shall be constructed of first class wood to the lines indicated on the Plans.

Treated wood posts of 4 by 4 nominal dimensions set a minimum of 36 inches deep in the ground shall be no greater than 8 foot centers.

Post holes shall be concrete filled.

Treated wood stringers of nominal 2 by 4 dimensions shall be placed between the posts for the fastening of fence boards.

A minimum of three stringers shall be used between each set of posts.

The fence boards shall be 6 inches wide by 3/4 inch thick and shall be treated No. 2 pine, or better, with dog-eared tops. Boards shall

be straight and true when erected. The complete height of the fence shall be 6 feet.

The finished fence shall be straight and true to the lines indicated on the Plans. All defective or out-of-line work shall be removed, replaced and repaired at no additional cost to the Owner.

All fasteners and hardware shall be galvanized.

All cracks or openings greater than 1/4 inch shall be repaired.

Traffic gate shall be double-leaf, swing type for a 12-foot opening for heavy duty service matching the fence. The hinges shall be adequate to support the weight of the gate. There shall be furnished a brass weatherproof padlock for the gate of 4-pin tumbler type (minimum), and the Owner shall be provided with keys as noted in Section 10 entitled "Special Provisions".

**13.14 ACCESS DRIVE:**

Access drive paving and base course shall be constructed according to the State of Alabama Highway Department Standard Specifications for Highway Construction, latest edition.

**13.15 SUBMERSIBLE PUMPS:**

A. All pumps of the same type, frame and size shall be of the same manufacturer and shall have interchangeable parts, and shall be a type and brand listed as approved by the Board of Water and Sewer Commissioners of the City of Mobile for use in the Mobile Area Water and Sewer System. All screws, small bolts, nuts, washers and miscellaneous items normally subjected to corrosion shall be constructed of Everdur, Monel, bronze, or stainless steel exceeding 12 percent chrome and 7 percent nickel. All completed and installed operating pump units and accessories shall be suitable for the intended location and service and shall be free of operating problems, unusual vibrations and noise in a pump unit or accessories shall be corrected, and if necessary, the entire unit shall be replaced at no additional cost to the Owner.

B. General – Motors shall be rated as to full load horsepower values shown on the Plans (see Appendices) and shall have electrical characteristics corresponding to the electrical power system at the installation. The motor shall be designed for continuous operation and shall be non-overloading over the entire operational range of the pump.

Thermal sensors shall be used to monitor stator temperatures. Sensors shall be built into the motor, be supplied by the motor manufacturer, and activate a switch upon high temperature.

The motor shall have bearings designed for a minimum B-10 life of 15,000 hours and shall be equipped with moisture sensors located between two mechanical seals in an oil-filled seal chamber for external seal-failure alarm.

The motor shall be labeled by Underwriters Laboratory, Inc., Factory Mutual, or Physical Technical Bureau as approved for use in Class I, Division 1, Group D hazardous locations and rated as suitable for submergence in raw sewage.

Pumps with motors less than 21 HP, except grinder pumps, shall have a recessed impeller allowing passage of 3-3/4" diameter solids. Pumps with motors greater than 21 HP shall be a non-clog design which will pass 3" diameter solids.

All pumps except grinder pumps, shall have a 4" minimum diameter discharge with flange for connecting to a discharge pipe. Grinder pumps shall have a minimum 2" diameter discharge connection.

Unless otherwise specifically noted, not less than 30 feet of heavy-duty grease resistant submersible, multi-conductor electrical power cable and pilot cable each with grounding conductor shall be provided connected to the motor ready for operation.

Provide not less than four copies of technical information and parts listing, including recommended maintenance, describing pumps and motors including pump performance curve, minimum submersion head for pumps and range of

available impeller sizes and their power requirements.

Provide written five (5) year Limited Warranty (100% 1<sup>st</sup> year, 50% years 2 – 5) for replacement of pump and motor for failure of satisfactory performance and for defective parts or assembly.

Pumps provided for variable speed duty shall, in addition to requirements specified herein elsewhere, be provided with the following written documentation by the pump manufacturer.

1. The pumps furnished shall be suitable for the variable speed duty at the conditions encountered at the installation location.
2. The types of pumps and drives to be used in this service shall have been in satisfactory operation in similar services for a minimum of one year.

C. Pump Installation – Pumps shall be installed in accordance with the manufacturer's recommendations, and as approved. Where guide bars are indicated, pumps shall be mounted on guide bars as shown on the Plans (see Appendices). The size of the guide bars shall be determined by the pump manufacturer. Anchor bolt size and material shall be as recommended by manufacturer. Coat bolt thread projections with lubricant to facilitate future nut removal.

D. The Contractor shall provide in a suitable substantial case any special tools or adjustment devices necessary for the proper maintenance and adjustment of the equipment furnished. This shall include all special or unusual items necessary for the dismantling and assembling of all furnished equipment.

E. Four instruction manuals, clean and unused, shall be delivered to the Owner for the pumps, motors and all accessories. Each instruction manual shall carry the serial number of the piece of equipment to which it applies, design data, operating instructions, lubricating instructions, maintenance instructions, and assembly drawings showing location of parts and test

curve. Each instruction manual shall be bound in a stiff back folder with the name of the plant and the unit numbers or name embossed on the outside.

F. The Contractor shall furnish and install all necessary break-in lubricants and all final lubricants as recommended by the manufacturer for all pumps, motors and accessories.

G. Supplier's/Manufacturer's Services:

A supplier's and/or manufacturer's representative for the equipment specified herein shall be present at the job site and/or classroom designated by the Owner to provide the minimum services listed below, travel time excluded:

1. Installation assistance, inspection, and written certification of installation acceptability for each pumping system.
2. Functional testing.
3. Metering for acceptance testing.
4. Startup services and training of Owner's personnel shall be at such times as requested by the Owner.

H. Start-Up:

The Contractor shall furnish the services of an engineer, representing the manufacturer or group of manufacturers for each equipment grouping or system within the Project, for checking the installation, making the necessary adjustments, placing the equipment in operation, and during acceptance tests. This includes radios, remote telemetry units, and the computer system in the Williams Plant central control room. The representatives shall be available for no less than one 8-hour day scheduled with the Owner to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial on-line operating period. All components and equipment shall be installed in accordance with the recommendations of the manufacturer.

Operating tests shall be made on all equipment in the presence of the Owner and the Engineer or their representatives in order to demonstrate the entire facility to be complete, functional, and ready to be placed in operation.

Operating instructions shall be given to the Owner's regular operating personnel by the equipment manufacturer's representative where complex equipment is provided and by the Contractor for other equipment in order to thoroughly familiarize the operators in the correct procedures and functions for operating and maintaining the facility.

I. Variable Speed Pumps:

1. Where a variable speed pump installation is provided, the pump manufacturer/supplier shall furnish the pumps and associated variable frequency controlling system as sole-source responsibility. The manufacturer/supplier shall provide a written guarantee for the pumps and controls as a single unit installation relative to materials quality and durability, system performance, and coordinated completeness of the overall system.
2. Performance curves for the variable speed pumps shall be submitted to show families of curves for the ranges of pressures, flows, and speeds anticipated at the specific location of the pumps within the hydraulic system.

J. Pump Identification Plate:

A 16-gauge stainless steel identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the ¼ inch die-stamped equipment identification number that is assigned each pump in the Pump Specification Sheets and shown on the Plans (see Appendices).

K. Lifting Lugs:

Equipment weighing over 100 pounds shall be provided with lifting lugs.

L. Performance Test:

The Contractor shall perform field tests on all completed pump and control system assemblies, as required by the Pump Specification Sheets, to demonstrate their conformance to the Specification to the satisfaction of the Engineer. A test log shall be presented to the Engineer upon the completion of each test that records the following:

1. Flow, in gallons per minute.
2. Pump discharge pressures as measured by calibrated gauges, converted to feet, of the liquid pumped and corrected to pump datum as defined by Hydraulic Institute.
3. Standards, calculated velocity heads at the discharge flanges, and total head, all tabulated in feet.
4. Applied voltage and amperage measured for each phase.
5. Complete nameplate data.

M. Factory Tests:

1. Pumps – A factory test certified by the pump manufacturer's test representative shall be performed on all pumps actually furnished, and written notice of the same shall be furnished to the Engineer. Information required to be furnished at the time of test is necessary to show conformance to specified performance. Tests shall conform to the Hydraulic Institute Standards test code.
2. Motor Tests and Test Reports – As specified in Pump Specification Sheets. Pump drivers shall not be overloaded within a 1.0 service factor rating at any point on the pump curve.
3. Balance of Vibration – The rotating parts of each pump and its driving unit shall be dynamically balanced before final assembly. The driving

unit alone shall operate without vibration in excess of the limits stated in the latest revision of NEMA MG 1.

N. Functional Test:

Prior to plant startup or field performance test, all equipment described in the Pump Specification Sheets following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

O. Spare Parts:

Spare parts shall be furnished for pumps to provide 12 months of full time service, and special tools required for that service shall be suitably boxed and marked for shipment and storage.

**NOTE: See attached Pump Specification Sheets for pump system and performance warranty requirements. All pumps, both single and variable speed, shall be on the Board's list of materials and approved manufacturers.**

**13.16 VALVES AND PIPING:**

Valves and piping shall be located as shown on the Plans. Gate valves, check valves, and flanged ductile iron piping shall be as specified on the attached Specification Sheets.

**13.17 ELECTRICAL:**

- A. All electrical material and equipment provided by the Contractor shall be new and free of defects. All work performed under this Section of the Specifications shall be carried out by skilled workers regularly engaged in the performance of such duties. The entire electrical installation shall not be less than that required by the latest edition of the National Electrical Code, the Occupational Safety and Health Act, and all electrical codes locally enforced in the Project area. The Contractor shall obtain all permits required by local ordinances; and after completion of the Work, shall give the Engineer a certificate of final inspection and approval from the local Electrical Inspection Office. Any expenses connected with such

inspection and certificate shall be borne by the Contractor.

Electrical material and equipment shall be designed in accordance with the latest requirements of applicable standards such as NEMA, ANSI, IEEE, and where listings are available for such items shall be approved by the Underwriters Laboratories, Inc. Equipment, components, material, etc., rated by other standards and agencies, including but not limited to IEC, VDE, and DIN, will not be considered equal to NEMA, ANSI, IEEE, and UL. Electrical items shall be standard cataloged products of manufacturers regularly engaged in the manufacture of such products, unless otherwise noted.

B. Grounding:

1. Non-Current Carrying Metal Parts of electrical items such as cabinets, enclosures, frames, etc., and the neutral conductor shall be grounded in accordance with the National Electrical Code unless additional grounding requirements are indicated. Grounding conductors shall be copper, sized as noted. Special grounding system features shall be provided as indicated.
2. All Conduit Runs installed for lighting and power loads shall contain a grounding conductor throughout the entire length of the run forming a part of the grounding system. The grounding system shall be electrically continuous throughout the electrical system and shall be connected to earth ground at the point of power service and as otherwise indicated.
3. Ground Rods shall be copper-welded steel type, 3/4 inch diameter, 20'-0" length, minimum. The top of the ground rods shall be driven to 1'-0" (minimum) below finished grade unless otherwise indicated and shall be electrically connected with suitable cast-type ground clamps or exothermic welding.

4. Resistance to Ground of each ground rod shall not exceed 25 ohms when measured during dry weather. In the event this value is not obtained, one additional rod or rod section equal to that tested shall be driven. Should the additional rod or section fail to achieve the required value, the Engineer shall be immediately notified. A written record of all resistance measurements and test dates shall be submitted to the Engineer prior to completion of the Project.

C. Lightning and Surge Protection:

Lightning Protector Units shall be provided for power circuit protection at the main service connection point and elsewhere as noted on the Plans. Lightning protectors shall be Innovative Technology Inc. P3D for three and single-phase circuits, respectively. Lightning protectors for radio antennas shall be in accordance with antenna manufacturer's recommendations.

D. Insulation Test:

1. Circuit insulation tests shall be performed to prove each circuit free of faults after all wiring is completed prior to equipment and fixture connections, and again after the installation is complete and ready for use.
2. Tests shall be made at the main electrical service connection between all conductors and between line conductors and ground. Tests shall be made with a 500 Vdc instrument capable of accurately measuring the resistance involved. Readings shall be taken in the presence of the Engineer or his representative for each test and the written results of each test shall be submitted to the Engineer.

E. Conductors:

1. Single Conductors Installed in Raceways shall be copper with AWG sizes as noted, and shall have 600 volt rated, type THW,

THHN/THWN or XHHW, 75 degrees C (minimum) insulation. Conductors requiring special consideration shall have insulation material and ratings noted on the Plans and as required by the National Electrical Code. Type TW insulation shall not be used for any purpose in this Contract except ground wire identification only.

2. Lighting and Power Conductors shall be minimum size No. 12 AWG, with AWG No. 8 and larger to be stranded, and AWG No. 10 and smaller to be solid unless otherwise noted. Conductors shall be stranded where movement, vibration, or other flexing occurs in order to prevent conductor fatigue. Control conductors may be AWG No. 14 stranded, and inputs to remote telemetry units (RTU) may be 16 gauge, unless otherwise noted.
3. Insulation Colors shall be: Green for ground; white for neutral; and black for single phase line conductor. "Stinger" phase conductor of 120/240 V systems shall be orange as per NEC 215.8. Unless otherwise noted, a uniform insulation color scheme for all new three-phase systems shall be established as black for phase A, red for phase B, and blue for phase C. Control circuit insulation shall be yellow. Conductors size AWG 10 and larger may be black with entire exposed ends taped with "Scotch #35", or equal by Plymouth, in accordance with color schemes mentioned herein.
4. Direct Buried Grounding System Conductors shall be bare copper, sized as noted.

F. Splices and Terminations:

1. 600 Volt System conductors shall be spliced with "Ideal Wire-Nuts", or equal by T & B, for AWG Number 10 and smaller for dry areas, and machine crimped or

bolted connectors with "Scotch 88," or equal by Plymouth, full coverage tape for all other splices. Soldered and taped splices will not be acceptable. Terminations shall be made with mechanical lugs or other acceptable termination features of the equipment supplied.

2. Control Conductors and RTU Inputs shall terminate on box clamp, binding post screw, or set screws only. Soldered, taped, and free-standing connections will not be acceptable.

G. Conduit:

1. Steel Conduit shall be provided unless otherwise indicated and shall be heavy-wall, rigid galvanized type bearing the Underwriters Laboratories, Inc., label of approval. Conduit minimum size shall be ½ inch. Steel conduit and fittings installed through concrete shall be manufactured with an exterior 40 mil thick polyvinyl chloride bonded jacket "Plasti-Bond" by Robroy, or approved equal. Fittings for rigid steel conduit shall be threaded types made up with conductive waterproof compound. Poured seal fittings shall be provided as required by the National Electrical Code and shown on the drawings.
2. All Conduit shall be clean and free from dents, scars, or other deformities. Connections shall be made up watertight, and bushings shall be provided where smooth hubs are not encountered. Changes in directions shall be made with symmetrical bends or conduit boxes. Field-made bends shall be made with an approved hickey or conduit bending apparatus. Conduit runs shall be installed parallel or perpendicular to structural members. Conduit hangers and supports shall be provided at intervals recommended by the manufacturer and the National Electrical Code.

Underground conduit runs shall be installed at least 1'-6" below finished grade unless other depths are indicated. Plain earth used for backfill shall be free from objectionable material such as rocks, glass, metal, wood, etc., and shall be tamped to surrounding earth density.

3. All Conduit routed from the RTU to the wet-well shall include an expansion proof seal at the control box. Seals shall be poured with sealant as per the National Electrical Code.

#### H. Cable Connectors and Supports:

1. Conduit runs into the wet-well for cable protection shall be positioned to suit field conditions to achieve an unobstructed passage for removal and installation of pumping units and shall provide close accessibility to allow removal of the cable connector by maintenance personnel from outside and above the wet-well.
2. Cables entering conduit protection and as otherwise noted shall be fitted with connectors sized to suit the cable and conduit actually installed. Connectors shall be plastic body and threaded cap type with neoprene or equal internal gas-tight compression gland.
3. Cable grips shall be provided as strain relief for cables and shall be wire mesh offset eye, closed mesh type, all fabricated with 304 stainless steel and shall be sized to suit the cable actually installed.

#### I. Receptacles:

1. Duplex Convenience Receptacles shall be rated 15 amps, 125 volts, 2 pole, 3 wire, grounding type, specification grade, NEMA configuration 515R, ground fault interrupting type, unless otherwise noted. Receptacles shall be brown for unfinished areas and ivory for

finished walls. Where installed in damp locations, receptacles shall be installed in weatherproof enclosures.

2. Special Receptacles shall be provided as noted and shall have electrical ratings, pole configuration, and number of poles as shown or required. Enclosures, receptacle types, and other special features shall be suitable for the duty and conditions encountered.

#### J. Switches:

Safety Switches shall be provided where indicated and elsewhere as required by the National Electrical Code. Safety switches shall be heavy-duty type, with voltage, current, fuses, number of poles, and enclosure types as noted. All switches requiring security including main power service, transfer, and switches installed out-of-doors, shall be provided with padlocks as hereinafter specified. NEMA 3R switches installed out-of-doors, in corrosive areas, or in wet or damp areas shall be thoroughly cleaned of surface films after installation and given one coat of Indurall rapid dry epoxy primer H-1175 and two final coats of Indurall two-part epoxy paint "Perma-Clean", or approved equal, in color approved by the Engineer.

#### K. Fuses:

1. Unless otherwise noted, fuses provided for motor protection and other general purpose loads shall be dual-element type, "Buss Fusetron", or equal by Shawmut, with voltage and current ratings as required.
2. Control circuit fuses shall be "Buss FNM" for 120-volt circuits and "Buss KTK" for 480-volt circuits, or equal by Shawmut. Unless otherwise noted, control circuit fuses shall be installed in terminal strip mounted switch action fuse blocks rated for 15 amps at 600 volts.

L. Circuit Breakers:

1. Branch and feeder circuit breakers shall be thermal-magnetic, molded case, industrial type, unless otherwise noted, and shall be listed by the Underwriters Laboratories, Inc. for not less than 14,000 amps symmetrical interrupting at 480 volts. Voltage, trip and frame current ratings, and number of poles shall be as indicated or required. Circuit breakers shall have trip-free operating handles with trip current rating permanently molded therein.
2. Circuit breakers provided as an integral part of combination motor starters may be as specified herein or may be magnetic only type manufactured specifically for motor protection duty and set for the actual motor nameplate data.
3. Circuit breakers provided to serve 120 volt lighting, receptacles, and other small loads shall be rated by Underwriters Laboratories, Inc. for not less than 10,000 amps symmetrical interrupting, and otherwise shall be as specified herein. Multiple circuit breakers shall be factory assembled and sealed. Tandem-type breakers and bailed-tied handles of single-unit breakers are not acceptable for this work.

M. Motor Starters:

1. Starters shall be sized in whole increment NEMA designation with voltage rating poles and enclosure as noted or otherwise required. Starters shall be approved by the Underwriters Laboratories, Inc. Ambient temperature compensated overcurrent protection shall be provided in each ungrounded phase of the circuit and shall be sized to suit the motor provided. Auxiliary equipment including contacts, selector switches, pushbuttons, lights, control power transformer,

fuses, etc., shall be provided as noted or otherwise required.

2. Starters shall be designed and rated in accordance with NEMA Table 2-321-1. Ratings by IEC, VDE, DIN, etc., will not be considered for this work. Terminal temperature rise rating shall not exceed 50 degrees C. Operating coils and overcurrent sensors shall be readily and independently replaceable in the field without requiring complete starter exchange.
3. Starters indicated as being combination type shall be circuit breaker type motor circuit protector combination type set to suit the motor provided.
4. Starters shall be magnetic type, full voltage, non-reversing, NEMA Size 1 minimum with wiping style contacts, unless otherwise noted.

N. Variable Speed Controls:

1. Pumping stations designed for variable speed pumping shall be two-pump, pump-down, continuous near linear transition flow type unless otherwise noted herein or on associated Plans. A wet-well mounted analog level sensor shall be provided to produce a 0-20 ma control signal for processing by the control system. Separately mounted NEMA 4X enclosed units with adequate structural support racks shall be provided for the variable-speed drive electronics and the two pump motor controllers. Where required by the equipment manufacturer, a building or other approved shelter shall be provided as a part of the work in order to utilize NEMA 12 type enclosures.
2. The control box shall house the common level detecting and speed processing components. These components shall be of solid-state electronic design. The following

minimum features shall be provided on the control panel:

- a. Digital depth of liquid in feet.
  - b. Hand-off-automatic switching for each pump.
  - c. Manual speed set for each pump.
3. Pump motor controllers shall be variable frequency, pulse width modulated, voltage source design, and shall be marketed as a successful controller by a nationally known firm as an equal product for a minimum of one year. Internal controller circuitry shall be solid-state electronics. The following minimum features shall be provided:
- a. Controller horsepower rating shall be a minimum of 1.15 of the pump motor nameplate rating.
  - b. Speed turn-down of 10:1 (minimum).
  - c. Internal speed monitoring without remote feedback.
  - d. Hand-off-automatic switch.
  - e. Manual speed set.
  - f. Reset pushbutton.
  - g. Digital speed readout, RPM.
  - h. Internal adjustment settings for:
    - (1) Acceleration rate.
    - (2) Deceleration rate.
    - (3) Speed limit.
    - (4) Overcurrent protection.
  - i. Ambient temperature rating 0-40 degrees C.
  - j. Controller overheat shut-down with alarm indication.

k. Motor overheat shut-down.

l. Voltage, phase, and frequency input to suit the characteristics of the power supply system at the station location.

O. Special Control Panel:

1. Control panel and remote telemetry enclosure shall be surface mounted NEMA 4X 304 stainless steel Hoffman style A-SSLP type construction. Control components shall be as indicated on the Plans (see Appendices). Control panels and RTU enclosures shall be provided with padlocks as specified herein. Keyed locks with switches shall also be installed and shall provide inputs to a remote telemetry unit to indicate authorized entry. Dimensions shall be as shown on the Plans (see Appendices). Stainless steel cabinets shall be brushed finished. All drilling and cutting shall be smooth, and escutcheon plates or bezel rings shall be provided on all openings.
2. Control components and associated items shall be as shown on the Plans (see Appendices) and in accordance with other applicable paragraphs of these Specifications. Component arrangements shall be as shown on the Plans (see Appendices). Panel manufacturer shall completely wire the panel using AWG No. 14 (minimum) conductors rated XHHW, 75 degrees C (minimum). Each end of all conductors shall be identified with permanent type markers corresponding to Shop Drawing wiring diagram submitted for the control panel. All field wiring shall be connected to terminal strips or lugs of starters, contractors, or other larger components. Each conductor within the panel shall be labeled at each end for identification.

3. A plastic laminated electrical schematic of the controls shall be permanently mounted to the inside surface of the cabinet door of all control panels.
4. Shop Drawings showing physical dimensions, component placement, and complete coordinated composite control diagrams and elementary diagrams shall be submitted to the Engineer for approval and shall show the individual control components by manufacturer's catalog number and the wire numbers actually connected in the completed installation. Complete coordinated Drawings are to include all devices internal and external to the control panel.

P. Control Components:

1. Selector Switches and Pushbuttons unless otherwise noted shall be round style, heavy-duty, oil-tight type equal to Square D Class 9001, Type K, or Cutler-Hammer Type T, and shall have nameplate lettering as noted on the Plans. Miniature style units will not be acceptable unless otherwise noted on the Plans. Operator mechanism including locking ring and legendplate shall be of corrosion resistant material. Mechanisms exposed to corrosive atmospheres or wet areas shall be NEMA 4X rated. Switch contacts shall be arranged for the configuration and duty as indicated, and operating handles shall be easily operated by hand without the use of tools. Pushbuttons shall be momentary or maintained contact type as indicated. Switches and pushbuttons located remotely from the controller shall be with lockout features. Where control unit exhibits corrosion or other physical failure during the Contract time frame, the Contractor shall replace the entire item at the expense of the Contractor.

2. Control Relays shall be equal to Square D, Type X, 120 volt, fixed mounting type, molded case frame industrial type, with number of poles, contact arrangements, and operating voltages indicated. Contacts shall be convertible type rated for at least 10 amps. Relays noted to have time delay actions shall be adjustable type with time delay values as noted. Contacts shall be convertible type and shall be readily replaceable without requiring complete relay exchange. Open style, "Ice Cube" style, and plug-in type relays will not be considered for this work unless specifically noted on the Plans. Relays shall be NEMA rated and Underwriters' Laboratories, Inc. approved. Ratings by IEC, VDE, DIN, etc., will not be considered for this work. Relays with special voltage ratings or designated as special purpose relays shall be provided where indicated.
3. Resistance Relays shall be provided for the moisture detection (seal failure) circuits and shall be solid state sensing with 10 volt, DC, external sensing circuit and 16 amp at 120 volts output control contacts. Relay unit shall be Warrick 2800-ICO, for air-filled motors and 2DIFO for oil-filled motors. Set point resistors shall be selected to suit the process liquid characteristics.
4. Power Failure Relays shall be plug-in type with special fixed mounted socket and shall be rated for the voltage supplied to the facility. The relay shall have a 20 percent (minimum) adjustable range below normal voltage rating and output contacts rated for 3 amps at 115 volts. Relay shall be Time-Mark No. B252B or equal by General Manufacturing Company.
5. Float Switches shall be a sealed type PVC foam filled with hermetically sealed switch, 5-1/2 inch, 10 amps, 115 volt, tilting

mercury switch; and extra-flexible cable connection. Float switches shall be "Consolidated Model LS", Anchor Scientific, or equal, complete with supporting yoke and clamp assembly. Cable suspended pendant type switch units will not be considered equal.

Q. Special Hardware:

1. Nameplates provided to identify component duty or associated equipment on control centers, special panels, etc., shall be black-laminated plastic type with white engraved characters as indicated and shall be fastened with screws. Adhesive attachment methods will not be acceptable.
2. Legendplates for pilot lights, switches, etc., shall reflect wording shown on the Plans and shall be non-corrosive metal types fastened by the device locking ring.
3. Concrete Masonry Inserts shall be self-driven expansion type "Phillips Red Head", or equal by Star.
4. Padlocks shall be brass weatherproof padlock for the gate, of the 4-pin tumbler type (minimum), and the Owner shall be provided with keys as noted in Section 10 entitled "Special Provisions". Padlocks shall be provided on all lockable items including:
  - a. Service Disconnect and Transfer Switches.
  - b. Control Panels.
  - c. Access Hatches.

R. Miscellaneous:

All devices, equipment, and materials not definitely specified or noted that are required for complete installations shall be manufactured for the purpose intended and shall be installed in conformance with good accepted practice for the conditions

encountered. All hardware such as straps, supports, bolts and nuts shall be of rust or corrosion-resistant material unless otherwise noted.

S. Painting and Touch-Up:

All electrical equipment, cabinets, and items that require protective painting shall be painted in accordance with the item manufacturer's standards except that this shall not be less than a three-coat system suitable for the exposure intended in this Project. After installation, items including welded seams shall be thoroughly cleaned of grease, dirt, rust, and foreign matter and repainted or touched-up as required with the same color paint applied at the factory.

Unless otherwise approved by the Engineer, and in addition to the normal approval action, all items with carbon steel enclosures installed out-of-doors, in corrosive areas, or in wet or damp areas shall be thoroughly cleaned of surface films after installation and given one coat of Indurall a rapid-dry epoxy primer H-1175 and two final coats of Indurall two-part epoxy paint "Perma-Clean", or approved equal in color approved by the Engineer.

**13.18 CONTINUITY OF OPERATIONS:**

The Contractor as a part of this Work shall provide all stand-by facilities, power systems, etc., in order to maintain the operations of existing facilities throughout the construction phases of the new work. The Contractor shall schedule his work with that of the Owner in order to coordinate all interruptions of the existing facilities operations to suit the Owner's schedule. All temporary facilities and provisions shall be made after being submitted to the Owner and approved thereby.

**13.19 ELECTRIC POWER METERING:**

The Contractor shall provide all labor and materials required for a complete installation to meter electrical power usage in accordance with the power company's detailed requirements. Meter location shall be as shown on the Plans. Contractor shall contact Alabama Power Company regarding new or revised installation. Power company shall supply new meter socket free of charge. Contractor shall install meter socket and coordinate power hook-up by power company.

The Contractor, at his own expense, shall provide power and all necessary temporary wiring as required to perform his work. After completion of the permanent electrical connections, the Contractor shall be required as a part of this Work to secure all utility services from the respective utility companies and shall pay all monthly bills until such time as acceptance of the equipment is made by the Owner. Upon acceptance, the Contractor can have the respective utility companies transfer their billing to the Owner's name.

**13.20 ELECTRICAL SERVICE:**

When required and as instructed by the Owner, the Contractor shall request 3-phase power service from the utility company, and shall make arrangements for the utility company to bill the Owner directly for any installation charges, other than those associated with power metering, for the service.

**13.21 DEFINITION OF ACCEPTANCE:**

System acceptance shall be defined as the point in time in addition to the requirements of Section 5 when all of the following requirements have been fulfilled:

- A. All submittals and documentations have been submitted, reviewed and approved.
- B. Operations and Maintenance Manuals have been submitted on all equipment items.
- C. The complete system has successfully passed all testing requirements.
- D. All fees, permits and reports have been satisfactorily completed.
- E. All Owner's staff personnel training programs have been completed.
- F. Beneficial use by the Owner has occurred.

**13.22 CLEAN-UP:**

After final operation tests, the interior and exterior of the station shall be cleared of all trash and debris and left in final operating condition. Final grading of the site and restoration of surfaces with grass shall be in strict accordance with the applicable Plans.

**13.23 CONTROLS AND COMMUNICATION:**

A. Overview

- 1. The Board of Water and Sewer Commissioners of the City of Mobile, Alabama has installed a supervisory control and data acquisition system (SCADA) at the Williams Wastewater Treatment Facility at McDuffie Island. This system is designed to control the operation of the Williams Plant, monitor the operation at the Ziebach Plant, and monitor the status of sewer lift stations throughout Mobile County. It is the Board's intent to have a remote telemetry unit and radio communication system (RTU) installed at all sewer lift stations in the Mobile Sewer System as soon as funds are available.
- 2. The existing SCADA system at the Williams Plant includes:
  - a. Bailey/Fischer Porter system six distributed control system with ethernet highway connections.
  - b. Microwave Data System (MDS) 928/952 MHz radios.
  - c. Mod bus protocol.
  - d. Repeater stations.
  - e. ARCOM Model M1 RTUs at several field locations.
  - f. Bristol Babcock RTUs at several field locations.
- 3. The Contractor installing the RTU shall be responsible for ensuring that the telemetry system's and the host SCADA computer system's protocols, speeds of transmission, buffering of information and scanning rates are all totally compatible with each other to guarantee a fully functional system.
- 4. RTUs installed by contractors shall be programmed to control the pump motors at all new stations and all existing lift stations

whenever the entire electrical control box is being replaced. The RTU shall be programmed to provide monitoring only at lift stations where controls are in good condition and not being replaced.

5. Additions or modifications for controls at lift stations can be categorized as follows:

- a. New Lift Stations: The control panel and all electrical components shall be new. The pump motors shall be automatically controlled by an RTU that is mounted in a separate enclosure beside the local electrical control panel.

- b. Existing Lift Stations with Older Controls: The control panel and all electrical components except the starter shall be new. The pump motors shall be automatically controlled by an RTU that is mounted in a separate enclosure beside the local electrical control panel.

- c. Existing Lift Stations with Newer Controls: The control panel and all electrical components shall be retained as is. Pump motors shall continue to be controlled by conventional relays. The RTU shall be mounted in a separate enclosure by the electrical control box and be used for monitoring purposes only.

**B. Contractor Responsibility**

1. It shall be the responsibility of the Contractor to ascertain and understand which category the controls for each lift station fall into and how much of the work they are to do before bidding on the job.

The Board of Water and Sewer Commissioners shall have the following options:

- a. Furnishing the RTU/radio and its enclosure to the Contractor.

- b. Performing a portion of the work to install the RTU/radio.

- c. Specifying that the Contractor furnish and install all controls and components.

2. The Contractor shall be responsible for:

- a. Requesting the assignment of loop numbers for the RTU inputs and outputs, and the assignment of a station number if the lift station in question is new.

- b. Utilizing the loop numbers for tagging field devices.

- c. Requesting that the SCADA system program be revised to accept the new signals and/or new lift station.

- d. Providing coordination for programming, checkout, and startup of the inputs, output loops and their transmission of data to the SCADA system.

- e. Installation of the RTU if so directed by the bid request.

- f. Installing the proper program in each RTU to provide monitoring and/or control of a given lift station.

- g. Ascertaining the proximity of the lift station to airports or heliports to determine whether a red beacon light is needed atop the antenna pole to meet FAA requirements.

3. The supervision for the Williams Wastewater Treatment Facility at McDuffie Island or their designee shall be responsible for:

- a. Assigning loop numbers to all inputs and outputs to any RTU added at a new or existing sewer lift station.

b. Modifying the SCADA program at the Williams Plant computer system to add all point of measurement from any new or existing lift station.

C. New Lift Stations:

All newly constructed lift stations shall have an electrical control panel with a separate RTU/radio enclosure installed beside the control panel as shown on Drawing E-2 entitled "Electrical Details for New Installations". The enclosure shall include an RTU, radio, fuse block, relays, power supply, battery backup system, and battery charger. The control system shall include sensors designed to detect the presence of high moisture or temperature in motors, power failure or phase loss, and shall integrate run time for motors. Level switches shall be utilized to indicate when motors or timer modules should be started. The RTU shall start motors to prevent the wet-well from running over and stop motors before the wet-well runs dry. The wiring and control logic shall be provided as shown on Drawing E-1, entitled "Wiring and Control Logic".

D. Existing Lift Stations With Older Controls:

At existing sewer lift stations where the electrical control box is in poor condition due to corrosion or normal wear, the entire electrical control box shall be replaced. The control system shall be equal to that shown in Drawings E1 and E2, entitled "Wiring and Control Logic" and "Electrical Details for New Installation."

The station shall be wired and the RTU programmed to provide complete automatic control of pump motors. All existing electrical components except the starter shall be replaced. The Owner shall make the decision at each lift station for the Contractor to either relocate or replace the starter.

E. Existing Lift Station With Newer Controls:

Some of the existing sewer lift stations already have electrical control panels installed as per the Board of Water and Sewer Commissioners standard design

developed in the early 1980s and constructed before 1995. The Owner shall decide at each lift station whether the control panel shall remain as is, or be completely replaced. If the control panel is to remain as is an RTU with radio shall be installed in a separate NEMA 4X enclosure and programmed for monitoring purposes only. This is shown as the RTU/radio enclosure on Drawing E3, entitled "RTU Details for Existing Control Panels".

F. Radio Propagation Study:

1. Existing Lift Stations: A radio propagation study was conducted in January 1996, by the Bristol Babcock Corporation at all lift stations in existence at the time. This study determined whether or not there was a direct line of sight between each lift station and the Williams Plant SCADA system antennas and where repeater type radios would be required. Contractors bidding on adding an RTU or modifying controls at existing lift stations shall be responsible for adding such repeater stations if specified by the propagation study.

2. New Lift Stations: In cases where new construction such as for subdivisions, shopping center, or industry that requires the addition of a lift station, the contractor shall be responsible for requesting that a propagation study be performed by the Owner with a radio and antenna temporarily set up at the proposed new site.

This is necessary to ensure that there is a clear path of transmission between the lift station site and the host system antenna mounted on top of the civil defense antenna tower at Springhill Avenue. This study shall determine the feasibility for transmission from the site, the height and location of the antenna pole, and the need for a repeater. This study must be conducted prior to the final preparation of cost estimates by the Contractor. If a repeater is required, the Contractor

shall be responsible for having a second propagation study conducted by a radio survey company to determine the most suitable site and supplying the unit. The Board of Water and Sewer Commissioners shall be responsible for obtaining any easements or land disturbance permits required for the repeater. The Contractor shall be responsible for coordinating all these activities and determining how they effect costs. The Contractor shall pay all initial fees for the propagation study, easements, and permits, and the Board shall pay any continuing rental fees thereafter.

G. Remote Telemetry Units:

1. The remote telemetry unit (RTU) shall be an ARCOM Model M1, an ELSAG/Bailey Model 6790, or a Bristol Babcock Model 3310 that has ISO 9000 certification, and 64K bytes of SRAM, EPROM, and EEPROM memory. The manufacturer of the RTU shall provide a complete enclosure with the RTU, radio, fuse block, relays, power supply, and battery backup system installed as shown on Drawing E-2 and E-3. The battery backup shall be capable of furnishing 12 VDC to the RTU and a 5-watt radio for up to 24 hours of continuous services.
2. The RTU shall be mounted in a NEMA 4X enclosure separate from that used for the motor controls, but with the same specifications.

The RTU shall include a 16 key pad operator interface for changes and diagnostics and pass work codes, and an LCD display. All mounted inside the enclosure.

3. The RTU shall be easily removable. Terminals shall be plug-in types with detachment and reattachment possible without the use of special tools. All connections shall be gas tight.

Wire cabling between the RTU and input termination shall be the plug-in type. It shall not be necessary to take any individual wires loose when replacing an RTU.

4. Fuses shall be installed in all circuits wired to the 12-volt power supply for the radio and the RTU. Fuses shall be appropriately sized to protect each branch of the circuit.
5. Key switches shall be installed on the enclosures for the electrical controls and for the RTU. The key switch shall be of the type that retains the key until switch is returned to normal. Turning the key will:
  - a. Allow entry into the enclosure.
  - b. Bypass the switches that cause an alarm for enclosure opening.

The key switch and lock is in addition to the brass pad lock already detailed in this Specification.

6. Contractors shall contact the staff of the Board of Water and Sewer Commissioners for further details and drawings for the communication system.
7. The circuitry inside the RTU shall be designed to function at 100% humidity. This shall include the addition of conformal coating to the circuit boards.

H. Radios:

Radios for communication shall be MDS Model 2310, 5 Watt UHF, with 4800 Baud Rate. The radio shall be powered by the same 12 volt power supply used for the RTU, be mounted in the same enclosure, and share the 12 volt battery backup system. The radio shall be purchased to operate at the same UHF frequency as already established by the host SCADA system at the Williams Plant. There shall be no trunking or sharing of frequencies with any

other radio system in the City of Mobile, Alabama and/or Baldwin County, such as fire and police, ambulances, etc. The Contractors shall modify the existing license with the FCC and pay any fees required by state or federal authorities.

It shall be the responsibility of the Contractor to make sure that the radio is compatible with the existing master radio system at the Williams Plant.

I. Antennas:

Radio antennas shall be Yagi type or approved equal. Lightning protection for the antenna shall be as per manufacturer's recommendation or as indicated on the Drawings. The antenna shall be mounted on a wooden pole separate from the power pole at each remote site.

**13.24 LIFT STATION CONTROL SPECIFICATIONS:**

A. General:

1. All activities related to inputs or outputs shall be visible at the display for the RTU. Signals listed under "Notify SCADA" in the control logic for the RTU as shown on Drawing E-1 shall be automatically sent to the main control room SCADA system operator terminal at the Williams Wastewater Treatment Facility for alarm or display. All other signals at the RTU shall be visible at the SCADA system terminal upon request.
2. All starting/stopping of pump motors shall be controlled locally by each lift station remote telemetry unit (RTU). The alternation of run time between motors shall be controlled locally by the RTU.
3. Adjustment for time delays shall be made locally at the RTU.
4. The RTU shall keep track of whether or not each motor is running, and if each motor is

available as indicated by the position of its hand-off-automatic switch. If the control logic dictates a given motor should be started and its H-O-A switch is not in automatic, the logic shall start an alternate motor.

5. Whenever conditions that cause alarms at the SCADA system are reversed, the alarm notification to the SCADA shall be cleared. Timer modules shall be incorporated to delay activating or deactivating alarms and starting or stopping pumps as shown in the control logic for the RTU.

B. Operator Inputs:

1. Time delay in seconds between when level switches are activated (LS-2, LS-3) and pump motors turn on. (Time modules labeled as T1 and T2).
2. Time delay in seconds between when the door switch at the control panel is activated and an alarm occurs if the circuit for the keyed switch for authorized entry is not closed (T4).
3. Time delay in seconds between when the door switch at the RTU enclosure is activated and an alarm occurs if the circuit for the keyed switch for authorized entry is not closed (T5).

C. Switches:

1. Switches shall be three way with hand-off-automatic positioning.
2. Motors shall start independently of all interlocks when switched to the hand position.
3. In the auto position:
  - a. A motor shall be started by the RTU when the appropriate contact is closed (R9 or R10) and timer cycles are completed.

b. Relays shall be activated to provide inputs to the RTU that the switch is in the automatic mode (R3 and R5).

D. Moisture Probes:

Moisture probes in the motors shall detect the presence of excess moisture and cause a relay to engage, (R1 or R2). This shall provide inputs to the RTU for a given motor.

E. Power Failure:

If the power fails or a phase is lost, there shall be an input provided to the RTU via the power failure relay (PFR). The RTU shall shut down both motors when a power failure or phase loss is detected.

F. Over Temperature:

A temperature switch inside each motor shall be activated and provide an input to the RTU if a given motor overheats (TS-1, TS-2). The RTU shall shut down the overheated motor.

G. Level Switches:

Floating-ball type level switches shall be utilized to detect different levels in the wet-well, (LS-1, LS-2, LS-3). Each switch shall provide inputs to the RTU. LS-4 shall be direct wired to a red light mounted externally at the control box, and be activated by high level in the wet-well.

H. Motor Contractors:

Auxiliary contacts at the motor starters shall be utilized as inputs to the RTU to identify when motors are running. Integration and totalization of motor run time shall be done at the SCADA system (M1, M2).

I. Entry:

1. Control Panel

A switch and subsequent input to the RTU shall be engaged whenever the door to the control

cabinet is opened. Simultaneously, a timer module shall be started. If the keyed entry switch for authorized entry to the control panel is not engaged before the timer module times out, an alarm shall be provided to the Williams Plant SCADA system. The keyed entry switch shall be of type that retains the key until switch is returned to normal.

2. RTU Enclosure

A switch and subsequent input to the RTU shall be engaged whenever the door to the RTU enclosure is opened. Simultaneously a timer module shall be started. If the keyed entry switch for authorized entry to the RTU is not engaged before the timer module times out, an alarm shall be provided to the Williams Plant SCADA system. The keyed entry switch shall be of the type that retains the key until switch is returned to normal.

J. Motor Alternation:

The starting and stopping of pump motors to control lift station level shall be done in a manner that equalizes run times on the motors.

**13.25 SPECIFICATIONS FOR REMOTE TELEMETRY:**

A. General:

1. The I&C Contractor shall furnish and install a complete and functional remote telemetry system. This system shall include all hardware, software, training and support services to provide a functional system. The major functions of the telemetry system shall be to:

a. Monitor each remote site.

b. Interface to a Master RTU and Host Computer.

- c. Display operational parameters (real time and historical) by providing application and configuration engineering services on the Host Computer.
  - d. Provide alarm features.
  - e. Provide manual override of the remote sites.
  - f. Provide automatic operation.
2. The telemetry system shall be completely compatible with the existing master RTU for the SCADA system at the Williams Wastewater Treatment Facility.
  3. The remote telemetry units shall be one of the following:
    - a. Arcom Model M1.
    - b. Bailey ELSAG Model 6790.
    - c. Bristol Babcock Model 3310.
  4. The manufacturer of the remote telemetry unit shall supply the RTU in an enclosure as shown on Drawings E-2 and E-3, entitled "Electrical Details for New Installations" and "RTU Details for Existing Control Panels". The enclosure shall include the radio, fuse block, relays, power supply, and battery backup system.
  5. The RTU control panel shown on Drawings E-2 and E-3 shall be assembled and furnished by the manufacturer of the RTU, or companies located within a 250-mile radius of Mobile that represent factories of the RTU. In either case the manufacturer of the RTU shall be responsible for the entire RTU control panel and all components herein.

**B. System Operation:**

1. The system being supplied shall be a "distributed" type control system with operations such that a failure

at one or more sites shall not prohibit automatic control of the remaining functional system. Each remote site in the system shall be assigned a unique digital address. The Master RTU shall address each remote site in sequence every 1.5 seconds to send command data and receive status, alarms, flow rate, and level data as required by that site. The Host Computer shall indicate, display, alarm, and record all information received as required.

2. There shall be an automatic mode and a manual mode for each RTU in this system. Each lift station shall either be in automatic mode or manual mode. Each mode shall be operator selectable from the RTU.
3. In the event of AC power failure at a remote site, the operation of the RTU and radio shall be maintained by a battery backup system for at least 24 hours. Communications shall be maintained via the host and radio system for 24 hours without AC power.
4. Remote terminal units (RTUs) at the remote site shall be specified for operation over a temperature range of -20 degrees to +70 degrees C. This range shall be achievable while operating in a non-ventilated enclosure and without the use of mechanical cooling devices or heaters.
5. RTUs shall be easily removed for repair or replacement. Terminals shall be of the plug-in type with detachment and reattachment possible without the use of tools.
6. RTUs shall be easily programmed using a ladder logic type programming language. The ladder logic shall be capable of handling such functions as block move of data, floating point and long integer math, PID control, timers, watchdog counters, and creation and printing of customized reports

to the local MMI or serial printer. The ladder logic editor shall include program editor, customized report editor, simulator mode to permit debugging of programs, monitor mode to debug the program on the RTU in real time, and print ladder logic programs.

7. In the automatic mode, the software for the Master RTU shall totally control the monitoring at each remote site as required. Each remote RTU shall operate identically except for the number of input and output points.

8. RTUs shall use a real-time multitasking operating system capable of simultaneously scanning all I/O points (including expansion modules), handling communication and handshaking on each serial port separately, and interpreting any ladder logic program resident on the RTU.

9. RTUs shall include a standard Microsoft Windows based configuration utility, including, but not limited to the following functionalities:

a. Ability to set the communication parameters and protocol on each serial port.

b. Enable data/alarm archiving, and set analog deadbands.

c. Retrieve archive database from RTU and store as a standard MS-DOS database file.

d. Configure HART transmitters and monitor HART transmitter process variables.

e. Allow monitoring and control of Modbus registers in the RTU, both within the configuration utility and in another DDE-aware application in Windows.

The RTU configuration utility shall include the provision to communicate with the RTU using

RS-232, radio, leased-line modems, or dial-up modems. All of the standard functions shall be available in a similar manner, regardless of the communication medium being used.

10. Signals to be monitored:  
See Drawings E-1, E-2, and E-3.

C. Method of Communication:

1. The method of communications for all remote locations shall be accomplished with a UHF radio using a 928/952 MHz frequency as per the FCC license already in existence. Any new fees required by federal or state authorities shall be the responsibility of the I&C Contractor. The Contractor shall also be responsible for requesting that the Owner determine whether or not radio repeaters are needed. If needed, they shall be provided by the Contractor. In the event a solar panel is required, it shall be supplied by the Contractor. Any easements or permits required for the installation of the repeater site(s) shall be supplied by the Owner.

2. The Contractor shall request that the Owner perform a propagation study with a hand-held radio to determine signal reliability, necessary antenna heights, and the prerequisite for a data repeater. By utilizing the information obtained from the propagation study, the Owner shall determine antenna location, acceptable antenna line losses, antenna heights, etc. The Contractor shall be responsible for the final radio path integrity.

3. Remote telemetry equipment at all field locations shall be single units with no redundancy. Loopback diagnostics shall be available on both remote and host end telemetry equipment.

4. The radio frequencies to be used shall provide at least 5watts and

transmit at a rate of at least 4800 BPS. There shall be no trunking or sharing of frequencies with any other radio systems, such as fire and police departments, ambulances, utility authorities, etc.

5. The telemetry system shall provide Modbus Binary and receive Modbus Binary as the standard communication protocol.

D. Process Graphics:

1. Graphic templates shall be provided which illustrate an overview of the hydraulics of the entire system. One template shall be provided for each remote site. The templates shall be formatted with colors and special characters illustrating major process elements such as pumps, flowmeters, valve positions, etc.
2. Each template shall display all available I/O for the particular site or sites being represented. Real-time analog values shall be displayed next to the corresponding process component (i.e., the measured flow rate and linearized values shall be displayed next to the flowmeter symbol with the correct engineering units).
3. Colors shall be used to denote alarms and to illustrate status points. Any analog value or status in an alarm condition shall be displayed in a flashing mode until acknowledged by operator. Status of equipment which can be displayed as on/off shall have the words "ON", "OFF", etc. next to the symbol for the equipment to which they correspond.
4. It shall be the Contractor's responsibility to prepare typical graphics displays for review and approval by the Engineer and the Owner. Whenever possible, pre-developed software for graphics used in other similar systems

should be utilized and only slightly tailored to the specific site's needs.

E. Shop Drawing Responsibilities:

1. Requirements:
  - a. Shop drawings and product data shall be submitted as required by Contract Documents.
  - b. Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to sheet and detail, schedule, or item numbers, or titles shown on Contract Drawings.
2. Product Data:
  - a. Contractor shall:
    - (1) Clearly mark each copy to identify pertinent products or models.
    - (2) Show performance characteristics and capacities.
    - (3) Show dimensions and clearances required.
    - (4) Show wiring diagrams and controls.
    - (5) Supplement standard information to provide information specifically applicable to work.
3. Contractor's Responsibilities:
  - a. The Contractor shall:
    - (1) Determine and verify:
      - (a) Field measurements.
      - (b) Field construction criteria.

(c) Catalog numbers and similar data.

(d) Conformance with specifications.

(2) Begin no fabrication or work without submittal approval.

(3) Supply the Owner with a minimum of three (3) copies of submittals. Submittals shall contain:

(a) The date of submission and dates of any previous submissions.

(b) The project title and number.

(c) Identification of the product, with the specifications section number.

(d) The names of the Contractor, supplier, and manufacturer.

(e) Field dimensions, clearly identified as such.

(f) Contractor's stamp, initialed, or signed, verifying the review of submittal, verification of products, field construction criteria, and coordination of information within the submittal with

requirements of the Work and of Contract Documents.

(g) Identification of deviations from Contract Documents.

#### 4. Resubmittal Requirements

a The Contractor shall:

(1) Make any corrections or changes in the submittals required by the Owner and resubmit until approved.

(2) Revise initial drawings or data and resubmit as specified for the initial submittal.

(3) Indicate any changes which have been made.

#### F. Manufacturer:

All of the remote telemetry equipment shall be manufactured by Arcom Control Systems, Bailey, or Bristol Babcock.

#### G. Remote Site Hardware and I/O Requirements:

The manufacturer of the remote telemetry unit shall assemble the RTU, radio, power supply, battery, and input/output hardware in one box suitable for each remote site. The RTUs shall each contain the following:

1. One (1) – Arcom M1 Mini RTU, or approved equal.
2. One (1) – Arcom IOM-A Expansion Module, or approved equal.

3. One (1) – Power Sonic 20 AH battery, or approved equal.
4. One (1) – MDS Model 2310 5-watt UHF data radio and 4800 B and digital interface, or approved equal.
5. One (1) – 12-24 volt Acopian DC Power Supply.
6. One (1) – NEMA 4X Enclosure
7. One (1) – Antenna pole, if required, and Yagi type antenna, or approved equal.
8. All related conduit, wire, cabling and installation.
9. Discrete output/inputs as required.
10. Analog output/inputs as required.
11. See Drawings E-1, E-2, and E-3 for input/output details at each RTU.

H. Remote Terminal Unit Hardware:

Arcom M1 Mini RTU or approved equal to include:

1. Environmental
  - a. Ambient temperature: -20 degrees to 70 degrees C (operational)
  - b. Ambient humidity: 100% non-condensing with conformal coating.
2. Power Supply Requirements
  - a. Voltage: 12 or 24 VDC with reverse polarity protection
  - b. Power 1.2 watts
  - c. Battery backup: 10 amp-hr with trickle charger
3. Field Wiring Requirements
  - a. Type: Screw type clamping

- b. Wire size: #14 AWG
4. Operation
  - a. Processor: 64180, 9.2 MHZ
  - b. Operating System: USX Multitask real-time multitasking kernel, or approved equal
  - c. Programming: Arcom Smart Ladder Logic, or approved equal
5. Memory
  - a. 64k bytes SRAM, battery backed (minimum)
  - b. 64k bytes EPROM (minimum)
  - c. 64 bytes EEPROM (minimum)
6. Serial Ports – Two (2) RS 232, One (1) RS 485
7. Analog Inputs
  - a. Range: 4-20 mA, 1-5V.0-5 V DC
  - b. Resolution: 12 bits
  - c. Surge protection 1EEE 472
8. Discrete Inputs
  - a. Range: 10-32 VDC
  - b. Pulse: 8 inputs may be used as counters and 4 may be used as frequency inputs (10 KHZ)
  - c. Isolation: ±2000 Volts peak logic to field
  - d. Surge protection: 1EEE 472
9. Analog Outputs

- a. Range: 4-20 mA
- b. Resolution: 8 bits
- c. Surge protection: IEEE 472
- 10. Discrete Outputs – Contact type – Darlington
- 11. Input/Output Expansion
  - a. Up to seven I/O expansion modules can be added to each RTU. All modules must be available to be powered with either 12 VDC or 24 VDC
  - b. Module types: IOM-A: 4 A1, 2 AO, 10DI, 10 DO; IOM-B: A1, 2 AO; IOM-C: 10 DI 4 DO

I. Enclosures:

- 1. Enclosures shall be Hoffman, or equal, furnished with a NEMA 4X rating that will provide adequate protection against any elements that exist in the environment in which the equipment will be installed. Each enclosure installed shall be mounted as close to the antenna as possible.
- 2. The enclosure shall be large enough to house the radio, communication adapter, and all RTU cards needed at that site. It shall also be sized large enough to house any of the three acceptable brands of RTU to facilitate interchangeability in the future.

J. Installation Details:

- 1. If the Contractor finds it desirable to make changes and/or alterations in plans, equipment or materials in order to facilitate construction, he shall submit a proposal for the changes to the Engineer for approval. The Contractor shall not initiate such changes without the Engineer's written approval. **No**

**adjustment in quantities or unit prices shall be made for the changes unless attached to the written approval as an authorization for "Change in Work" or "Extra Work".** The Contractor, by his acceptance of the approval, agrees not to submit any "Claims for Damage" in connection with the approved changes or alternatives. Design time required by the "Engineer" to facilitate the change will be charged to the Owner and subsequently deducted from the Contractor's bid price.

- 2. There shall be no mixing of different types of signals within a single conductor; i.e., radio cables or low voltage DC with 120 VAC.
- 3. Initial calibrations with documentation shall be required for all hardware being installed under this Contract and shall be the responsibility of the Contractor.
- 4. The Engineer or Owner shall determine the stability of the soil to ascertain whether it will support the antenna pole. Poles may require concrete supports at the ground as shown in the alternate pole installation detail on Drawing E-2.
- 5. All trenching, excavation and meter pits required for proper installation shall be performed or supplied by the Contractor under the Owner's supervision.
- 6. All equipment installations and calibrations shall comply with the standards of the following organizations:
  - a. Institute of Electrical and Electronics Engineers, IEEE.
  - b. Instrument Society of America, ISA
  - c. American Water Works Association, AWWA

- d. National Electrical Code, NEC
- e. National Electrical Manufacturing Association, NEMA
- f. National Fire Protection Association, NFPA
- g. Occupation Safety and Health Act, OSHA
- h. Underwriters Laboratories, UL
- i. Factory Manual, FM

K. Training:

The Contractor shall provide factory employed personnel to conduct training courses for the Owner for designated personnel in the operation and maintenance of the telemetry system as specified. The training shall be at least 24 hours of class, and be oriented to the specific system to be installed. The course will include:

- 1. General system hardware architecture.
- 2. Functional operation of the system.
- 3. Color graphics generation.
- 4. Database entry.
- 5. Reports generation.
- 6. Alarm reporting.
- 7. Historical trending.

The Contractor shall either provide the training or provide written verification that such training has been performed for the selected brand of RTU.

L. Warranty:

- 1. The Contractor warrants that there are no defects of material or workmanship in the goods described herein. This warranty shall bind the Contractor for a period of two (2) years from the date of the shipment and/or

installation of the goods. If within such warranty period it is established that any material or workmanship in the goods was defective, the Contractor shall, at its option, either repair or replace defective materials of workmanship, in either case F.O.B. from its factory. The purchaser agrees that the Contractor's liability under the foregoing warranty shall be limited as stated and that there are no other warranties which extend beyond the description of the face hereof, and that except as stated, the Contractor shall not be liable for any loss, damage or expense; and that in no event shall the seller be liable for any loss of profits or other consequential damages.

No allowance will be made for repairs or replacements not authorized by the Contractor; such allowance will be credited to the purchaser only after he has returned to the Contractor the material which is claimed to be defective. The warranty will provide a two-year limited warranty from date of installation.

- 2. This limited warranty does not cover repair of components damaged by abuse by the Owner or personnel not in the employ of the Contractor, accident, lightning, disaster or misuse.

M. Maintenance:

- 1. All suppliers submitting proposals must have available at least one (1) factory parts and service center. This center shall be staffed with full-time technical as well as order and shipping personnel during regular business hours and days. This factory center must have a toll-free telephone service or agree to accept all calls from Owner.
- 2. Maintenance service shall be available from the system supplier either by a maintenance contract or

on a per-call basis. The service representative (Contractor) shall also maintain an inventory of replacement modules and major components for quick service for the Owner.

3. If the manufacturer's service center is unable to repair and have ready to return any I/O cards in the system within 48 hours of receipt from the Owner, the service center shall have available a rental or loaner component for immediate shipment.

### 13.26 SPECIFICATIONS FOR RADIOS:

#### A. General:

1. The SCADA system for the Board of Water and Sewer Commissioners for the City of Mobile requires the use of three types of radios as follows:

- a. A redundant Master Station radio for polling the radios at remote locations.

- b. A single radio at each remote site.

- c. A redundant repeater station to collect data from remote locations that do not have a clear line of sight between the remote location and the Master Station radio.

The Master Station referred to in this specification already exists at the Williams Wastewater Treatment Facility. If repeater stations are required, they shall adhere to the same specifications described herein for the Master Radio Station.

2. A repeater station already exists at the Civil Defense Tower located adjacent to the Springhill Water Tower in Mobile, Alabama. The Contractor shall be responsible for determining if additional repeater stations are required.

3. The Contractor shall be responsible for the cost of any propagation study required to determine repeater locations, and the fees for modifying the FCC license to add additional radios.

#### B. Master Station Radio:

1. The master radio and repeater station radios shall be capable of being configured from the terminals/computers to be located in the central control room at Williams Wastewater Treatment Facility.

2. The radios shall include self-diagnosis that shall provide appropriate alarms at the central computer monitors at the Williams Plant.

3. The master radio shall operate in the 928/952 MHz, 928/929 MHz and 932/941 MHz frequency bands. The unit shall be able to operate either in keyed mode, as a repeater, or with continuous carrier. Each master station and its assigned remote units shall operate on a unique transmit/receive frequency pair and on a noninterfering basis with the other master/remote systems.

4. The master station radio shall have redundant transmitters, receivers, power supplies, and batteries operating in hot standby mode. It shall provide automatic switch over to the standby equipment upon the detection of an alarm in the on-line system. The radio must be capable of switching to operate on any receiver/transmitter combination; switch over must occur in less than 50 msec. Warm standby operation is not acceptable.

5. The radios shall have FCC authorization of notification or type acceptance under FCC rules Part 94 for operation in 12.5 kHz bandwidth, at 4800 BPS operation.

6. The master radio shall operate in continuous duty mode with both the transmitters and the receivers operating simultaneously. (Full duplex).

C. Radio System Diagnostics:

1. The radio shall include system diagnostic capability to permit continuous or scheduled automatic monitoring of key radio operating parameters and alarm conditions. In addition, critical radio status and alarm conditions must be enunciated on LED indicators on the front panel of the radio.
2. Diagnostic software must be supplied to enable an IBM compatible personal computer (PC) to communicate with the radio diagnostic controller via a separate RS-232 diagnostic port. The PC with software will serve as a central diagnostic reporting tool for the entire multiple address radio system for up to 8 master radios, with up to 60 remotes per master station.
3. The diagnostic package must communicate diagnostic data from all remote radios in the system to the master station radio over the radio's RF channel. If a repeater radio is utilized, diagnostics from all remote radios and from the repeater must be sent over the RF channel to the polling remote radio. It will not be acceptable to require a separate external communications link between the PC and the repeater radio in order to obtain diagnostic data at the polling remote site.
4. Diagnostic software must be able to accommodate any combination of communications links to remotely located master or repeater stations. Software must automatically connect to all master stations in the radio system via hard wired RS232 link. Each master station, repeater

station, and polling remote must have a unique diagnostic address.

5. Diagnostic data transmitted over the RF channel must use DTMF (Dual Tone Modulated Frequency) encoding to eliminate the possibility of diagnostic information being misinterpreted as data being sent by the associated SCADA system.
6. All status and alarm information obtained from the master radio system must be displayed on CRT screens, and printed or archived to database files for future recall and analysis. As a minimum, diagnostic screens must be dedicated to display the following information:
  - a. Master Station Alarm and Status Displays – display of radio status and alarm indicators.
  - b. Master/Repeater Station Polling Report – display alarms for each station as it is polled and archive alarm and status data for each station as it is polled.
  - c. Remote Station Polling Report – display master/repeater/polling remote station alarms and remote station status of each radio as it is polled. Archive master/repeater station alarms and status data and remote radio status data.

D. Diagnostic Data and Control Functions:

Diagnostic data and control functions monitored by the diagnostic system shall include:

1. Master/Repeater Station Diagnostics shall:
  - a. Monitor the operation and status of redundant transmitters, receivers and power supplies and automatically switch over to standby unit upon failure. All modules must be continuously

monitored while online and in standby states.

b. Remotely switch to the alternate transmitter or receiver to permit remote troubleshooting of radio hardware and software.

c. Remotely test the hot standby switch over logic and alarm reporting logic.

d. Monitor power supply voltage, current and transmit power of redundant power supplies and transmitters.

e. Monitor received signal strength, frequency offset and FM deviation levels of redundant master station receivers.

2. Radio Diagnostics must include control capability to permit remote adjustment of key parameters in the remote radio from a PC connected to the master radio or polling remote radio.

3. Radio Diagnostics must display the data shown below as received from each remote radio. Parameters indicated with a \* must be remotely adjustable from the master station. All diagnostic values must be displayed in engineering units (volts, watts, dB, etc.) Radio status must include the parameters listed below:

a. Frequency\*

b. Deviation\*

c. Transmit Power Outlet\*

d. Receive Signal Strength

e. Power Supply Voltage

f. Internal Voltage Regulator Voltage

g. Phase Lock Loop Voltage

h. Internal Radio Temperature

4. System diagnostics shall be performed by connecting a PC to the radio. Opening the radio, changing modules or changing DIP switches is unacceptable.

5. An option for adding a temporary voice communication at a later date shall be provided through an RJ11 jack located on the master radio unit. This shall provide voice communication between the master unit and any remote site. This shall be used to facilitate any start-up or troubleshooting procedures. The actual communication card shall be added later at the discretion of the Owner.

E. Directional Antenna For Master Station Radio:

1. The master radio station antenna shall meet the following minimum requirements:

a. Frequency range: 925 to 960 MHz

b. Gain: 10 dB, minimum

c. Maximum power input: 150 watts

d. Lightning protection: Direct ground protection to mast

e. Front-to-back ratio: 20 dB, minimum

f. Connector: Type N, female

g. Mounting hardware: Weatherproof clamp suitable for direct mount to 2 inch Schedule 40 steel pipe.

2. The antenna shall provide SCALA TY-900 or equal.

3. The Contractor shall provide all masts, lightning suppressors, and other apparatus required to make a complete and operable system.

4. The surge arrestor for the antenna wire shall be a polyphaser model IS-50-NX-C2.

F. Transmission Cable and Miscellaneous For Master Radio:

1. Transmission cable connecting the master station radio antenna port with the antenna shall be the low-loss foam-dielectric type.
2. A 3-foot section of "super flexible" transmission cable shall be provided at the master radio antenna port. Standard Type N connectors for connection to a continuous piece of cable extending to the antenna shall be used.
3. Weatherproof transmission cable suitable for direct environmental exposure with "o" ring seals on connectors shall be used.
4. Contractor shall include pricing on cable hangers, ground kits, surge suppressor, etc.

G. Repeater Radio Station:

If repeaters are required, they shall adhere to the same specification established for the master radio station including redundancy at each repeater site.

H. Remote Radio Station:

1. The remote station radio shall operate in the 928/952 MHz, 928/959 MHz or 932/941 MHz frequency band. Each group of remote station radios and their associated master station radio shall operate on unique transmit/receive frequency pairs, on a noninterfering basis with the other master/remote systems.
2. The unit shall have FCC authorization of notification or type acceptance under FCC rules Part 94 for operation in a 12.5 kHz

bandwidth, including 9600 bps operation.

3. The unit shall operate at 1200 bps, 480 bps, and 9600 bps in a 12.5 kHz channel (data rate should be specified).

4. The unit shall operate in the half-duplex mode with transmitter keying provided by the associated remote terminal unit.

5. The remote station radio shall meet the following physical requirements:

a. Mounting: All radio PC boards including RF, modem and diagnostic PC boards must be enclosed in a sealed steel, NEMA 4X enclosure. A plastic housing or a housing with vents which can allow dust into the radio is not acceptable.

b. Custom Integrated Circuits: The radio design shall not make use of custom designed large scale integrated circuits that are not commercially available through normal distribution channels.

c. Temperature Range: Full performance from -30 C degrees to 60 degrees C. Operational performance from -40 degrees C to +70 Degrees C.

d. Humidity range: 0 to 95% relative humidity, non-condensing.

e. Antenna Connection: Type N, female mini UHF connectors are not acceptable.

6. The remote unit must be fully synthesized and programmable to all 900 MHz frequencies via a personal computer or handheld terminal without changing internal components. Opening the radio to change modules, frequency crystals, or DIP switches is unacceptable. Programmability

over a limited range of MAS frequencies is not acceptable.

7. The remote radio must include an Automatic Frequency Control (AFC) circuit to automatically adjust (net) the remote radio frequency to the frequency transmitted by the master radio. The need for manually changing frequency drift is not acceptable.
8. The remote unit shall have a loop back decoder board that operates in conjunction with the master station's microprocessor to provide signal strength, frequency error, and deviation levels for each remote unit.
9. The antenna connectors must be Type N. Lower quality UHF type connectors are not rated for use at 900 MHz and are not acceptable.
10. The remote unit must have the ability to monitor its internal operation and diagnostic parameters via a handheld terminal or personal computer plugged into the remote radio. Frequency, transmit power and deviation must be remotely adjustable from the master station, repeater or polling remote. The terminal or PC must be able to monitor the following functions:

Radio Parameters:

- a. Transmit and receive frequencies
- b. Time-out timer setting
- c. Soft carrier dekey setting
- d. Loop back code
- e. Squelch tail eliminator
- f. PTT delay
- g. CTS delay
- h. AFC mode

- i. Hardware/software revision level
- j. Date of manufacture
- k. Serial No./Model No.

Radio Diagnostics:

- l. Transmit power
  - m. Deviation
  - n. Frequency
  - o. Received signal strength
  - p. Regulator voltage
  - q. Power supply voltage
  - r. Phase lock loop voltage
  - s. Internal temperature
  - t. Reflected power
  - u. Voltage standing wave ratio
11. The remote radio must be FM/UL approved as an option.

I. Directional Antenna For Remote Station Radio:

1. The directional antenna shall meet the following requirements:
  - a. Frequency range: 925 to 960 MHz
  - b. Gain: 10 dB, minimum
  - c. Maximum power input: 150 watts
  - d. Lightning protection: Direct ground protection to mast
  - e. Front-to-back ratio: 20 dB, minimum
  - f. Connector: Type N, female
  - g. Mounting hardware: Weatherproof clamp suitable for

direct mount to 2 inch Schedule 40 steel pipe.

2. The Contractor shall provide all masts, lightning suppressors, and other apparatus required to make a complete and operable radio frequency transmission system. All antennas shall be fully protected with proper grounding wires and voltage suppressors at each pole or tower to prevent damage to the radios from lightning strikes.

J. Transmission Cable and Miscellaneous For Remote Station Radio:

The Contractor shall:

1. Provide cable connecting the radio antenna port with the antenna which is the low-loss foam-dielectric type, 0.5 inch in diameter. Provide Andrew Corporation, LDF4-50A or equal.
2. Provide a 6-foot section of "super flexible" transmission cable at the radio antenna port. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.
3. Provide weatherproof transmission cable, suitable for direct environmental exposure. Use "O" ring seal on connections.
4. Enclose all coaxial lines to antennas in conduit to protect against vandalism.
5. Properly label hangers, ground kits, surge suppressors, etc.

K. Modem:

The entire system shall be able to have the following digital interfaces: an internal 4800 baud, asynchronous modem with either RS-232 or TTL direct interface. Request to send/clear to send turnaround time not to exceed 10 milliseconds. This interface must work in a 12.5 kHz channel.

L. Equipment Verification:

1. The supplier of the radio equipment must demonstrate radio system performance by providing references from 10 systems operating at 9600 bps in 12.5 kHz channels. (Include company name, contact and phone number.)
2. The manufacturer must demonstrate a system operating at 4800 bps with a bit error rate of  $\leq 10^{-6}$  at  $-107$  dBm received signal strength.

M. Spare Parts:

The Contractor shall not be required to furnish any spare parts unless otherwise specified in General Section 13000 of the specific project scope as prepared by the Engineer.

N. Terminal/Repeater Options:

1. Orderwire service channel to provide a single link party line channel for voice communications shall be quoted as an option. A Front Panel RJ-11 type connector shall be provided to accept a standard telephone handset.
2. E&M signaling for orderwire service channel shall be available.
3. Orderwire/E&M Speaker & Alert panel shall be available, as an option. The panel shall include a speaker with volume control, signaling push-button and audible alert.
4. Space diversity shall be available, as an option. When configured for space diversity, both transmitters and one receiver will be connected to one antenna with the second receiver connected to a separate antenna.
5. Transmitter isolator to minimize intermodulation products at multi-transmitter sites shall be available as an option.
6. Internal diagnostic modem shall be available in order to provide radio

parameter diagnostics communication via the orderwire channel of each radio.

7. Directional RF coupler panel shall be available. The coupler panel shall provide an isolated port in order to monitor the transmitted RF signal without interrupting radio link communications.
8. PC software to automatically poll all radios for alarms and/or store all radio diagnostic data on a printer or the PC hard disk for future analysis shall be available as an option. The software must be able to store routing information such that automatic data retrieval can be performed through the use of both direct and dial-up modem connections.

O. Diagnostic Capability:

The radio shall include an internal microprocessor controller. The diagnostic controller should be addressable through a separate RS-232 data port on the back of the unit. A personal computer connected directly to the RS-232 data port will serve as an onsite system diagnostic tool. Diagnostic software for the PC shall be included with the radio and be provided on 5 ¼" or 3 ½" disks. The software package shall enable the user to individually address up to 255 radios and monitor all diagnostic radio parameters. The user shall be able to select any radio and continuously monitor its diagnostics. Diagnostic capabilities must include:

1. The ability to measure and report on the operational parameters of the terminal/repeater radio's two internal transmitters, two internal receivers, and two internal power supplies. Monitored parameters must include transmitter supply voltage, supply current, power output and transmitter peak baseband levels, and receiver received signal strength and peak baseband level.
2. The ability to display all front panel alarms, transmitter and receiver status and control transmitter and receiver switching.

3. The ability to remotely or locally test the hot-standby switchover logic and alarm reporting logic.

P. Master Station Radio Hardware:

1. The master redundant point to multipoint radio station shall be an MDS 2130BH master station or polling remote station manufactured by Microwave Data Systems or another brand of equal or better value that meets the Specifications.
2. The master radio shall meet the following Transmitter Requirements:
  - a. Output Power (at the antenna port): 5 watts (+37 dBm) maximum, adjustable from .5 watt (+27 dBm) to 37 dBm
  - b. Duty Cycle: 100%, continuous at 5 watts over -30 degrees C to +60 degrees C
  - c. Data Turn Around Time: 10 msec, including RTS/CTS delay with internal modem
  - d. Transmit Frequency: 937 to 960 MHz
  - e. Stability:  $\pm 0.00015\%$  from -30 degrees to +60 degrees C (for both 12.5 kHz and 25 kHz channels)
  - f. Modulation Type: FM
  - g. Spurious/Harmonic Emissions: -65 dBc
  - h. Output Impedance: 50 Ohms
  - i. Modulation Deviation:  $\pm 2.5$  kHz (12.5/25 kHz channels)
  - j. PTT Delay: 1-31 msec Programmable in 7 msec increments

3. The unit shall meet the following Receiver Requirements:

- a. Type: Dual conversion, super heterodyne
- b. Frequency Stability: +0.00015% from -30 degrees C to +60 degrees C (12.5 kHz and 25 kHz channels)
- c. Automatic Frequency Correction (AFC): Built in, on/off
- d. Sensitivity/Bit Error Rate (at antenna input port):
  - (1) 4 Wire audio - 117 dBm (0.3 uV) 12 dB SINAD
  - (2) 4800 bps digital interface - 110 dBm for  $1 \times 10^{-6}$
- e. Receive frequency range: 937 to 960 MHz
- f. Bandwidth Compatibility: 12.5 kHz or 25 kHz channels
- g. Spurious and image rejection: 85 dB, minimum
- h. IF selectivity: 100 dB, minimum at adjacent channel
- i. RF input impedance: 50 Ohms
- j. Intermodulation (EIA): 75 dB, minimum
- k. Desensitization (EIA): 70 dB, minimum - (25 kHz channels) 60 dB, minimum - (12.5 kHz channels)
- l. Harmonic distortion: <3%, measured with de-emphasis
- m. Received signal strength indicator: built-in, range: -120 dBm to -60 dBm
- n. Squelch opening time: 2msec

4. The radio shall meet the following general requirements:

a. Input power: 12 VDC in stand-alone cast aluminum housing or 120/240 VAC with battery backup standard, or 12, 24, 48 or 125 VDC with external power supply.

b. LED indicators: Analog radios - key line active, transmitter ON, Squelch open, Power ON, out of lock, radio disabled.

5. The master radio shall meet the following voice frequency parameter requirements:

a. Frequency response: +1, -4 dB, 50 to 3000 Hz

b. Analog input: Adjustable level from -20 to +10 dBm

c. Output: Adjustable level from -20 to +2 dBm

d. Interface: 4-wire, 600 Ohms impedance, balanced

e. Emphasis: None

f. Transient protection: 2500 volt isolation on VF inputs and outputs; power supply, keying and alarm circuits (option)

g. Data rate: 300 to 9600 Baud

**END OF SECTION**

---

## PUMP SPECIFICATION SHEET

---

Tag No.:

Service: Sewage

Type of Pump: Submersible Sewage Pump

Solids Handling Capability: 3" Sphere - Discharge connection not less than 4" diameter

Materials of Construction:

Casing	Cast iron, Class 30
All Exposed Bolts & Nuts	304 stainless steel
Pump Exterior	Sprayed with PVC epoxy primer with chloric rubber paint finish
Shaft	Stainless steel ANSI 431
Upper Bearing	Single row deep groove ball bearing
Lower Bearing	Two row angular contact ball bearing
Guide Rails	Stainless steel

Installation: The pump shall have a discharge connection elbow connected to a vertical discharge pipe. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically aligned and connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service without a need for personnel to enter the wet well.

Drive Motor:

1. \_\_\_ Horsepower
2. Design - squirrel-cage, induction
3. NEMA Design - Type B
4. Windings - Copper, Class F Insulated
5. Service Factor - 1.15 continuous
6. Design Temperature - 40°C ambient

---

**PUMP SPECIFICATION SHEET**

---

- Drive Motor (Cont.):
- 7. Non-overloading at any point on pump curve
  - 8. Explosion Proof
  - 9. Motor Terminal Board
  - 10. Stator shall be heat-shrink fitted
  - 11. Motor Winding Overtemperature Thermostats
  - 12. Seal Failure Moisture Probe

<u>Guaranteed Performance:</u>	<u>GPM</u>	<u>TDH</u>	<u>RPM</u>	<u>EFF</u>	<u>HP</u>
Design	_____	_____	_____	_____	_____
High Head	_____	_____	_____	_____	_____
Low Head	_____	_____	_____	_____	_____

Warranty: The pump manufacturer shall warrant the unit being supplied to the Owner against defects in workmanship and material for a period of five (5) years or 10,000 hours.

---

**PIPING SPECIFICATION SHEET**

---

Service: 250 psig to 150°F  
Above ground installation

Pipe: Ductile iron – Thickness Class 53  
Grade 60,000 psi tensile, 42,000 psi yield, 10% elongation ANSI/AWWA  
C151/21.51

Fittings: 250 psi rating, ductile iron, flanged in accordance with ANSI/AWWA  
C110/A21.10. Flanges shall be ANSI B16.1, Class 125

Pipe Connections: Flanged joint, 250 psi rating in accordance with ANSI/AWWA C115/A21.15

Gaskets: Rubber, full face, 1/8" thick in accordance with ANSI/AWWA C110/A21.10

Bolting: American Standard stud bolts, ASTM 307 Grade B, with semi-finished heavy  
nuts

Remarks: 1. Lining: Pipe and fittings are to be cement mortar lined in accordance  
With ANSI/AWWA C104/21.4

---

## VALVE SPECIFICATION SHEET

---

Type: Gate – (Resilient Seated)

Rating: 200 PSI working water pressure to meet or exceed AWWA C509 requirements.

Ends: Flanged, F.F., 125 # ANSI B16.1

Body: Cast Iron, ASTM A126

Bonnet: Cast Iron, ASTM A126

Body Bolting: ASTM A307, Gr. B

Disc: Cast Iron with resilient seat of SBR or Buna “N” rubber vulcanized to gate.

Stem: Bronze, non-rising

Seat: Resilient Seated Gate

Seals (or Packing): O-ring stem seals. S.S., Delrin, Teflon or Polymer thrust washers.

Operator: Handwheel unless otherwise shown on Plans.

Service: Water or Wastewater

Remarks Valve shall be furnished with all accessories for proper installation.

---

## VALVE SPECIFICATION SHEET

---

Type: Swing Check

Rating: 2" – 12" = 150 psi water, 14" – 36" = 150 psi water

Ends: Flanged, F.F., 125# ANSI B 16.1

Body: Cast Iron, ASTM A126, Class B

Bonnet: (Cover) Cast Iron, ASTM A126, Class B

Body & Bonnet Bolting: ASTM A307, Gr. B

Disc: Cast Iron, ASTM A126, Class B with Bronze Bushing and Bronze Faced

Stem: (Clapper Arm Shaft) Stainless Steel

Seat: Bronze Renewable

Seals (or Packing): Conventional Packing

Operator: Outside Weight and Lever

Service: Water and Wastewater, Oil and Gas

Remarks: Horizontal or Vertical Installation