MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**PUMP STATION EQUIPMENT, ELECTRICAL**

TAY:PJS 1 of 9 APPR:BMB:NJM:07-10-24

**a. Description.** This work consists of furnishing and installing the pump station electrical equipment as detailed on the plans, in this special provision, and as directed by the Engineer. Follow industry standards and the details shown on the plans.

**b. Materials.** Furnish new materials that meet the standards and practices of the *NEC, ANSI, ASTM, UL, NEMA*, the standard specifications, *MIOSHA*, and this special provision.

Ensure all electrical devices furnished under this contract are new and are received at the job site in the manufacturer’s shipping container that clearly identifies the items. Used, rebuilt, or discontinued models are prohibited for installation under this contract unless otherwise specifically noted on the plans.

Ensure all components installed in hazardous areas shown on the plans are explosion proof or intrinsically safe as outlined in the *NEC*.

1. Conduit and Fittings. Furnish PVC-coated rigid steel for all exposed conduit and fittings in the pump station and all exposed exterior conduit and fittings. Ensure couplings and connectors are “threaded” type. Ensure outdoor buried conduit is schedule 80 PVC with PVC-coated rigid steel sweeps.

Ensure conduit terminations consists of double locknuts and insulated bushings, wet location connectors, or threaded hubs as applicable to maintain the ratings of the enclosure to which it is being terminated.

Ensure all joints in conduits are made with standard couplings unless neither conduit can be turned; then, ensure the union is made with a threaded rigid split coupling or three-piece couplings. Running threads is prohibited.

Furnish flexible liquid tight metal conduit for connections to vibrating or rotating equipment listed and appropriately labeled by a nationally recognized testing laboratory (NRTL) as conforming to applicable *UL* standards.

Flexible steel conduit is prohibited.

2. Wire and Cable. Ensure indoor feeder circuit, branch circuit, and control circuit wiring is stranded copper, 600-volt (V) insulation, *UL* Type “THW”, “THWN”, or “XHHW” moisture and heat resistant thermoplastic approved by the *NEC* for operating temperature of 75 ºC and for installation in wet or dry locations.

Use *UL* Type “XHHW” heat resistant wire when wiring between fixtures and their adjacent outlets.

Use single conductor stranded copper cable that has corona, ozone, heat, and moisture resistant cross-linked polyethylene 600 V insulation, or approved equal, rated to withstand a copper temperature of 90 ºC without deterioration for 480 V standards service. Ensure cable meets applicable *ICEA Standards* and is NRTL labeled, *UL* type “XHHW”.

Ensure all wire and cable, including feeders, main, and branch circuits, is color coded as follows:

480/277 V

Color Phase

Brown A

Orange B

Yellow C

Gray Neutral

Green Ground

Ensure conductors #8 and smaller have color-coded insulation. Ensure conductors #6 and larger have terminations and conductors in pull boxes taped with colored tape not less than two inches wide.

3. Pull Boxes. Furnish pull boxes, junction boxes, and cable support boxes of proper size and design in accordance with the *NEC* and as required to facilitate installation of wires. Ensure covers are gasketed and held in place with corrosion-resistant machine screws. Furnish cable supports for vertical runs at code required locations with pull or junction boxes. Ensure boxes are *NEMA 4X* stainless steel construction or *NEMA 7,* where shown on the plans.

4. Wiring Devices. Ensure wiring devices (switches, receptacles, and other such appurtenances) are rated for 20 Amperes (A) at 120 VAC unless otherwise shown.

5. Outlet Boxes. Ensure outlet boxes for exposed work are of PVC-coated steel construction with threaded shallow depth ferris box (*UL* Type “FS”) openings unless otherwise shown.

6. Lighting Fixtures. Furnish light fixture types, as shown in the lighting fixture schedule on the plans, that are complete, including all power supplies, drivers, fuses, support brackets, and other parts and devices necessary for complete operation. Ensure lighting fixtures utilize LEDs as the light source and operate on 120 V as shown on plans. Furnish LEDs of the color temperature as follows: 3,000 kelvin (K) (±500 K) for the machine room, 5,000 K (±500 K) for the rake room, and 4,000 K (±500 K) for all other spaces. LED luminaires must have a minimum 100,000-hour rating for 70 percent lumen-depreciation (minimum) with lumen output within 20 percent of listed fixture. Clean all fixtures at the end of the project.

7. Motor Control Centers. Ensure motor control centers comply with *NEC, NEMA, UL*, and are as shown on plans. Furnish motor control centers of code grade gauge steel, of the dead front safety type, with ampere interrupting capacity (AIC) ratings not less than that shown on the plans, and with circuit breakers and motor starters as shown on the plans. Ensure the main bus is copper. Ensure the horizontal bus bars are fully rated for the entire length of the motor control centers. Ensure vertical bus bars are sized for loads served. Ensure enclosure is of *NEMA*-type rating as shown on the plans. Ensure motor control centers conform to the arrangements and details on the plans and to the spaces designated for installation.

A. Circuit Breakers. Furnish motor circuit protectors with adjustable instantaneous trip for pump motors. Furnish thermal magnetic-type circuit breakers for overcurrent protection.

B. Motor Starters. Furnish combination type, three phase, *NEMA*-rated single speed, non-reversing, across the line, magnetic type motor starters with motor circuit protector disconnect for each pump, *NEMA* size 1 minimum. Furnish fused control power transformer, control devices and two spare auxiliary contacts in addition to those used in the pump control circuit. Furnish starters with melting alloy type thermal overload relays. Motor starters to be included as part of a motor control center where shown. Refer to wiring diagrams for specific details.

8. Lighting Transformer. Furnish 480 V primary with 240/120 V single phase secondary. Ensure the transformer is rated for 115 ºC temperature rise above 40 ºC ambient. Ensure all insulating materials are in accordance with *NEMA ST20 standards*. Ensure the transformer is in a heavy-duty stainless steel waterproof enclosure. Design the transformer to be floor, or wall mounted.

9. Branch Circuit Panelboards. Furnish branch circuit panelboards of code grade gauge stainless steel, dead front safety type with 22,000 AIC single or multi-pole circuit breaker, with branches of the number and ampere rating as shown on the plans. Ensure the main bus is copper. Furnish bolt-on breakers only. Fabricate panel enclosures in sections not exceeding 36 inches in width and 6 inches in depth.

Ensure panels have a main circuit breaker as shown on the plans and have 22,000 rms symmetrical interrupting capacity for 120/240 V panels.

10. Receptacles. Furnish receptacles that are a duplex convenience ground type, unless otherwise specified, with weather-tight gasket and covers and install in exposed cast conduit standard depth ferris boxes (*UL* Type “FD”) with metal mounting ears. This includes receptacles used for disconnects.

Ensure convenience receptacles are rated 20 A with back and side wiring and with exposed metal parts finished to resist corrosion.

Ensure special purpose receptacles are rated 20 A, 230 V, unless otherwise called for on the plans.

Ensure receptacles have a wet location, cast-metal spring type cover for each receptacle mounted on an *UL* Type “FS” and *UL* Type “FD” box.

11. Light Switches. Ensure switches are *UL* “T” rated. Ensure switches and receptacles are heavy duty, specification grade, and as called for on the plans.

Ensure device covers are listed for wet location, cast metal, for *UL* Type “FD” box application, unless otherwise called for on the plans.

12. Grounding and Bonding. Ensure ground rod electrodes are of copper-clad material, 3/4-inch diameter, and a minimum of 10-feet in length.

13. Supporting Devices. Ensure support systems can support the weight of said equipment, conduit, and wiring.

Ensure fastening equipment is of stainless-steel construction. Ensure all channel strut and fastening products are of stainless-steel construction.

14. Transient Voltage Surge Suppressors (TVSS). Ensure the motor control center and branch circuit panelboard are protected with a TVSS device that meets the requirements of *ANSI/UL 1449* and *ANSI/IEEE C.62.41-1980* and furnished with a fused or circuit breaker disconnecting means. Ensure the units are rated 600 V, 160 kiloampere (kA) per phase, Line-to-Line, Line-to-Neutral, and Line-to-Ground.

15. Pump Control Panel Control Sequence. Design to monitor and control the operation of up to two pumps in a pump-down mode in accordance with the level in the wet well as monitored by a submersible level transducer and high and low float switches. To minimize the number of pump starts per hour, provide first-on, first-off alternation. Furnish all necessary circuit breakers, power supplies, and automatic control equipment, etc., in a single enclosure. Incorporate all pumps into the alternation sequence. Furnish each pump with an adjustable 0 to 30 second start time delay. If the high-level alarm float switch is activated, bypass the normal level sensor control and start all pumps in the Auto mode. Adjust the start time delays to furnish a staggered start of the pumps. When started by the high-level alarm float, the pumps must run until the level in the wet well drops to the low-level float switch elevation. The float switch control logic must function independently of the pump controller specified herein. The pumps must cycle on the float switches until the control system is manually reset. Furnish separate fuse protection for the float switch 120 V control circuitry and the pump controller 120 V power circuitry. Ensure the pump control system automatically resumes normal operation after a power outage.

A. Enclosure. Furnish *NEMA 4X,* 14-gauge minimum 316 grade stainless steel, with inner doors sized as required for the equipment furnished. Fabricate the enclosure in sections not exceeding 36 inches in width and 24 inches in depth, unless otherwise shown. Ensure enclosure is mounted at 6 foot to top of enclosure. Furnish jumpers to bond section to section field connections of bus and interconnecting wiring. Furnish enclosure sections with lifting eyes. Furnish a thermostatically controlled 120 V heater within each enclosure to prevent condensation. Ensure the control panel is NRTL listed as meeting *UL* requirements.

B. Control Relays. Furnish *NEMA* rated industrial control relays with 120 V field replaceable coils and a minimum of two normally open and two normally closed contacts. Ensure contacts have plug-in type cartridges and are arranged for easy contact conversion or replacement. Furnish contact current ratings sufficient for the purpose specified. Plug-in style *International Electrotechnical Commission* (*IEC)* rated relays are prohibited.

C. Time Delay Relays. Furnish industrial grade, *NEMA*-rated type with timer head. Ensure relays operate at 120 V with adjustable time delays.

D. Intrinsically Safe Relays. Furnish intrinsically safe relays for the high and low wet well level float switches.

E. Equipment Hour Meter. Furnish all pumps with a mechanical, five-digit (hours and tenths) hour meter.

F. Selector Switches. Furnish heavy-duty, three-position, 30 mm, Hand-Off-Auto selector switches.

G. Pilot Lights. Furnish heavy-duty, 30 mm, push to test alarm and running pilot lights. Furnish pilot lights with LED type lamps and lens colors as shown on the plans; G indicates a green lens, R indicates a red lens.

H. Phase Monitor Relays. Furnish phase monitor relays with a voltage range of 200 V to 480 V, and protect against phase loss, phase unbalance, phase reversal and under/over voltage. Ensure output contact rating is 10 A. Ensure phase monitor relays reset automatically and are furnished with adjustable time delays on drop out and reset. Ensure phase monitor relays are surface *Deutsches Institut fur Normung* (DIN) rail mounted.

I. Terminal Blocks. Furnish 1⅜ inch, DIN rail mount sectional type with white marking strip for numbered identification, recessed screw head, compression clamp, 600 V, 60 A maximum rating.

J. Control Panel Wiring. Ensure panel wiring is a minimum #14 AWG-Machine Tool Wire (MTW), 60 °C rated for AC connections. Ensure thermoplastic wire cover is rated at 600 V and be colored red for AC wires; light blue for direct current (DC) wires, canary yellow for wires interconnecting with other control panels or systems which may be energized from alternate power source; green on all ground wire connections; black for power source and white for power neutral.

16. Conduit to Wall Penetration Seals. Furnish seals with interlocking, bolted rubber links shaped to the annular space between the pipe and the concrete cored opening. Furnish the size and number of rubber links to suit the pipe outside diameter and sleeve, as recommended by the manufacturer. Ensure all hardware is stainless steel.

17. Level Control System. Ensure the pump controller is microprocessor-based with a pump module, user interface, and 120 V power supply. Ensure the processor has a speed of 200 megahertz (MHz), 64 megabyte (MB) random access memory (RAM), and 32 MB of flash memory. Ensure the software supports a two pump operation (minimum). Ensure there is a time delay between start-up of pumps during loss of power. Ensure the controller operates in the “pump down” mode. Ensure the system furnishes monitoring, control, alarming (including alarm dialing) and configuration. Ensure the system furnishes a web-based interface to the user which does not require any equipment or software installed by the user, except for Internet Explorer and an internet connection. Ensure the system uses the cellular data network for communicating between remote sites and the web interface. Ensure the system delivers alarm messages via mobile phone messaging or via email and allows alarm acknowledgement via web site access or mobile phone.

Furnish a cellular modem for wireless data communications with the internet. Ensure modem includes standards-based quad-band global system for mobile communications/general packet radio service (GSM/GPRS) Class 10 performance; recommended standard (RS)-232, universal serial bus (USB) and Ethernet interfaces; embedded transmission control protocol/internet protocol (TCP/IP) protocol stack; and supports 850/900/1800/1900 MHz cellular connectivity. Ensure a 2.0 decibel isotropic (dbi) gain, ground dependent antenna housed in a high impact UVPVC radome furnished. Furnish RG58 low loss antenna cable with appropriate connectors and surge suppression in lengths as required to connect the cellular modem to the antenna. Coordinate activation of cellular service at each pumping station site.

Furnish the pump controller with the capability and all necessary hardware to monitor the pump station’s three-phase power and three-phase motor current for each pump installed. Ensure the three-phase power monitoring circuitry includes fuse protection.

Furnish the pump controller with the capability of calculating volumetric flow based upon wet well level and volume as shown on the plans.

Furnish the pump controller with the capability of disabling pump operation (in Hand or Auto mode) through a normally open output that energizes a “run permissive” relay. A normally closed contact from the “run permissive” relay is wired to each pump motor starter as shown in the wiring diagrams.

Furnish a Multi-Smart Pump Station Manager pump controller as manufactured by Multi-trode, with no exceptions. Ensure pump controller supports *IEEE Standard 1815 Distributed Network Protocol (DNP3)* for electric power communication systems.

Ensure the level probe is a submersible hydrostatic-type level transducer constructed with a welded 316 stainless steel with a Teflon coated elastomeric diaphragm. Ensure accuracy is ±0.25 percent of full scale. Ensure probe output is a 4-20 mA DC signal, is 2-wire, loop powered, and includes intrinsically safe barriers. Ensure lightning protection is also furnished. Ensure cable length is long enough to go from the wet well to the junction box. Splicing of cable is prohibited.

Furnish battery backup for pump controller, wet well level transmitter, and cellular modem. Ensure battery backup is sized to furnish at least 24 hours of runtime.

18. Float Switches. Ensure float switches are Teflon-coated, stainless steel, direct acting type, approximately 5 inches in diameter with potted single-pole double-throw (SPDT) mercury contact switch, narrow activation range. Furnish with 16-gauge, chlorinated polyethylene (CPE) jacketed cable of sufficient length to reach the terminal box as shown on the plans. Cable splicing is prohibited. Furnish float switches with suitable clamps for installation on a stainless-steel suspension cable. Furnish stainless steel suspension cable and plastisol coated cast iron weight. Ensure float switches are 120 VAC, normally opened contacts, hermetically sealed, and rated for duty in sewage applications.

19. Caution Tag. Ensure each panel receiving power from a separate source, which is not disconnected by the primary disconnect means, has a laminated orange tag 3-inches wide by 1.5-inches high with 3/8-inch-high white lettering reading: “CAUTION - SEPARATE VOLTAGE SOURCE.”

20. Nameplates. Ensure nameplates for safety switches, lighting panels, starter enclosures, panelboards, etc., are laminated white plastic with black lettering and are attached with sheet metal screws. Ensure nameplates are 2½-inches by 3/4-inches. Ensure the first line character size is 1/4-inch high and the second line 3/16-inches high. Ensure all panelboards include the final typed circuit directory installed inside of cover.

Ensure field located instruments and devices are equipped and identified with 1-inch by 3-inch engraved nameplates (similar to panelboard nameplate) and affixed to their respective device in a positive but flexible method (wire strap or similar means).

21. Exhaust Fan and Motor. Ensure the fan is a utility, upblast, belt drive fan, by Greenheck, Loren Cook, or Engineer approved equal, capable of exhausting 250 cfm at 0.50 inches water column driven by a maximum of 1800 revolutions per minute, 1/4 horsepower motor. Maximum of 70 dB sound power level at the inlet. Ensure all fan motors are explosion proof (EXP). Fan to have spark B rated construction. Ensure fan shrouds, motor and fan wheel are removable for service. Furnish *MIOSHA* approved guard. Furnish manual motor starter at control room entrance. Furnish 120 V room temperature sensor for fan operation. Ensure fan is automatically controlled as shown in wiring diagram. Furnish Hi-Pro-Polyester coating on all fan components. Furnish isolation base with neoprene isolators. Furnish 1 spare set of belts. Furnish stainless steel shaft. Furnish 120 V actuator (explosion proof) for air intake louver damper. Furnish 120 V actuator (explosion proof) for fan discharge damper. Coordinate size of intake damper with intake louver and coordinate exhaust fan damper with discharge size of fan.

22. Electric Unit Heater. Ensure electric unit heater furnishes a minimum of 9.5 kilowatts of heat. Furnish wash down style, *AISI* 304 stainless steel case with iridite coated element assembly and gasketed terminal box, *UL* listed, 316 stainless steel tubular elements, totally enclosed, fan-cooled (TEFC) motor, *NEMA 4X* electrical enclosures, hi limit safety, integral 1 stage thermostat, disconnect, and stainless-steel universal mounting bracket.

23. Mixes. Ensure patches, conduit sealing compound, fire stop compound, etc., are mixed in accordance with the manufacturer’s recommendations.

**c. Construction.** Ensure all work meets the standards and practices of the *NEC, ANSI*, the standard specifications, *MIOSHA*, and this special provision. Ensure all electrical work is done by a licensed electrician and in accordance with the *NEC*. Electronically submit a copy of the license to the Engineer.

Construct and install all materials and components at the locations shown on the plans unless otherwise approved by the Engineer.

Field verify and document the existing pump operation level prior to construction. Ensure reconnected float switches and sequences of operation match the information shown on the plans.

Furnish temporary seals on outlet boxes during construction.

Preassemble, to the degree possible, panelboards, control panels, relay panels, etc. This preassembly should be done offsite in a clean shop environment by the Contractor or manufacturer. Configure equipment to fit through the hatch size shown on the plans.

Ensure all wire and cable is continuous in the same color code and type to its extreme termination point. The use of different type of insulated wire to the same device or equipment is prohibited.

Install electrical grounding system in accordance with *NEC* requirements. Measure grounding system resistance using the “fall of potential” method. Ensure this test is witnessed by the Engineer, with the final test results electronically submitted to the Engineer for final approval.

Install support systems that are adequate for the weight of equipment, conduit, and associated wiring. Ensure support devices are not fastened to piping, ductwork, mechanical equipment, or conduit.

Install surface mounted cabinets and panelboards with a minimum of four anchors. Furnish stainless-steel channel supports to stand cabinet one inch off the wall. All freestanding electrical equipment is to be installed on a raised, six-inch reinforced concrete pad.

Furnish wire markers on each conductor in motor control center, panelboard, or pump control cabinet gutters, pull boxes, outlets, junction boxes, and load connection. Identify branch circuit and feeder number for power and lighting circuits and with control wire number as identified on the schematic and interconnection diagrams for control wiring. Ensure wire markers are preprinted and not pieced from single and/or double-digit tags. Embossed tape is prohibited for any application.

1. Pump Wiring. Verify that the motor cable is of sufficient length for termination in the power section of the motor control center. Ensure the cable is routed via electrical terminal box. Ensure motor cabling is one continuous length. Cable splicing is prohibited. Only cable specially developed by the manufacturer can be used for replacement. Ensure cable replacement is performed by factory authorized and trained service personnel.

Furnish an electrical system Short Circuit and Arc Flash hazard study in accordance with National Fire Protection Association (*NFPA) 70E, OSHA 29-CRF, part 1910 Sub-part S,* and *IEEE 1584 standard*. Upon acceptance of the study, furnish and install on the appropriate equipment, preprinted, adhesive-backed arc-flash warning labels that incorporate the information in subsection c.1.B of this special provision. Ensure the study addresses the following:

A. The available short circuit and ground fault currents available at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.

B. The flash hazard protection boundary, limited approach boundary, restricted boundary, prohibited boundary, incident energy level, required personal protective equipment class, and type of fire-rated clothing required.

2. Submittals. When directed by the Engineer or required by the specifications, submit samples of materials and accessory equipment such as light fixtures, switches, receptacles, etc. Do not use these materials in the work until the Engineer has had ample time to determine the products’ suitability and compliance with the specifications. Submit all documents in electronic PDF. Allow 15 working days for shop drawing reviews. Electronically submit the following information for approval by the Engineer.

A. Catalog cuts and/or product data sheets. Furnish catalog cuts for standard manufactured items such as conduit and conduit fittings, electric heaters, fans, light fixtures, lighting panels, instrument motors, switches, disconnects, transformers, wire, etc. Ensure each sheet identifies the exact equipment for which it is intended. Ensure all pertinent information such as physical dimensions, current rating, horsepower, kilowatt rating, phase, power factor, voltage, *NEMA* classifications, and material type used are labeled with an *NRTL* listing identification.

B. Control Cabinet Plans. Furnish a custom wiring diagram for this specific application. Ensure wiring diagrams are in ladder diagram format, comply with the latest *NFPA 79* and *IEEE 315* standards and are complete with line numbers, wire numbers and terminal numbers. Clearly identify field wiring connections. Furnish cabinet exterior and interior sub-plate dimensioned plans. Furnish a written sequence of operation on the control cabinet plans.

C. Schedule. Electronically submit a schedule that outlines the steps to be taken to maintain electrical service and showing the coordination effort which will be taken to coordinate the work between the various trades.

The approval of shop drawings does not relieve the Contractor from the responsibility to correct errors or omissions or to furnish adequate field measurements and quantities of materials that may be required. It is the Contractor’s responsibility to call attention to all deviations from the plans, specifications, and details. If deviations have not been clearly identified, they will not be considered as part of the shop drawing approval.

**d. Measurement and Payment.** The completed work, as described, will be measured as a lump sum and paid for at the contract price using the following pay item:

**Pay Item Pay Unit**

Pump Station Equipment, Elec (Structure Identification) Lump Sum