

DIVISION 43

ELECTRICAL AND CONTROLS

43.01 GENERAL: Work to be performed under this section includes furnishing all labor, equipment, material, incidentals and appurtenances for the electrical systems and circuits supplying power, lighting, general purpose uses, instrumentation and control for the project as specified hereinafter and/or shown on the plans. It is the intent of the plans and specifications to describe a complete and working electrical system and to prescribe for the complete electrical installation and testing of the equipment and devices specified under other sections of the specifications and/or shown on the plans. The Contractor is charged with familiarizing himself with these and other plans and specifications prior to submitting a bid. No extra payment will be made for incidental work not specifically called for, but which is necessary for the proper installation of equipment and functioning of the system.

- A. Equipment: The Contractor shall furnish and install all equipment obviously of an electrical nature as well as those items specifically called out by manufacturer's names on the plans and in the specifications.
- B. Workmanship: Workmanship shall be of the highest quality and no substandard work will be accepted. All equipment furnished by the Contractor shall be new and in good condition.

43.02 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS:

- A. The latest effective publications of the following standards, codes, etc., as applicable, form a part of these Specifications the same as if written fully herein and shall be followed as minimum requirements. Minimum requirements shall not relieve the Contractor of the responsibility of furnishing and installing higher grade materials and workmanship than therein specified.
 - 1. City of Chesapeake Building, Electrical and Fire Codes.
 - 2. National Electric Code.
 - 3. Standard Rules of the Institute of Electrical and Electronic Engineers.
 - 4. Service Rules and Regulations of Virginia Power.
 - 5. National Electrical Manufacturer's Association.

6. State Fire Safety Regulations.
 7. Virginia Occupational Safety and Health Administration (VOSHA).
- B. The Contractor shall give all required notices, obtain all necessary permits and pay all required fees.

43.03 DRAWINGS: These Specifications are accompanied by floor plans and details of the building electrical systems, and what is called for by one shall be as binding as called for on both. The drawings indicate diagrammatically the extent of the work, so the Contractor shall examine the architectural, structural, and mechanical drawings to avoid conflict with other trades. Minor variations in location of equipment shall be made upon written approval of the Engineer at no additional charge.

43.04 ELECTRICAL CONSTRUCTION METHODS:

- A. Construction Methods: The methods are generally diagrammatic and the Contractor shall harmonize his work with that of other trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets in raceways, fittings, etc., required to properly install the work shall be furnished so as to take up minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor without additional expense to the Owner. In case interference develops, the Owner's authorized representative is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.
- B. Conduit and Wiring:
1. Conduit shall be run exposed.
 2. Wiring installed in concrete work shall be installed in Schedule 40 PVC conduit, unless otherwise noted.
 3. All exposed Raceways shall be securely fastened in accordance with the NEC.
 4. All conductors and conduits have been sized in accordance with the latest edition of the NEC. Conductors or conduit shown larger than code requirements on the plans will be installed at the larger size. All conductors are minimum No.12 copper and all conduit is 3/4-inch minimum, unless otherwise marked.

5. Main circuit wiring is generally shown on the plans. Miscellaneous wiring, grounds, etc., shall be furnished and installed as specified and/or required for proper operation of equipment furnished. Where specific equipment requires additional circuits or wiring in excess of those shown, or equipment horsepower is in excess of those shown requiring larger conductors, such changes shall be made. The Contractor is cautioned to ascertain, through the equipment suppliers or other sources, the requirements of all equipment and include cost for additional conductors, conduit, etc., in his bid. No additional compensation will be allowed in such instances unless, in the opinion of the City, such compensation is due.
6. All wiring within electrical cabinets, control panels, etc., shall be done in a neat and workmanlike manner with true color coding observed throughout. Conductors pertaining to specific devices shall be bundled and identified. All control circuits shall originate and terminate on screw-type insulated terminal strips and shall be protected at the point they receive electric energy by a panel-type fuse and holder mounted near the terminal strip. All conductors entering a control center, which may be energized from a remote source shall be properly identified and marked so as to source.
7. All cables shall have the manufacturer's written approval for use under the type conditions to which the cable will be subjected on this project.

C. Identification of Wiring and Equipment:

1. All interior exposed raceways, wiring and equipment shall be suitably identified by the Contractor. Identification of raceways and apparatus shall be done only after all painting has been completed. The Contractor shall provide access to and shall open boxes, etc., as required, at the time of final inspection to satisfy the Public Utilities' representative that the proper identification procedures for conductors, etc., have been adhered to.
2. Control equipment shall be identified by the use of engraved laminated plastic nameplates. Lettering shall be 3/16 inch in size. Plates shall be black surface and white core to produce white letters. Where equipment is not suitable for mounting, the nameplate shall be bolted or riveted and shall be suitably fastened to the equipment or mounted immediately adjacent thereto.

43.05 MATERIALS AND WORKMANSHIP:

A. General:

1. Electrical materials furnished under these Specifications shall be new and listed, inspected and approved by the Underwriters' Laboratories and shall bear the UL label where labeling service is available.
 - a. Line voltage items shall be Westinghouse, Square D, Cutler Hammer or Allen Bradley only.
 - b. Control circuit items shall be manufactured by above or as specified.
 - c. Replace or repair defective equipment and materials, or material damaged in the course of installation or tests as approved by the Engineer.
 - d. Install materials in a first class and workmanlike manner and throughout the structure.
2. All materials and equipment shall be properly stored and protected until installed.
3. Eight (8) complete schedules of materials and equipment proposed for installation shall be submitted to the Engineer within thirty (30) days of the Notice to Proceed. The schedules shall include catalogs, cuts, diagrams and such other descriptive data and/or samples as may be required by the Engineer. In the event any items of material or equipment contained in the schedule fail to comply with the Specification requirements, such items will be rejected and approved items must be substituted for the items rejected. If, after expiration of the 30-day period or any duly authorized extension thereof, the Contractor fails to submit a schedule of acceptable material or equipment covering the rejected items, the City reserves the right to select the items, and such selection shall be final and binding upon the Contractor and a condition of the contract, without additional cost to the City.

Submittals shall be provided for the pump station control panel and the electrical installation. Each submittal shall contain the following:

- a. Control Panel Submittal:
 - 1) Material List
 - 2) Data Sheets
 - 3) Control Panel Wiring Diagram
 - 4) Control Panel Layout

- b. Electrical Installation Submittal:
 - 1) Material List
 - 2) Data Sheets on Installation Material
 - 3) Drawings showing electrical installation, showing conduit sizing and layout; locations of junction boxes, and field mounted control devices.

NOTE: Control Panel Manufacturer is responsible for item (a) and Electrical Contractor is responsible for item (b). The above submittals can be submitted as one, if one contractor is taking the responsibility for both.

- 4. No consideration shall be given for partial or incomplete submittals.

- 5. Qualifications:
 - a. Control Panel Manufacturer: The Control Panel Manufacturer must have been in business for a minimum of five years and throughout such five-year period, must have been regularly engaged in the design and manufacturer of water treatment and wastewater control panels. Contractor must have a graduate registered professional electrical engineer on staff having full responsibility for design, layout, production and supervision of the manufacturing and installation of the control panels of all projects undertaken by the control panel manufacturer involving the design and manufacturing of water treatment and wastewater control panels. The engineer must also have a had a minimum of five years experience in the design, manufacture, and installation of water treatment and wastewater control panels and five years experience in the sizing of the electrical service, motor controls and control panel layout and wiring.

 - b. The Electrical Contractor must be a Class A Contractor registered in the State of Virginia and must have had a minimum of five years experience in the .electrical

installation of water treatment and wastewater control systems. The electrical contractor must have a graduate electrical engineer on staff with the regular responsibility of electrical design, layout and supervision of electrical installations of this type for the electrical contractor. In lieu of an engineer on staff, the electrical contractor may have the installation submittals and drawings approved and stamped by a registered professional electrical engineer who is, and has been for a minimum of five preceding years, regularly installation of water treatment and wastewater treatment control system.

- c. Submittal must be provided to document the above requirements. The submittal shall include as a minimum, a list of selected jobs covering the last five years, and the name and phone number of a contact person at the organization for when the work was done.

B. Raceways and Fittings: The Contractor shall furnish and install all raceways and fittings. All raceways and fittings shall be Underwriter's approved galvanized rigid steel unless noted otherwise. Minimum conduit size shall be one-half inch; otherwise, conduit size shall conform with the requirements of NEC.

1. Galvanized rigid steel conduit shall be Underwriter's approved, hot-dip galvanized zinc metalized. All conduit fittings shall be zinc coated, threaded type, and manufactured by Appleton, Crouse Hinds, Pyle National, Thomas and Betts, or approved equal. All conduit joints shall be made up tight and no running threads will be permitted; "Erickson" couplings being used wherever necessary. Where conduit is cut, the inside edge shall be reamed smooth to prevent injury to conductors. Where conduits enter or leave all outlet boxes, cabinets, safety switches, tap boxes, motor controllers, etc., other than those having threaded hubs, a standard locknut shall be used on the outside of the box, and a locknut and grounding-type bushing used on the inside of the box.

Grounding bushings shall be OZ Electrical Manufacturing Co., type "BLG", Crouse Minds type GB, or approved equal. Bushings one inch and larger shall be of an approved insulated type.

2. Electrical metallic tubing shall be seamless, non-corrosive steel tubing, listed by the Underwriter's Laboratories, Inc.
3. Flexible conduit shall be galvanized, single strips, with a copper strip interwoven. In areas subject to moisture, or where call for on

the drawings, flexible conduit shall have plastic covering in accordance with NEC, Article 350-2. Fittings shall be standard UL approved with ground connector.

Watertight connectors shall be used with plastic covered conduit. Flexible conduit shall be used for connections to motors, and other equipment subject vibration.

4. The Contractor shall install larger-sized raceway than detailed where, there is excessive length of unbroken run or excessive number of bends and drawing-in tensions exceed the conductor manufacturer's recommended maximum. Size of raceways shall not be less than NEC requirements, but in no case shall be less than indicated on the plans; combining of circuits other than detailed shall not be permitted.
5. Bends in conduit shall be made while cold and in no case shall raceways be heated. Raceways shall not be bent through more than 90 degrees. The radius of bends shall not be less than six times the internal diameter of the raceway. Bends shall be minimized, in any event, not more than four (equivalent 90 degree) bends will be permitted between Outlets; the bends at the outlets being counted.
6. Raceways shall be properly aligned, grouped and supported. Exposed raceways shall be installed at right angles to, or parallel to, the principal structural members. Concealed raceways, if shown on the plans, unless otherwise indicated, may take the most direct route between outlets. Raceways shall be run to avoid trapping wherever possible. The Contractor shall provide and install necessary inserts in poured concrete areas for the proper support of his equipment and wiring, and shall furnish and install all necessary sleeves through the walls, floors and roofs for passage of raceways. Open area between sleeve and conduit shall be neatly cemented.

Sleeves through roofs and/or exterior walls shall be properly sealed against entrance of moisture, etc., into the building. Raceways, which are stubbed up or down, through or from, concrete slabs or other permanent type of materials, shall be extended by one conduit length until slab is poured to insure proper alignment of stubbed out raceways. During construction all installed raceways shall be temporarily plugged or otherwise protected from the entrance of moisture, dirt, trash, plaster, etc., and any raceways, which may become clogged through neglect of the Contractor to so protect, shall be replaced by the Contractor without additional expense to the Owner. No kinked, clogged, or deformed raceways

will be permitted on the job. Conduit shall be supported at intervals not exceeding NEC requirements.

7. Conduit in direct contact with the earth shall be given two overall coatings of asphalt base paint, first which shall be permitted to dry before second application and back filling. Paint shall be extended 6 inches above finished grade.
8. Conduits installed underground shall be buried with at least 24 inches of cover.
9. All joints, where underground cable runs enter building conduits, shall be made watertight.

C. Electrical Conductors:

1. Conductors: All conductors shall be copper and of standard shapes and sizes in accordance with American Wire Gauge, conforming to the applicable ASTM specifications as to conductivity.
2. Electrical Conductors: Electrical conductors shall be furnished in electrical grade copper; solid conductors in sizes No. 12 and 10, and Class B stranded in sizes No. 8 and larger. All conductors shall be NO. 12, or larger, and in sizes specifically noted on drawings, except as approved for control circuit wiring for specific equipment.
 - a. Service, feeder and branch circuit conductors shall be furnished with 600-volt THWN or THHN thermoplastic insulation. Lighting fixture taps, from junctions to lighting fixtures, shall be furnished with 600-volt THHN insulation.
 - b. Conductor insulation types specified shall conform to NEC standards and shall be furnished in the following colors according to voltage levels of systems installed:
 - 1) 120/208 volt system shall be furnished with black (phase A), red (phase B), blue (phase C), white (neutral), and green (ground) color identifications.
 - 2) 480 volt systems shall be furnished with the following color insulation identifications: Brown (phase A), orange (phase B), yellow (phase C), white with traces (neutral), and green (ground).

- 3) Control system conductors shall be No. 14 stranded, type THWN furnished with insulation color combinations not otherwise used for power systems, and as approved.
- c. Conductor insulation color for No. 6 AWG and smaller shall be a product of the conductor manufacturer. Conductors larger than NO. 6 AWG may be provided with black insulation color provided color marking tapes are applied as indicated above, at all terminations, splices and accessible locations.
- d. Shielded, signal cable shall be polyethylene insulated, 18 gauge, twisted with aluminum-polyester shield, stranded tinned copper drain wire with an overall chrome vinyl jacket. Signal cable shall be manufactured by Belden, or equal, as follows:

Conductor Belden No. 8760, or equal.

D. Grounding:

1. General: The Contractor shall be responsible for installing and testing a grounding system as shown on the drawings and/or specified herein. Grounding shall be in accordance with the NEC as a minimum. Additional grounding requirements shall be as specified or indicated on the drawings.
2. Products: Materials and equipment shall conform to the following requirements.
 - a. Ground rods shall be copper-plated steel rods, 10 feet in length and 3/4-inch in diameter.
 - b. Ground connections to ground loop, steel columns and ground rods shall be exothermic type, Erico "Cadweld", Burdy "Thermoweld", or equal.
 - c. A bare or green insulated copper, grounding conductor, sized in accordance with NEC 250-95 and as listed below, shall be solidly grounded and electrically continuous throughout the installation. Grounding-type bushings shall be installed on all conduit terminations. The ground wire shall be looped through the bushing lug upon exiting the conduit. Grounding conductors may not be shown on the plans, but the Contractor shall understand that where a

circuit is shown as two, three, or four-wire, an additional conductor for grounding purposes is required. Grounding conductors for circuits shall be sized according the following:

Overcurrent Device Ampere Rating	AWG Size of Copper Grounding Conductor
15	12
20	12
30	10
40	10
60	10
100	8
200	6
400	3
600	1
800	1/0
1000	2/0

3. Installation: Ground all motors, switches, receptacles, lighting fixtures, etc., using appropriate compression lugs bolted to bare surface of enclosure or ground screw. All grounding conductors shall be connected to the electrical control panel equipment ground bus and not to the neutral bus. Grounding bushings shall also be connected to the ground bus.
4. Tests:
 - a. Ground resistance measurements shall be by the "Fall of Potential" method.
 - b. Each ground rod shall be tested and the results shall be submitted in writing to the Engineer. Tests shall be made in normally dry weather and not less than 48 hours after a rainfall. Resistances shall not exceed 25 ohms to ground. If the resistance exceeds 5 ohms, additional ground rods shall be driven and the Engineer shall be notified in writing.
 - c. The entire ground system shall be left uncovered until approved by the Engineer.
- E. Boxes: Boxes shall be rigidly mounted and shall be equipped with suitable screw-fastened covers. The Contractor shall furnish and install all outlet boxes, tap, junction, or pull boxes, device boxes, etc., necessary for the complete finished installations as indicated on the drawings and/or

required. All raceways entering boxes shall be mechanically and electrically secure. Open knockouts or holes will not be tolerated but shall be plugged with approved blanking devices. NEMA 4 devices shall have openings closed with threaded plugs. Extra openings in NEMA 3R or 12 devices shall be closed with gasket devices. Boxes shall be cleared of all dirt, trash, etc., before the installation of any wiring devices and/or before the installation of cover plates.

1. Pull boxes shall be constructed of code gauge, welded and galvanized sheet steel. Boxes shall be sized in accordance with NEC requirements. Holes for raceways shall be drilled on the job. Where necessary for boxes to be supported away from ceiling or beams, structural steel members shall be provided for support.
2. All ceiling outlet boxes in dry areas shall be 4-inch octagonal, $2\frac{1}{8}$ inches deep for exposed work and 3 inches deep for concrete work. Fixture studs shall be provided where required. Flush-mounted wall outlets shall be 4-inch square boxes or gang boxes, $1\frac{1}{2}$ inches deep, and shall be provided with suitable extension rings and covers. Covers for flush-mounted wall boxes shall be 0.40-inch thick stainless steel minimum with satin finish and suitable for the device covered and/or the purpose intended. Boxes shall be of standard galvanized or sheradized sheet steel as manufactured by General Electric Co., Appleton Co., Steel City Electric Co., or equal.
3. All boxes for exposed wall mounting shall be a F.S. cast metal-type approved for this construction and fitted with gaskets as manufactured by Crouse Hinds, Appleton Co., or approved equal.

F. Wiring Devices:

1. Receptacles: Standard duplex receptacles shall be specification grade, brown color, rated 20 ampere, 125 volts, A.C., 2 pole, 3 wire, NEMA 5-20R, for back and side wiring.
2. Lighting Switches: Lighting switches shall be toggle-type, specification grade, brown color, of the number of poles shown on the drawings. Switches shall be rated 20 amperes, 120-277 volts.
3. Switch and Receptacle Boxes:
 - a. Boxes installed in hollow masonry walls shall be Standard sheet steel boxes of the appropriate type and size for the intended device(s).

- b. Boxes installed exposed shall be the cast metal-type FS or FD boxes of the appropriate size for the intended device(s).
- 4. Cover Plates: Stainless steel cover plates shall be installed on all devices. Plates shall exactly fit the mounting boxes.
- 5. Device Mounting Heights: Receptacles shall be installed 24 inches above finished floor to bottom of outlet box. Switches shall be installed 48" above finished floor to bottom of switch box.
- 6. Devices shall be as manufactured by General Electric, Arrow Hart, Bryant, Hubbell or Pass and Seymore.

G. Panelboards:

- 1. General: Furnish and install a panelboard as indicated on the panel schedule and where shown on the plans. Panel shall be dead front, safety-type equipped with thermal magnetic, molded case circuit breakers of frame and trip ratings as shown on the schedule. Panelboard shall be Square D Type NQOB, or approved equal.
- 2. Panelboards:
 - a. Circuit Breakers: Circuit breakers shall be quick-make, quick-break, thermal-magnetic, trip indicating, and have common trip on all multi-pole breakers. Trip indication shall be clearly shown by the breaker handle taking position between ON and OFF when the breaker is tripped. Branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker, to prevent repeated arcing shorts resulting from frayed appliance cords. Connections to the bus shall be bolt-on.
 - b. Panelboard Bus Assembly: Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard bussing shall be such that any two adjacent single-pole breakers can be installed in any location. All current-carrying parts of the bus assembly shall be tin-plated copper. Mains ratings shall be as shown in the panelboard schedule on the plans.
 - c. Wiring Terminals: Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for the type of conductor specified. Terminals for branch

circuit wiring, both breaker and neutral, shall be UL listed as suitable for the type of conductor specified.

- d. Cabinet and Front: The panelboard bus assembly shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge of steel shall be in accordance with applicable current NEMA Standards and UL Standards panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel.

Front shall include door and have flush, brushed stainless steel, cylinder tumbler-type lock with catch, and spring-loaded door pull. The flush lock shall not protrude beyond the front of the door. Front shall have adjustable indicating trim clamps, which shall be completely concealed when the door is closed. Door shall be mounted by completely concealed steel hinges. Front shall not be removable with door in the locked position. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. The directory card shall provide a space at least $\frac{1}{4}$ inch high x 3 inches long, or equivalent for each circuit. The directory shall be typed to identify the load fed by each circuit. Front shall be of code gauge, full-finished steel with rust-inhibiting primer and baked enamel finish.

- e. UL Listing: Lighting panel shall be listed by Underwriters Laboratories and bear UL label.

- 3. Shop Drawings: Shop drawings for the panel shall be submitted to the Engineer for review.

H. Circuit Breakers:

- 1. General: This specification covers molded case circuit breakers rated 15 through 1000 amperes, up to 480 volts, A.C. All devices shall be UL listed and meet NEMA Standards Publication No. AE1-1969. All devices shall meet Federal Specification No. WC-375a where applicable. Breakers covered under this specification may be installed in panel-boards, motor control centers, combination motor starters and individual enclosures.
- 2. Construction: Molded case circuit breakers shall be quick-made and quick-break type. They shall have wiping type contacts. Each pole shall be provided with arch chute and individual trip mechanisms. All breakers shall be calibrated for operation in an ambient temperature of forty degrees C. Molded case circuit

breakers shall be trip-free. Each breaker shall have trip indication independent of the ON or OFF positions.

3. Lugs: Breakers shall have front removable lugs for easy maintenance. Lugs shall be UL listed for both copper and aluminum cables.
 4. Magnetic-Only Breakers: Motor starters shall be furnished with magnetic-only type molded case circuit breakers or motor circuit protectors. Each breaker shall be provided with fixed trip and all poles to the same trip current.
 5. Interrupting Ratings: Circuit breakers shall have RMS symmetrical ampere interrupting ratings as directed.
- I. Electrical Equipment Supports: The Contractor shall furnish and install all necessary supports for properly mounting all electrical equipment and raceways. Such support shall be fabricated and installed in a neat and workmanlike manner. Should any building, structure, or the installation of any other Contractor, sustain damage through carelessness or through failure of this Contractor to properly support and install the electrical equipment, this Contractor shall bear all costs involved in repairing or replacing such installation.
1. All structural steel furnished shall be standard shapes and sizes and shall be free from rust and/or scale and shall have one shop coat of lead and oil paint thereon when delivered to the job site, except where galvanized finish is indicated or specified.
 2. All steel shapes exposed to the weather shall be galvanized after all cutting, drilling and/or welding is done. All shop connections shall be welded or riveted and all field connections shall be bolted.
- J. Transfer Switches: A three (3) pole double throw transfer switch (600 VAC) shall be provided and wired between the incoming service and the control panel. The transfer switch shall be heavy duty and sized for the incoming service amperage. The enclosures shall be NEMA 1 for indoor usage and NEMA 3R for mounting outside. The operating handle must be padlockable in all three positions. A standard padlock must be able to pass through a plate on the enclosure so as not to be able to force the lever into another position. The main power shall be wired so as to be energized when the operating lever is in the upper position. When the lever is in the lower position, the station shall run on the generator power, which is provided through a receptacle outside of the building. In the middle position, all power is disconnected from the building.

1. General: Furnish and install safety switches as indicated on the plans and specifications. All switches shall be NEMA Heavy Duty Type HD, Underwriters' Laboratories listed, as manufactured by Square D Company or equal. Switches shall be non-fusible, as noted on the plans.
2. Switch Interior: All switches shall have switch blades, which are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. All current carrying parts shall be plated.
3. Switch Mechanism: Switches shall have a quick-make and quick-break operating handle and mechanism, which shall be an integral part of the box, not the cover. Switches shall have dual cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open. Handle position shall indicate if switch in ON, OFF or on GENERATOR.
4. Enclosures: Switches shall be furnished in NEMA 1 general purpose enclosures or NEMA 3R (rainproof for outdoor mounting), unless noted otherwise on the plans. Covers on NEMA enclosures shall be attached with pin-type hinges. Rainproof covers shall be securable in the open position. NEMA 3R switches through 200 amperes shall be provided with closing caps, and shall have closing caps and have provisions for interchangeable bolt-on hubs and these hubs shall be provided as indicated on plans.

Enclosures shall be of code gauge (UL 98) sheet steel for NEMA 1 or code gauge (UL 98) galvanized steel for NEMA 3R. They shall be treated with rust-inhibiting phosphate primer and finished in gray baked enamel.

K. Fixtures:

1. General: Furnish and install all fluorescent, incandescent, high-pressure sodium lighting fixtures as shown on the drawings and as specified in the "Lighting Fixture Schedule" on the plans. The Contractor shall furnish and install lamps of the type specified on the drawings. The Contractor shall replace all burned-out or damaged lamps until final acceptance of the job.
2. Shop Drawings: Shop drawings for each type of lighting fixture shall be submitted to the Engineer for review.

L. Generator Receptacle:

A three (3) pole, four (4) wire generator receptacle shall be mounted outside the building and wired to the transfer switch. The plug shall be sized according to the amperage of the main service unless otherwise indicated. The manufacturer shall be Crouse Hinds with the following part numbers:

<u>SERVICE SIZE</u>	<u>RECEPTACLE PART NUMBER</u>
100A	AREA-10416-S22-T
200A	AREA-204127-S22-T
400A	AREA-4041210-S22-T

M. Electrical Control Panel (Wetwell/Drywell & Suction Lift Stations):

1. The control system supplier shall be responsible control system design, shop drawings to include installation drawings and wiring diagrams, submittal data and start-up assistance.
2. Drawings adequate for panel fabrication, installation and maintenance shall be submitted and approved prior to the control panel manufacturer starting any fabrication.
3. The control system shall be furnished to control two pumps driven by motors at hp and voltage ratings as noted, 3-phase, 60 hertz with across-the-line, non-reversible magnetic starters.
4. All components to be those specified or equal manufactured by an established manufacturer with replacements available from local suppliers.
5. The Contractor shall furnish and install a bubbler-type liquid level pump control system housed in a NEMA 12 control panel. All field devices are to be terminated to tubular terminal blocks or pneumatic type bulkhead fittings. All front panel mounted devices shall be heavy duty oil tight/dust tight NEMA 12 rated devices. The finished control panel must maintain the NEMA 12 rating.
6. ENCLOSURE: Enclosure to be constructed from 14-gauge steel, NEMA 12 design with Flange mounted circuit breaker operator for main and pump breakers. Enclosure to be provided with 3-point door latching hardware. Panel to be painted white on the inside and red on the outside. Panel to be sized according to NEC, NEMA and JIC requirements and allow enough

room in enclosure for neat field installation and easy maintenance. Panel to be Hoffman Bulletin A-25, Hammond Series 1447 or approved equal. Two corrosion inhibitors shall be installed in the control panel, sized according to manufacturer's recommendation. Corrosion inhibitor shall be Hoffman A-MCI10E or approved equal.

7. Interior Mounted Devices:

- a. Main circuit breaker sized as shown. Flanged circuit breaker operator to be provided and also interlocked with enclosure door to prevent door from opening unless main breaker is de-energized. Through-the-door circuit breaker operators will not be accepted. Circuit breaker will be sized to handle the full load Current of the pump station and interrupting current available from Virginia Power.
- b. Pump circuit breaker to be Motor Circuit protector type with adjustable instantaneous magnetic trip, which is NEMA rated for the horsepower load of the pumps. Circuit breakers for pumps are to be equal to Cutler Hammer, HMCP, or Westinghouse MCP. Pump circuit breakers are to have flanged mounted operators. Through-the-door operators are not acceptable.
- c. Full voltage across-the-line starters, NEMA and horsepower rated for each pump motor are to be provided. IEC rated starters are not acceptable. Properly sized overload thermal elements are to be provided for each phase. Starters to be Allen Bradley 509 Series or approved equal.
- d. 100A Main Breaker load with 1-20A two-pole circuit breaker and 10-20A one-pole circuit breaker. Load center to be mounted in a panel to allow operation of branch circuit breakers from front of control panel without opening of enclosure. A hinged window kit is to be provided to allow operation of load center through front door. Window kit must conform to NEMA 12 standards. Window kit to be Hoffman A-PWK or approved equal, if load center and circuit breakers are attached to the front door of the enclosure, then all branch wiring will be run to a terminal strip located on enclosure back panel. Exposed circuit breakers through the front of control panel or a surface mounted load center will not be acceptable.

On 480V 3-phase stations, the Contractor will provide a 2-pole 480V circuit breaker to feed remote mounted 7.5 KVA 480V to 240/120V phase transformer. Transformer is to be provided with control panel to be mounted by electrical contractor.

- e. Three-phase power monitor to detect loss of phase, phase reversal or low-voltage condition. Power monitor is to be wired so as to de-energize the control circuit to the pumps and close a set of contacts wired to a terminal strip for the alarm transmitter. Fuse blocks and fuses 2 are to be provided for each phase of the power monitor. Power monitors to be Diversified SLA or approved equal.
- f. Alternator to provide automatic alternation of pumps. Alternator to change lead pump operation on each successive cycle of lead pump operation, alternation to be Diversified ARA or approved equal.
- g. Pump failure timer to be adjustable plug-in type timer with a range of 0-300 seconds. Time delay to be Diversified TUC-120-ALA-300 or approved equal.
- h. Pump failure relays to be of the heavy duty plug-in type.
Relays to be IDEC RH Series or approved equal.
- i. Over temperature relays will be provided on suction-lift type pump stations or where otherwise indicated. Relays shall be heavy-duty plug-in type. Relays to be IDEC RH series or approved equal.
- j. Latch relays shall be provided to control the Starting and stopping of the pumps by the level controller. Latch relays to be of the plug-in type and shall be IDEC RR2KP-U or approved equal.
- k. Two (2) air pumps to provide air for the bubbler system. Provide check valve in the supply of each air pump. A switched receptacle will be provided to supply power for the air pumps. Hard-wired air pumps will not be acceptable.
- l. Tubular, barrel type terminal strips shall be provided for terminating all field wiring. Open-screw type terminals will not be acceptable.

8. Exterior Mounted Items:
- a. Flanged circuit breaker operators to operator main and pump circuit breakers. Main and pump circuit breaker operator shall be interlocked with enclosure to prevent opening of door while main breaker is energized. Breaker operators to be Cutler Hammer C371 series or approved equal. Through-the-door operators will not be acceptable.
 - b. White control panel light to be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-U11W.
 - c. Green pump running light to be provided for each pump. Light to be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-Q11G or approved equal.
 - d. Illuminated pump failure resets are to be provided for each pump. Resets are to be heavy duty, oil tight and be of either transformer or resistor type. Resets to be Allen Bradley 800T-QB11R, red in color or approved equal.
 - e. Illuminated over temperature reset lights shall be provided for each pump on suction lift stations. Resets shall be of the heavy duty, oil tight type. Reset shall be Allen Bradley 800T-QB11R, amber in color or approved equal.
 - f. Hand-off-Auto switch shall be provided for each pump. Switches shall be of the heavy duty, oil tight type. Switches shall be Allen Bradley 800T-J2A or approved equal. Switches shall be illuminated in the auto position only.
 - g. A two-position selector switch shall be provided for selecting air pump No. 1 or No. 2. Switch shall be heavy duty, oil tight type. Switch shall be Allen Bradley 800T-H2A or approved equal.
 - h. A liquid level indicator and controller with snubber shall be provided to start and stop the pumps according to the liquid level. The gauge shall have adjustable start and stop points on the front of the gauge. The gauge shall have one stop level for both pumps, and have one start level for the lead

pump and another start level for the lag pump. Level gauge shall be Murphy OPLHAFC-10 with tickler contact.

- i. An air flow meter shall be provided on the fact of the control panel. Unit shall be Dwyer VFA-4 or approved equal.
- j. Reset push buttons for each pump starter shall be provided. Units to be Cutler Hammer 10935-H6 or approved equal.

9. Field Mounted Devices Furnished With Panel:

- a. Check valve limit switch for each pump. Unit to be heavy duty NEMA 4. Units to be Allen Bradley 802T-H or approved equal. Limit switch arms shall be provided to suit the check valve installed.
- b. Heat sensors for each pump shall be provided for suction lift pumps. Heat sensors shall be mounted on the pump casing and within the F.S. box.
- c. PVC Bubbler bell with forty (40) feet of ¼ inch polyethylene tubing, run in ½ inch PVC pipe throughout, outside of Control Panel.
- d. A float switch will be provided for the wetwell high level alarm and drywell high level alarm. Float switches to be provided with forty (40) feet of cord. Float switches to be Anchor Scientific Model SP4ONO or approved equal.
- e. On 480V 30 stations, a 480-240/12010 7.5 KVA Transformer shall be provided for load center.
- f. On wetwell/drywell stations, a lockout switch will be provided for each pump in the drywell within sight of its respective pump. Lockout will be wired in series with the control circuit for its respective pump station. Unit shall be padlockable in the OFF position. Unit shall be Cutler Hammer 10250H665 or approved equal.

10. Sequence of Operation:

The liquid level will be controlled by an air purging bubbler type control system. The two position selector switch on the front of the control panel will select either air pump No. 1 or No. 2. The air will flow through the air flow meter to the level gauge(s) on the

front of the control panel and through the bubbler tube and bell in the wetwell. As the level in the wetwell rises, the pressure in the bell and tubing will increase and the indication on the level gauges will rise proportionally. The start and Stop points will set with the knobs on the front face on the level gauge(s). As the water level rises above the first start level, the lead pump will start.

On a further rise in level, the lag pump will start. On three pump systems, as the liquid level continues to rise, a third pump will be started. When the liquid level drops to the stop points, the pumps will shut down. When the third pump is energized, the first and second pumps will be de-energized. On the subsequent cycle, the original lead-lag sequence shall be maintained.

A lead/lag switch will select the sequencing of the pumps. In the alternate position, each successive starting and stopping of the lead pump will cause the system to rotate the pump station on the next lead pump start.

A hand-off-auto switch shall be supplied for each pump to allow hand operation for each pump. In the automatic position, each pump will be under control of the bubbler control system.

Pump failure to operate is to be detected by limit switches mounted in the pump check valves. When a pump is called to run, a time delay shall be energized to allow enough time for the pump to achieve prime. If, after this set time elapses and the check valve limit switch has not detected flow, the respective pump failure light will be illuminated and a relay contact will close, signaling to the alarm transmitter the respective pump failure. Pump "Failure to Operate" shall not lockout the pump. The subsequently initiated alarm shall not cancel until the pump is again signaled to operate and succeeds.

Pump failure as stated above shall be provided for each pump.

On suction lift stations, pump over-temperature is to be detected by thermostat provided for each pump. Upon sensing over-temperature condition the affected pump will shut down, a red pilot indicating light on the control panel will illuminate an alarm signal initiated to the telemetering equipment and the other pump shall be signaled "ON". The affected pump will be locked out of operating until the fault is cleared and illuminated pilot light/reset. Hand operation of the H-O-A switch shall override the lockout condition.

The three-phase power monitor shall detect a phase loss, phase reversal, and low voltage condition, and shut down the control circuit to the pumps and initiate a signal to the alarm transmitter.

N. Electrical Control Panel (Submersible):

1. The control system supplier shall be responsible for complete control system design, shop drawings to include installation drawings and wiring diagrams, submittal data and start-up assistance.
2. Drawings adequate for panel fabrication, installation and maintenance shall be submitted and approved prior to the control panel manufacturer starting any fabrication.
3. The control system shall be furnished to control two pumps driven by motors at hp and voltage ratings as noted: 3 phase, 60 hertz, with across-the-line, non-reversible magnetic starters.
4. All components are to be those specified or approved equal, manufactured by an established manufacturer with replacements available from local suppliers.
5. The pump station control system will be a complete self-contained control system mounted in one NEMA 12/3R outside enclosure. The interior of the outside enclosure will contain a bubbler type liquid level control housed in a NEMA 12 control enclosure specified herein and room for city provided alarm transmitter. Outside enclosure will be large enough to provide proper clearances per NEC and allow for ease of maintenance. NEMA 12 rating must be maintained for both the inside and outside panel. Any penetrations to the enclosures must be sealed with sealing locknuts, Myers hubs, seal-offs, etc.

On the outside rear of the enclosure is to be mounted the Virginia Power meter base, 3PDT transfer switch and generator receptacle. Enclosure will contain a padlockable 3-point door latch on the outside of the large enclosure. Minimum size of the large enclosure will be 42 inches tall, 60 inches wide and 12 inches deep. Maximum height will be 60 inches unless specified otherwise. Minimum size panel will be Hoffman A426012WFALP with drip shield painted green with L1 door latch or approved equal. Inside of panel will contain a 20A 120V receptacle.

6. The Contractor shall furnish and install a bubbler type liquid level pump control system housed in a NEMA 12 control panel. All

field devices are to be terminated to tubular terminal blocks or pneumatic type bulkhead fittings. All front panel mounted devices shall be heavy duty, oil tight/dust tight NEMA 12 rated devices. The finished control panel must maintain the NEMA 12 rating.

7. Enclosure mounted within outside enclosure: Enclosure to be constructed from 14-gauge steel, NEMA 12 design with flange mounted circuit breaker operator for main and pump breakers. Enclosure to be provided with 3-point door latching hardware. Panel to be painted white on the inside and red on the outside. Panel to be sized according to NEC, NEMA and JIC requirements and allow enough room in enclosure for neat field installation and easy maintenance. Panel to be Hoffman Bulletin A-25, Hammond Series 1447 or approved equal. Two corrosion inhibitor shall be installed in the control panel, sized according to manufacturer's recommendation. Corrosion inhibitor shall be Hoffman A-HCI10E or approved equal.
8. Interior Mounted Devices:
 - a. Main circuit breaker sized as shown. Flanged circuit breaker operator to be provided and also interlocked with enclosure door to prevent door from opening unless main breaker is de-energized. Through-the-door circuit breaker operators will not be accepted. Circuit breaker will be sized to handle the full load current of the pump station and interrupting current available from Virginia Power.
 - b. Pump circuit breaker to be Motor Circuit protector type with adjustable instantaneous magnetic trip, which is NEMA rated for the horsepower load of the pumps. Circuit breakers for pumps are to be equal to Cutler Hammer, HCMP, or Westinghouse MCP. Pump circuit breakers are to be mounted with operators through the door.
 - c. Full voltage across-the-line starters, NEMA and horsepower rated for each pump motor are to be provided. IEC rated starters are not acceptable. Properly sized overload thermal elements are to be provided for each phase. Starters to be Allen Bradley 509 Series or approved equal.
 - d. Seal failure alarm relays will be provided for each pump. Relays will be of the transformer or solid state type. Units will detect moisture in the pumps by the oil submerged

electrodes provided in the pumps. These electrodes will be wired to the seal failure relays in the control panel.

- e. Three-phase power monitor to detect loss of phase, phase reversal or low voltage condition. Power monitor is to be wired so as to de-energize the control circuit to the pumps and close a set of contacts wired to a terminal strip for the alarm transmitter. Fuse blocks and fuses are to be provided for each phase of the power monitor. Power monitor to be Diversified SLA or approved equal.
 - f. A two-position selector switch shall be provided for selecting Air Pump No. 1 or No. 2. Switch shall be heavy duty, oil tight type. Switch shall be Allen Bradley 800T-J2KP7C or approved equal.
 - g. A liquid level indicator and controller with snubber shall be provided to start and stop the pumps according to the liquid level. The gauge shall have adjustable start and stop points on the front of the gauge. The gauge shall have one stop level for both pumps and have one start level for the lead pump and another start level for the lag pump. Level gauge shall be Murphy OPLHAFC-IO with tickler contact.
 - h. An air flow meter shall be provided on the face of the control panel. Unit shall be Dwyer VFA-4 or approved equal.
 - i. Reset push buttons for each pump starter shall be provided. Units to be Cutler Hammer 10935-H6 or approved equal.
9. Field Mounted Devices Furnished With Panel:
- a. Check valve limit switch for each pump. Unit to be heavy duty NEMA 4. Units to be Allen Bradley 802T-H or approved equal. Limit switch arms shall be provided to suit the check valve installed.
 - b. Heat sensors for each pump shall be provided (omitted for submersible) for suction lift pumps. Heat sensors shall be mounted in FS type box.
 - c. PVC bubbler bell with 40 feet of ¼ inch polyethylene tubing, run in ½ inch PVC pipe throughout, Outside of Control Panel.

- d. A float switch will be provided for the wetwell high level alarm and drywell high level alarm. Float switches to be provided with 40 feet of cord. Float switches to be Anchor Scientific NO. P4ONO or approved equal.
- e. On 480V 30 stations, a 480-240/120/10 7.5 KVA Transformer shall be provided for load center.
- f. On wetwell/drywell stations only, a lockout switch will be provided for each pump in the drywell within sight of its respective pump. Lockout will be wired in series with the control circuit for its respective pump station. Unit shall be padlockable in the OFF position. Unit shall be Cutler Hammer 1025OH665 or approved equal.
- g. Alternator to provide automatic alternation of pumps. Alternator to change lead pump operation on each successive cycle of lead pump operation, alternation to be Diversified ARA or approved equal.
- h. Pump failure timer to be adjustable plug-in type timer with a range of 0-300 seconds. Time delay to be Diversified TUC-120-ALA-300 or approved equal.
- i. Pump failure relays to be of the heavy duty plug-in type.

Relays to be IDEC RH series or approved equal.
- j. Over temperature relays will be provided to shutdown the respective pump in the automatic mode of operation and illuminate an over-temperature pilot light. Light to be amber in color.
- k. Latch relays shall be provided to control the starting and stopping of the pumps by the level controller. Latch relays to be of the plug-in type and shall be IDEC RR2KP-U or approved equal.
- l. Two (2) air pumps to provide air for the bubbler system. Provide check valve in the supply of each air pump. A switched receptacle will be provided to supply power for the air pumps. Hard-wired air pumps will not be acceptable.

- m. Tubular, barrel-type terminal strips shall be provided for terminating all field wiring. Open screw-type terminals will not be acceptable.
10. Exterior Mounted Items:
- a. Flanged circuit breaker operators to operate main circuit breakers. Main circuit breaker operator shall be interlocked with enclosure door to prevent opening of door while main breaker is energized. Breaker operators to be Cutler Hammer C371 series or approved equal. Through-the-door operators will not be acceptable.
 - b. White control panel light to be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-Q11W.
 - c. Green pump running light to be provided for each pump. Light to be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-Q11G or approved equal.
 - d. Illuminated pump failure resets are to be provided for each pump. Resets are to be heavy duty, oil tight and be of either transformer or resistor type. Resets to be Allen Bradley 800T-QB11R, red in color, or approved equal.
 - e. Pilot lights will be provided for pump over temperature for each pump. Pilot light will be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-Q11G, amber in color, or approved equal.
 - f. Hand-Off-Auto Switch shall be provided for each pump. Switches shall be of the heavy duty, oil tight type. Switches shall be Allen Bradley 800T-J2A or approved equal.
 - g. A two-position selector switch shall be provided for selecting Air Pump No. 1 or No. 2. Switch shall be heavy duty, oil tight type. Switch shall be Allen Bradley 800T-H2A or approved equal.
 - h. A three-position switch shall be provided to select pump alternation, No. 1 lead or No. 2 lead. Switch shall be heavy duty, oil tight type. Switch shall be Allen Bradley 800T-J2KP7C or approved equal.

- i. A liquid level indicator and controller with snubber shall be provided to start and stop the pumps according to the liquid level. The gauge shall have adjustable start and stop points on the front of the gauge. The gauge shall have one stop level for both pumps and have one start level for the lead pump and another start level for the lag pump. Level gauge shall be Murphy OPLHAFC-10 with tickler contact.
 - j. An air flow meter shall be provided on the face of the control panel. Unit shall be Dwyer VFA-4 or approved equal.
 - k. Reset push buttons for each pump starter shall be provided. Units to be Cutler Hammer 10935-H6 or approved equal.
 - l. Red seal failure light with push-button reset to be provided for each pump. Unit to be heavy duty, oil tight and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-QllG or approved equal.
 - m. Amber over-temperature failure light with push-button reset to be provided for each pump. Unit to be heavy duty, oil tight, and be of either transformer or resistor type. Pilot light to be Allen Bradley 800T-OllG or approved equal.
11. Field Mounted Devices Furnished With Panel:
- a. Check valve limit switch for each pump. Unit to be heavy duty NEMA 4. Units to be Allen Bradley 802T-H or approved equal. Limit switch arms shall be provided to suit the check valve installed.
 - b. PVC Bubbler bell with forty (40) feet of ¼ inch polyethylene tubing.
 - c. A float switch will be provided for the wetwell high level alarm. Float switches to be provided with forty (40) feet of cord. Float switches to be Anchor Scientific No. P4ONO.
12. Sequence Of Operation:
- a. The liquid level will be controlled by an air purging bubbler type control system. The two position selector switch on the front of the control panel will select either air

pump NO. 1 or No. 2. The air will flow through the air flow meter to the level gauge(s) on the front of the control panel and through the bubbler tube and bell in the wetwell. As the level in the wetwell rises, the pressure in the bell and tubing will increase and the indication on the level gauges will rise proportionally. The start and stop points will set with the knobs on the front face on the level gauge(s). As the water level rises above the first start level, the lead pump will start. On a further rise in level, the lag pump will start. On three pump systems, as the liquid level continues to rise, a third pump will be started. When the liquid level drops to the stop points, all pumps will shut down.

- b. A lead/lag switch will select the sequencing of the pumps. In the alternate position, each successive starting and stopping of the lead pump will cause the system to rotate the pump station on the next lead pump start.
- c. A hand-off-auto switch shall be supplied for each pump to allow hand operation for each pump. In the automatic position, each pump will be under control of the bubbler control system.
- d. Pump failure to operate is to be detected by limit switches mounted in the pump check valves. When a pump is called to run, a time delay shall be energized to allow enough time for the pump to achieve prime. If after this set time elapses, and the check valve limit switch has not detected flow, the respective pump failure light will be illuminated and a relay contact will close, signaling to the alarm transmitter the respective pump failure. Pump "Failure to Operate" shall not lockout the pump. The subsequently initiated alarm shall not cancel until the pump is again signaled to operate and succeeds.

Pump failure as stated above shall be provided for each pump.

- e. The three-phase power monitor shall detect a phase loss, phase reversal, and low voltage condition, and shut down the control circuit to the pumps and initiate a signal to the alarm transmitter.
- e. The seal failure relay will detect a seal failure in each pump and illuminate its respective red pilot light. This will be

wired into shut down the pump in the automatic mode only, and upon shutdown will call for the other pump to be energized.

- g. The over-temperature relay will detect an over-temperature in each pump. This will be wired in to shut down the pump in the automatic mode only, and upon shut down will call for the other pump to be energized.
- h. The following alarm conditions shall close a relay contact upon alarm and be wired to a terminal strip for remote connection to an alarm transmitter:
 - 1. High Water Wet Well
 - 2. Power Failure
 - 3. Pump No. 1 Failures
 - 4. Pump No. 2 Failures
 - 5. Pump No. 3 Failures (When Used)
 - 6. High Level Dry Level

13. Installation of Self-Contained Pump Station:

- a. Pump station control panel will be mounted on a minimum of 6'x6'x4" concrete slab located as shown or directed by Owner. Panel will be raised a minimum of 8" above the slab by a concrete or solid concrete block footing. Panel will contain a minimum of 3/4" spacing under panel where it is bolted down.
- b. A NEMA 4X junction box will be bolted under or on the back of the outside enclosure for conduits and wiring entering the enclosure. Penetrations between the junction box and control panel will be sealed by using neoprene insert strain reliefs around each cable. All penetrations entering the control panel must be sealed to prevent gases from entering control panel. SO and SJO cords from pumps, limit switches and float switches will be long enough to have final terminations inside of control panel. All conduits from control panel to the pump station will be sized large enough to allow ease of removal and replacement of each cable in the future for maintenance purposes. All conduits from the control panel to the pump station will be PVC. On retrofit and renovation pump stations, pump cords will be spliced with cable of same type and rating. Each cord that is spliced will be insulated using a scotch cast electrical splicing kit manufactured by 3M. Junction boxes inside the

wetwell will not be accepted. Limit switches will be wired with SO or SJO cords with neoprene insert strain relief grips installed at each limit switch. Bubbler tube will be installed in a secure fashion, which will allow ease of removal for maintenance while station is in operation.

- c. The over-temperature and seal failure circuits are to be run in separate conduits, properly sized. No other cable will be with the same conduit.
- O. A secondary high water float system shall be installed. The float shall 'be mounted on the pump station wall in close working proximity of the wetwell ladder. The float shall operate a function as follows:
- 1. In case of air pump failure and the continued rise of fluid in the wetwell, the N.O. float contacts shall close, activating the off delay, time delay relay (TD3), a control relay and pump #1 shall be signaled "ON."
 - 2. TD3 (0-10 min) shall provide sufficient adjustable time delay and, upon completion of the time delay, shall signal the pump #2 to the "ON" position.
 - 3. A high water signal shall be sent to the telemetry unit by the control relay upon pump #1 being energized.
 - 4. The pumps shall continue to run until the secondary high water float returns to its normal open position. Upon this return, an on delay, time delay (TD4) shall be energized and the pumps shall continue to run until TD4 has been satisfied.

The circuitry shall be independent of other control circuits and shall not interfere with their function, nor shall this circuitry interfere with other circuitry. Seal failure and over-temperature lockouts shall not effect this circuit's function.

- P. Finish: All metal structural and unit parts shall be completely painted using an electro-deposition process so that interior and exterior surfaces, as well as bolted joints have a complete finish coat on and between them. The basic process shall consist of using an iron phosphate pre-treatment for improvement of paint adhesion. The paint process shall consist of cleaning, rinsing, phosphating, four (4) pre-paint rinses, painting, three (3) post-paint rinses, a bake cure, and cool down. Paint shall be Acrylic-Mealamine Electrode position Baked Enamel, medium-light grey per ANSI Z55.1-1967. Removable push button operator plates, flange-

mounted operator handles and trim plates, and top horizontal wire trough cover plates shall be painted a contrasting light grey.

- Q. Shop Drawings: Shop drawings covering all details of the control center(s) shall be submitted to the Engineer for review prior to manufacturer of equipment.
- R. Heater: A forced air heater shall be installed in the sewage pumping station (except for submersible). Heater shall be Markeland Dayton or approved equal, with input controller. Heater shall be located over and directed towards pumps, with equivalent thermostatic control, range shall be 35 degrees F. to 85 degrees F.
- S. Submittals required for all field items mentioned or not. All electrical cut sheets to be submitted at the same time.
- T. Equipment Marking and Painting: All Safety switches, panelboards, cabinets, etc., shall be provided with permanently attached, engraved Bakelite designation plates to indicate equipment or circuit controlled. All exposed metal, conduit enclosures, panels, etc., shall be painted in accordance with the Specifications.

43.06 AS-BUILT DRAWINGS: Upon completion of the work and within thirty (30) days after the final inspection, the Contractor shall submit two (2) copies of as-built electrical drawings to the Engineer. These drawings may be prints of the original contract drawings with changes marked in red, addendum sketches and change order sketches or corrected sepias, at the option of the Contractor. The drawings shall indicate any and all deviations made in the actual installation to the contract plane.

43.07 ELECTRICAL SERVICE:

- A. Electrical service shall be as indicated on drawings.
- B. Arrangement shall be as indicated and as required by Virginia Power, including exact point of service and requirements of metering, etc.

43.08 FINAL INSPECTION AND TEST: Upon completion of the entire work, the Contractor shall perform such tests as required by the Engineer. The Engineer shall be given 48-hours notice before tests are made. The Contractor shall furnish the Engineer a certificate of approval from the local inspection authority having jurisdiction and absorb all costs of furnishing equipment and labor for the aforementioned tests.

43.09 WARRANTY: The Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that the work executed under

this Division of the Specifications shall be free from defects of materials and workmanship for period of 12 months from date of final acceptance of building. This warranty shall in no way affect or shorten individual manufacturer's warranty of equipment used.

43.10 MEASUREMENT AND PAYMENT: Electrical and controls will not be measured, but included in the lump sum bid price for the pumping station.