

DIVISION IV
GRAVITY SEWERS, FORCE MAINS, AND PUMP STATIONS

SECTION 48

PUMP STATION ELECTRICAL POWER AND CONTROL SYSTEM

48.1 GENERAL

This Section specifies the electrical power and control system requirements for wastewater pump stations. These requirements apply to duplex pump panels. Similar requirements shall apply when more than two pumps are involved, except for the quantity of control equipment and panel size shall be increased accordingly. The manufacturer of the control panel shall provide data to indicate that the manufacturer has a minimum of 3 years experience in the building of pump control panels.

A pump station control panel shall be provided for each wastewater pump station. See approved manufacturers' list in Appendix C. The control panel shall respond to liquid level float switches to automatically start and stop pumps as well as sound an alarm upon high or low wet well levels. The control panel shall operate two (2) electrical submersible pumps at the power characteristics stipulated. The control function shall provide for the operation of the lead pump under normal conditions. If the incoming flow exceeds the pumping capacity of the lead pump, the lag pump shall automatically start to handle this increased flow. As the flow decreases, pumps shall be cut off at elevation as shown on the PLANS. Pumps shall alternate positions as lead pump at the end of each cycle. A failure of the alternator shall not disable the pumping system. The alternator shall include a safe and convenient method of manual alternation with provisions to prevent automatic alternation without disturbing any wiring. Should the "pump off" regulator fail, the system shall keep the station in operation and provide a visual indication of the regulator failure.

The control panel shall consist of main circuit breakers and generator breaker with mechanical interlock, an emergency power receptacle, a circuit breaker and magnetic starter for each pump motor, and 15 ampere, 120 volt circuit breakers as required. All pump control operations shall be accomplished by a float type liquid level control system with all control components mounted in one common enclosure. Control switches shall provide means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall provide means to manually select or automatically alternate the position of the "lead" and "lag" pumps after each pumping cycle. A float type liquid level control system shall continuously monitor the wet well liquid level and control operation of the low-level cutoff for the pumps while operating off a 24 volt circuit.

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48.2 PANEL CONSTRUCTION

The duplex pump panel shall be housed in a NEMA 3R, Type 304, 14 Gauge stainless steel enclosure with 30 percent extra mounting space for additional equipment. The enclosure shall have provisions for padlocking the door and a dead front inner door unit for mounting controls. All exterior hardware and hinges shall be stainless steel.

There shall be permanently affixed to the interior side of the exterior enclosure door both a nameplate and a 10 inch x 12 inch pocket for log sheet storage. The nameplate shall contain the following information, voltage, phase, rated horsepower, speed, and date manufactured. Also contained shall be the pump and control panel manufacturer's name, address, and telephone number, pump data, including impeller data, operating point and head, kilowatt input, amps at the operating point, and at least two other points on the pump curve.

The control panel enclosure shall be Underwriters Laboratories (UL) 50 type 3R listed.

48.3 POWER SUPPLY AND MAIN DISCONNECT

Power supply to the control panel shall be either 240 volt, 3 phase, 4 wire or 480 volt, 3 phase, 4 wire. Minimum service shall be 100 AMP. Single phase power shall not be accepted unless specifically approved in writing by the DIRECTOR. The main disconnect box shall be made of either aluminum or stainless steel.

Non-fusible safety service main disconnects shall be installed at all stations. In all 240 volt systems, disconnects should be installed between the meter and the panel and on all 480 volt systems disconnect should be installed ahead of the meter, or as directed by the electric supply company. LED power available indicators shall be supplied on all legs.

48.4 CIRCUIT BREAKERS

48.4.1 MAIN BREAKERS

The panel shall have an interlock system between the normal power main breaker and the emergency breaker to ensure only one breaker is in the "on" position at a time. Both breakers shall be equal in size. See approved manufacturers' list in Appendix C.

48.4.2 CIRCUIT BREAKERS

All circuit breakers shall be heavy duty molded case breakers. The handle on the circuit breakers shall be operational through the inner door. See approved manufacturers' list in Appendix C.

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48.5 MOTOR CIRCUIT PROTECTORS

Each pump motor shall be protected by a 3-pole motor circuit protector. See approved manufacturers' list in Appendix C. The motor circuit protector shall be operated by a toggle-type handle and have a quick-make, quick-break over center switching mechanism that is mechanically trip-free from the handle so that the contacts cannot be held closed against a short circuit and abnormal currents which cause the motor circuit protection to trip. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the normal ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously. Motor circuit protector shall be completely enclosed in a high-strength glass polyester molded case. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes. A manual push-to-trip button shall be provided for manual exercising of the trip mechanism. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic-only element.

48.6 MOTOR STARTER AND SELECTOR SWITCHES

The panel shall contain two motor starters. The motor starter shall be across the line magnetic starter with individual overload protection on each power leg with reset installed through the inner door unit. See approved manufacturers' list in Appendix C. Local power company regulations shall govern.

Selector switches shall be installed on the face of the inner door unit. Selector switch shall be a heavy duty oil tight "Hand-Off-Auto" three position switch to control the operation mode of each pump motor starter.

48.7 PUMP ALTERNATOR

An eight pin plug-in solid state alternator (see approved manufacturers' list in appendix) shall be provided to change the pump starting sequence on each pumping cycle. A three position alternator test switch shall be provided to control the alternation operation. Switch positions to include the "Auto" to provide normal automatic sequence, "Off" position to disable alternator, and "test" position with a spring return to allow the alternating of the pump sequence to check alternator operation.

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48.8 LIGHTS AND ALARMS

48.8.1 INDICATOR LIGHTS

There shall be installed on the face of the inner door unit, heavy duty oil tight indicator lights as shown on the STANDARD DRAWINGS.

48.8.2 HIGH LEVEL ALARM

A vapor proof red light and weather proof horn for high level alarm shall be mounted atop a separate 1 inch minimum in diameter coated galvanized steel pipe located behind and connected to the bottom of the panel by a water tight electrical conduit. The bottom of said light shall be at least 1 foot above the top of the control panel. Also, there shall be an alarm silence pushbutton on the inner door and a silence relay which will silence the horn and automatically reset when these signals are restored to normal. The pushbutton shall be heavy duty oil tight. The red globe shall be the screw-on type.

48.9 EMERGENCY POWER RECEPTACLE

Emergency power receptacles shall be required on stations that do not have a permanent standby generator system. The panel shall have external mounted generator receptacle of the required size. See approved manufacturer's list.

48.10 ADDITIONAL REQUIREMENTS

48.10.1 WIRING

All power wires shall be THWN 75 Degree C insulated stranded copper conductors and appropriately sized for the given load application. All control circuit wire shall be type THWN; Size 14, stranded type. All wiring within the enclosure shall be neatly routed by the use of slotted type wiring duct with snap on type covers. Wiring on the rear of the inner door shall be neatly bundled with nylon ties and include sufficient loop across the hinges to prevent wire damage, with each end of conductor permanently identified with terminal number, Color: red, 24 volt; white, neutral; and black, 120 volts.

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48.10.2 TERMINAL POINTS

Terminal points of all terminal strips shall be permanently identified. All terminal numbers and identifying nomenclature shall correspond to and be shown on electrical diagrams. All wiring shall be permanently shown on electrical schematic diagrams.

48.10.3 ENGRAVED NAMEPLATES

All circuit breakers, control switches, indicator pilot lights and other control devices shall be identified with permanently affixed legend plates and laminate core type engraved nameplates where applicable.

48.10.4 SURGE PROTECTOR

A surge protector shall be included and wired to protect motors and control equipment from lightning induced line surges. All surge protectors shall be U.L. approved, installed, and attached to the main disconnects per respective power company requirements and manufacturer's specifications.

48.10.5 ELAPSED TIME METERS

Elapsed time meters shall be 115 volt non-reset type and totalize pump running time in hours and tenths of hours to 99999.9 hours.

48.10.6 CONVENIENCE RECEPTACLE

On the face of the inner door unit, there shall be installed a 15 AMP 120 volt, duplex convenience receptacle, GFCI protected. It shall be provided with its own single pole 15 AMP circuit breaker for protection.

48.10.7 CONTROL TERMINAL BLOCKS

Control terminal blocks shall be of the clamp screw type rated for 600 volts. Amperage rating shall accommodate the control circuit amperage. An additional 30 space terminal strip shall be installed in the cabinet for future use, with RTU equipment.

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48.10.8 CONTROL POWER TRANSFORMERS

There shall be a control power transformer with a minimum size of 500VA to provide 120VAC power to the coils for starters, 15A duplex receptacle, indicator pilot lights, alarm horn, alarm light, pump alternator, elapsed time meters, etc. The secondary side shall have one leg fused and the other grounded. This control power transformer is required only on 480 volt control panels.

The signal required by the float switches and relays shall be 24VAC. This shall be provided by a 24VAC control power transformer properly sized with a fused secondary.

48.10.9 CONTROL RELAYS

The level control relays shall operate from 24VAC. They shall be the enclosed plug-in 8 pin type with octal-style screw terminal sockets.

48.10.10 ELECTRICAL SCHEMATIC

There shall be permanently affixed to the interior side of the exterior enclosure door an electrical schematic diagram and a copy supplied to CITY personnel at start-up. The schematic diagram shall include the rated amperage and voltage for all components, and a component description with manufacturer's name and catalog number.

48.10.11 PHASE MONITOR

For all 240 volt stations, an eight pin plug-in type phase monitor shall be provided for protection of electrical components due to phase loss. Adequate dummy pin protection shall be provided to prevent accidental interchanging of the eight pin phase monitor with the eight pin alternator. All 480 volt stations shall have surface mount type phase monitors.

48.11 RADIO TELEMETRY AND MONITORING SYSTEM

Each pump station shall be equipped with a radio telemetry unit (RTU) capable of communicating with the existing Central Telemetry Unit (CTU) located at the CITY's Water Reclamation Facility via a state-of-the-art packet-switched technology radio and modem transceiver unit. All equipment, cabinets, and devices shall be of the field expandable heavy duty modular type designed for continuous industrial level service and produced, insofar as possible, by a single manufacturer.

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48.11.1 GENERAL

The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions. Field cabinets and enclosures shall be NEMA 4X stainless steel and provided with thermostatically controlled temperature and humidity controls to prevent condensation. The equipment furnished shall be designed to operate satisfactorily within officially recorded high and low temperature ranges for the Sanford Metro Area and up to 95 percent humidity.

All equipment shall be designed to operate from a 60 Hertz alternating current power source at a nominal 110 volts, plus or minus 10 percent, except where specifically approved by the DIRECTOR. All regulators and power supplies required for compliance with the above shall be provided.

Where regulation requires, constant voltage transformers shall be provided. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless otherwise approved by the DIRECTOR. Materials and equipment used shall be U.L. approved wherever possible. All equipment shall be designed and constructed so that in the event of a power interruption, said equipment shall resume normal operation without manual resetting when power is restored.

48.11.2 LIGHTNING AND SURGE PROTECTION

Lightning and surge protection shall be provided to protect the telemetry system from surges propagating along the signal and power supply lines. The protection systems shall provide a protective level that does not interfere with normal operation, is lower than the instrument surge withstand level, and be maintenance-free and self-restoring. All ground protection shall be in accordance with FIPS Publication 94 "Guideline on Electrical Power for ADP Installation".

48.11.3 REMOTE TERMINAL UNIT

The Remote Terminal Unit (RTU) shall be a completely self-contained, state-of-the-art, programmable controller-base data acquisition and control unit designed for monitor and control applications. The RTU shall be capable of communicating via a direct RS-232C data link, leased telephone line, or two way radio communications link in the frequency licensed for the application.

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The RTU shall be designed to accommodate plug-in Input/Output (I/O) modules that may be installed, without special tools, in the field by the CITY.

The RTU shall be programmable using relay ladder logic instructions from a DOS-base laptop computer or remotely over the communications medium. The minimum memory size of the RTU shall be 1.5K of 16-bit relay logic memory and 2K of the 16-bit register storage. Applications requiring more than 1.5K of ladder logic memory shall utilize a 4K or 8K logic CPU. The relay logic instructions of the programmable controller shall include normally open, normally closed, transitional positive and negative contacts, timers with 0.01, 0.1, and 1.0 second resolution, and up/down counters. Register and table instructions shall include block moves, table to register, register to table, FIFO, table search, and table to table. Register matrix operations shall include bit sense, bit set/clear, and, or, exclusive or, bit rotate, and complement. The programming language shall be the same across all models of the programmable controller family, allowing programs written in the smallest unit to be directly uploaded into a larger CPU. The application development software shall support all existing programmable controllers located in the treatment plant facilities as well as all existing and future remote units.

The RTU shall operate as a slave to the master site and only respond to polls addressed to the appropriate RTU. Control command from the central site shall be immediately executed in the logic of the RTU.

The RTU design shall utilize a low power CMOS design to allow for AC, DC battery, or solar power operation. The CPU shall be powered from a 24 VDC source. The programmable controller shall support a slot mounted AC power supply where required. The power supply shall be surge protected, accept input voltages of 95 to 270vac and short circuit protected by circuit limiting. Solar powered or battery-backed RTU operation applications shall require a dry lead-acid battery on float charge with a minimum float life of five years. The power supply and battery shall be housed in the RTU enclosure.

48.11.4 INPUT/OUTPUT MODULE

The I/O module shall be designed for ease of maintenance and future expansion. All I/O modules shall have a mechanical mechanism to prevent improper installation. All I/O points must

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be designed with surge suppression on all inputs and outputs in conformance with IEEE 472-1974. The configuration of additional modules shall be software configurable. The primary CPU and I/O chassis shall support the CPU, AC/DC power, if used, and two additional I/O modules of any type. Up to three additional I/O chassis may be added to the unit, each chassis shall house up to five I/O modules. Any I/O module of any type, digital and/or analog, shall be capable of being located in any unused I/O chassis slot.

The RTU shall support up to 256 digital inputs and outputs with a minimum of eight digital inputs and four digital outputs. 32 analog inputs and outputs shall be supported with four analog inputs and two analog outputs.

48.11.5 COMMUNICATION MEDIUM

The RTU shall be capable of two-way radio communications with the CITY's Wastewater Treatment Facility (WWFT) using a continuous polling method at a minimum rate of 1200 baud. All radio equipment shall be FCC accepted for telemetry use under FCC Regulations Part 94 at a frequency of 450 MHZ. The communications protocol shall be Modbus RTU mode and supported by multiple RTU manufacturers and computer software suppliers. Each message shall contain CRC-16 checksum for error checking. The unit shall have at least one communications interface which shall control the modem during the polling sequence.

48.11.6 RADIO TRANSCEIVER

The RTU shall have a solid-state FM radio transceiver with sufficient power to assure a 99 percent availability of signal from the remote site to the Water Reclamation Facility. The remote unit shall be of the same equipment manufacturer as the central unit. The communications modem shall be based on industry standard X.25 packet switch communications technology which shall support both RS-0232C and RS-422 communications at baud rates up to 9600 baud. The appropriate high gain antenna mounted on a 6 inch square tapered concrete mast pole or Rohn 25-G steel tube communications structure with stainless steel hardware shall be installed as shown on the STANDARD DRAWINGS. The coax cable utilized to connect the antenna to the RTU shall be a low loss type with an inert semi-liquid compound flooding all the voids between the polyethylene dielectric and the outer jacket. The flooding compound shall prevent water or water vapor from entering the cable even in the event that the outer jacket is cut.

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48.12 TESTING, SERVICE, AND WARRANTY

48.12.1 TESTING

After fabrication in the manufacturer's plant, an operational test shall be performed to check out the equipment before delivery. Three phase source voltage shall be used for the testing.

48.12.2 SERVICE

The manufacturer shall maintain a service organization in the Orlando Metropolitan Area.

48.12.3 WARRANTY

The manufacturer shall furnish a five (5) year warranty against defects in materials and workmanship covering parts and labor on all items supplied under this Section.