ITEM 599.0603XX04 M ELECTRICAL WORK

DESCRIPTION

This work shall consist of removing, furnishing, installing, and placing in operating condition all electrical work as specified. This work shall include all wire and cable, junction boxes, conduit system, fasteners and terminations, power panels, lights, electrical cabinets, receptacles, lighting fixtures, electric heaters, pumps, motors, fire alarm, timer and all cutting and patching. The Contractor shall be responsible for all negotiations with and work to satisfy the electric utility.

The Contractor shall remove all conduit and wire from the existing bridge structure, pit areas and operator's control tower. The Contractor shall disconnect power and remove the conduit and wire from the span motors, brakes, drum controller, secondary resistors, traffic lights and sump pump. The Contractor shall remove and turn over to the New York State as directed by the Engineer, drum controller, secondary resistors, sump pumps, span motors, brakes, electric panelboard and all lighting controls.

MATERIALS

1. Conduit System

   All exposed conduit on the bridge shall be rigid hot-dipped galvanized steel (RGS). All below grade wall penetrations shall use solid rubber links that expand when tightened to form a waterproof seal around the pipe. All conduit bodies and fittings shall be threaded malleable iron with cadmium or galvanized finish for use with rigid galvanized steel conduit.

   Acceptable manufacturers for RGS conduits: Republic, Allied Tube, Wheatland or approved equal.

   All conduit located in the pit areas, control tower, concrete embedded and direct buried shall be PVC-coated galvanized steel conduit meeting the provisions of NYSDOT Standard Material Specification 723-23 and rated for 90°C cable. Conduit shall conform to the latest edition of UL 651, NEMA TC-6 and ASTM F-512. Acceptable manufacturers: J-M Manufacturing, Contex, Carlon or approved equal. All fittings shall be made of the same material as the conduit.

   Final 381mm of conduit connections to motors or other mechanical equipment shall be liquid-tight flexible metal conduit. Conduit shall have a heavy galvanized steel core, Type H with an oil resistant thermoplastic covering of grey color. Provide steel, gasketed, insulated thread, compression type, and liquid-tight fittings. Acceptable manufacturers are Anamet Electrical, O.Z. Gedney, Electric-Flex Company or approved equal.

   Drag line shall be 3mm polypropylene non-filament utility rope as manufactured by Royal American Company, Thomas Industries or approved equal.

   All conduit located in the pit area shall be NEMA RN1; rigid steel conduit with external PVC coating, 40 mil thick, and 2-mil internal urethane coating. PVC coated rigid metal conduit shall have UL Category Control Number DYIX.E2314. The PVC-coated rigid metal conduit must be UL listed. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be UL listed with PVC as the primary corrosion protection. Applicable UL standards may include UL-6 – "Standard for

Safety, Rigid Metal Conduit", and UL-514B – "Standard for Safety, Fittings for Conduit and Outlet Boxes". Conduit and fittings shall be evaluated for reliability and performance. Fittings and conduit bodies shall be NEMA FB1; steel fittings with external PVC coating to match conduit. PVC-coated conduit fittings shall have UL Category Control Number DWTT.E200413. Acceptable manufacturers for PVC conduits are Robroy Industries or approved equal.

2. Low Voltage Conductors - 600V and Under

All wire and cable shall be copper and stranded. Sizes shall be as indicated on the plans with no size smaller than #10 AWG, except #12 AWG for lighting and receptacles and #14 AWG for control console and control panel internal control wiring.

Unless otherwise specified, all wiring external to control cabinets shall be insulated with moisture and heat resistant thermoplastic or cross linked synthetic polymer 75 °C, 600V or Types THW, THWN or XHHW. Wire internal to control cabinets shall conform to UL requirements for Type 515, 600V. Wire to secondary resistors shall be Type PFAH, 600V. Wiring for control tower lighting and receptacles shall be Type NM or NMC cable.

All wire and cable shall be provided with an outer jacket continuously identified with the following: Manufacturer, insulation type, conductor size, rated voltage. All power and branch wiring shall have circuit identification at both ends with panel name and number. All control wiring shall have 10 number identifications at each termination. Wire tags for identification shall be hot stamped or have plastic bands with heat-shrunk protective sleeves.

Acceptable manufacturers are American Insulated Wire Corp., Anaconda Wire and Cable or approved equal.

All wiring shall be color coded with #8-AWG or smaller having colored insulation and #6- AWG and larger having colored tape over black insulation at all panels, boxes, junctions, and terminations. The color green shall be used only for grounding and white for neutrals on 120/208V system. Phase conductors shall be red, blue and black for 120/208V, 3- phase systems. Control circuit cables shall be numbered as shown on the plans in lieu of color coding.

All terminations of #8-AWG wire and greater shall have solderless high compression indent type lugs except when connected to equipment with pressure, screw type lugs. All terminations of #10-AWG wire and smaller shall use nylon, self-insulating compression indent type for connections in control panels, terminal strips, etc.

Splice connectors for #8-AWG or smaller shall be the spring type with insulating thumb screw cover or indent type with insulating cover. For conductors #6-AWG and larger, use uninsulated indent type pressure connectors and apply insulating plastic or rubber to provide an insulation equivalent to that of the conductor.

Acceptable manufacturers of terminations and connectors are Burndy Corp., Ideal Industries, Thomas and Betts Company or approved equal. Acceptable manufacturers for insulating tape are 3M Company, Bishop/Tomic, Plymouth Rubber Company or approved equal.

3. Boxes

Interior flush mounted outlet boxes shall have a cadmium or galvanized finish and be pressed code gage steel. All covers shall be stainless steel with a satin finish to match size of box.

Exterior surface mounted outlet boxes shall be made of a malleable iron with the seal and shall be made of either aluminum or stainless steel construction.

Standard 51 mm x 102 mm outlet boxes shall be a minimum of 64 mm deep and standard 102 mm square outlet boxes shall be a minimum of 54 mm deep in size. Size shall conform to the NEC for wire fill and conduit attachments.

Wireways in the pit areas shall be NEMA 3R rain-tight construction with galvanized sheet steel material, rust-inhibiting primer and baked enamel finish.

All interior pullboxes and junction boxes shall be galvanized finish 14 gage steel to UL requirements for sizes required for interior applications. Covers shall be galvanized 14 gage sheet metal with sheet metal screws for fasteners. All edges shall be free from burrs.

All exterior applications in the pit area shall be stainless steel with waterproof conduit penetrations. Covers shall have neoprene gasketing with a complete rating of NEMA 4X. Boxes shall include provisions for drainage to prevent moisture build-up. Any exterior pullboxes on the bridge shall be malleable iron with cadmium or galvanized finish, threaded hubs for conduit entry and gasketed covers.

4. Wiring Devices

Lighting switches shall be mounted in outlet boxes with covers. The switches shall be 20A, 120/277 VAC rated toggle type tumbler switch for all indoor applications. The switches shall be brown in color heavy duty with silver alloy contacts on leaf spring, molded bases and cover cap with side and back terminal screw connections. Provide gasketed raintight covers for switches in pit areas. All switches shall be single pole and manufactured by Hubbell, Arrow-Hart, and Pass & Seymour or approved equal.

Convenience receptacles in the control tower shall be duplex type, 20A, 125V, 2 pole, 3 wire type and brown color. Receptacles shall be NEMA Class 5-20R of specification grade, grounding type with side and back terminal screw connections.

Receptacles for outdoor applications shall be in raintight boxes with neoprene gasketed, locking covers. 208V receptacles placed in the control tower basement and on the exterior of the control tower or bridge structures shall be twist-lock NEMA Class L6-30R with a 30A, 2 pole, 250V rating.

Ground fault interrupter (GFI) type duplex receptacles shall be NEMA Class 5-15R 15A, 120V rating. Device trip level shall-not-exceed 6 milliamps and a "TEST" and "RESET" button shall be in the face of the device.

Acceptable manufacturers for all receptacles are Hubbell, Arrow-Hart, Pass & Seymour or approved equal.

5. Panelboards and Circuit Breakers

Panelboards connected to the load side of the meter shall be UL labeled "SUITABLE FOR USE AS SERVICE EQUIPMENT".

All panelboards shall be a minimum of 14 gage sheet steel with a shop coat of light grey paint finish on panel, cover and trim. Gutters shall be provided on all four sides per Article 384 of the NEC. Box width shall be 508mm minimum, dead front construction and rust- proof trim, door and piano type hinges. Chrome plated catch and lock. Directory frame and plastic cover shall be located on the inside of the door. All busbars shall be copper with a solid full capacity neutral bus and a separate ground bus. All breakers shall be of the bolt-on type. Main breakers required as shown on the plans. Panel directory shall have identification number, characteristics, bus amperes, main device size, location, mounting and any special features. Panel ratings shall be as shown on the plans. Acceptable manufacturers are Square D, Cutler-Hammer, GE or approved equal.

All circuit breakers shall be of the bolt-on type with ampere rating, interrupting rating, voltage, poles, type, etc. as called for on the plans. Label all breakers and provide a distinct number adjacent to each branch pole. All circuit breakers shall be thermal/magnetic type indicating common trips. Manual operation shall be quick-make, quick-break type with mold construction. Circuit breakers shall be made by the same manufacturer as the panelboard in which they are being installed. GFI breakers of same make shall be provided with the panelboard as shown on the plans.

6. Disconnect and Safety Switches

All enclosures shall be NEMA 1 General Purpose for locations inside the buildings and made of code gage sheet steel. Finish shall be a rust-inhibiting phosphate primer and finished in a gray baked enamel. Enclosures used in the pit areas shall be NEMA 4X stainless steel. Enclosures outside shall be NEMA 3R raintight with galvanized sheet steel material, primer and enamel coatings as described for the NEMA 1 enclosures.

All safety switches, except in control panels, shall be heavy duty rated with an interlocking cover when the handle is in the “on” position. A single handle shall operate a blade switch creating a quick make quick break operation. Blades shall be visible in the “off” position with the doors open. The lugs shall be UL listed for wire specified and all current carrying parts electroplated. A solid neutral bus shall be included with the current rating and number of poles as indicated on drawings. Switches shall be rated for 250V for 240V or less rated circuits. Provisions shall be made for padlocking operating handle in either the open or closed position.

Manual motor starting switches shall be used as disconnects for the machinery and motor brakes. The enclosure shall be NEMA 4X stainless steel. Steel type enclosures will not be accepted. The disconnect shall not have any overload protection or pilot lights. Contact mechanism shall be quick make, quick break toggle action with silver alloy contacts visible from side of starter. Terminals shall be binder head screw terminals suitable for #10 or smaller copper wire. External rocker arm operates the toggle on the NEMA 4X. A handle guard lock off shall be provided for padlocking in the “OFF” position.

Safety switches which are fused shall have fuse clips with equal or greater ampere rating than the switch. Fuses shall be UL listed for a minimum 100,000A RMS symmetrical short circuit rating at the applied voltage. Fuses shall be dual element time delay cartridge type. Provide 3 spare fuses for each disconnect.

Acceptable manufacturers of safety switches are Square D, General Electric or approved equal. Acceptable manufacturers of fuses are Bussman, Gould or approved equal.

7. Grounding

The grounding and grounding circuit shall equal or exceed the requirements of the NEC 2002 issue, Article 250. The conduit system which includes metal conduit, surface metal raceway, pullboxes, junction boxes, built-up enclosures, enclosures, motor frames, panelboards, etc. shall be made to form a continuous, conducting, permanent ground circuit of 25 ohms or less resistance to allow the safe conduction of ground fault currents. All conduits shall have an equipment ground to be connected to the ground bus and to all devices. The grounding system shall be designed to prevent objectionable differences in voltage between metal non-load current carrying parts of the electrical system. In the event of a conflict or discrepancy with plans or other specifications and the NEC Article 250, the more stringent requirements shall apply.

Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc. shall be bare copper unless otherwise called for. The cable size shall be as required by NEC code, Article 250, stranded, soft drawn or soft annealed, unless otherwise called for. All ground rods shall be copper-clad, 19mm diameter, solid cylindrical 3.048 m long. Mechanical connectors and clamps shall be copper alloy and solderless compression terminals shall be copper long barrel, NEMA two bolt type. Any welding shall be molded fusion designed for size and type of cable, rods, and structure. Acceptable manufacturers are Caldweld, Metalweld, Thermoweld, or approved equal.

8. Contactors and Motor Starters.

The contactors and starters shall be minimum NEMA size 1, full voltage type, 600VAC, 60Hz rated with 120VAC operating coil voltage. Contact ratings, size, and number of poles are shown on schematic drawings. Contactors and starters not shown in enclosures shall have integral NEMA 1 type enclosure or NEMA 4X stainless steel if located outside the control tower. Combination motor starters in separate enclosures shall have a main disconnect switch operating a thermal magnetic circuit breaker, starter with overloads, control transformer, hand-oft-auto control and pilot light. Overloads shall be sized according to nameplate data of the motor. Heating contactors shall be electrically operated and held with normally closed contacts. This section does not include starters in the control panel.

Acceptable manufacturers are Square D, Cutler-Hammer, Allen-Bradley or approved equal.

9. Photocontrol

Photocontrol shall be capable of 120V operation with 20A contact rating suitable for inductive and continuous contactor coil burden. The photocontrol shall turn on at four footcandles with time delay to prevent false turn on or off. Contacts shall be single pole, single throw. Acceptable manufacturers are Tork, General Electric, Stonco or approved equal.

10 Electric Heat

The heating shall be electric fin tube radiation type. All sections and accessories shall be mounted on a wall. Casings shall be furnished with beige gloss enamel finish. The electric heating elements shall be aluminum tinned, full length thermal cut-offs. The lengths, wattage and mountings are shown in the Electric Fin Tube Radiation Schedule on the plans. Provide bi-metal thermostats integral with the

unit at locations shown on the plans. Acceptable manufacturer is Markel Products Co. or approved equal

11. Sump Pump and Controls

Each sump pump shall have an aluminum casing ASTM A-413M and be equipped with an enclosed impeller dynamically balanced for all hydraulic loads within the pump's operating range. A tripod support shall be cast integral with the pump casing. The pump shall be submersible and be capable of handling leaves, dirt and small objects without impeding the operation or function of the pump. The design of the pump shall permit removal of the motor-shaft-impeller assembly without need to disconnect the discharge piping or to remove the pump casing from the basin.

The motor shall be 1.6HP, 208V, 3-phase, 60Hz and shall have a corrosion resistant cast iron frame, cast iron end shields and a stainless steel motor/impeller shaft. The motor shall incorporate an inner and an outer water seal. Thermal protection rated NEMA MG1-12 shall be standard with insulation compatible with Class B rated system with Class F components. The combined service factor shall be a minimum of 1.15 with a voltage tolerance of ±10 percent. The pump shall have a capacity to pump 100GPM with discharging against a total dynamic head of 12m.

The pumps shall be located as shown on the plans.

The stator shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open and stop the motor.

All exposed nuts or bolts shall be type ASTM 304M stainless steel or brass construction.

The cable shall be a multi-conductor cable with ground and shall be furnished with the motor with length to connect motor to controller. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers to fit against the cable and compressed by the body containing a strain relief function. A cable entry junction chamber shall be separated from the motor by a stator level sealing gland or terminal board.

The discharge pipe shall be 50 mm PVC Schedule 80 with flange to connect to the pump. The pipe will transition to a galvanized steel pipe of equal interior size and continue up to discharge into the canal above high water level.

The pump system shall be provided with a liquid level sensor system consisting of 3 float type devices. The floats shall have mercury switches internal that open and close according to water level. The floats shall be suspended by a 3-conductor cable containing a ground with a protective flexible boot and locked compression cable entry.

The pump shall be provided with a controller made up of a starter with overloads, 120V control transformer and hand-off-auto selector switch. The voltage service shall be 208V, 3-phase. The enclosure shall be NEMA 4X stainless steel construction.

The pump shall be manufactured by ITT Flygt Model BS-2052 with 232 impeller or Engineer approved equal by Peerless Pump Co., Davis EMU, or WEIL.

12. Electric Heat Lamps with Thermostat

The Contractor shall furnish, as indicated on the plans, a heating system for each sump and a galvanized sheet metal reflecting hood.

The heating system shall consist of radiant heaters, where required, controlled by a thermostat for each sump. The radiant heaters shall be Chromalox FRB-38 or approved equal by Indeeco or Wattlo. The Contractor shall furnish sockets and junction boxes suitable for the installation. Drawings and/or catalog cuts of the sockets and junction boxes shall be submitted to the Engineer for approval.

13. Lighting

The walkway lights on the bridge structure shall be high pressure sodium fixtures with vandal proof guard and globe. Fixtures shall be resistant to water, wind, snow, sleet, dirt, dust, vibration and corrosion. Gasketing shall seal between the mounting module, housing and lens. Housing shall be constructed of aluminum with a powder epoxy finish and a heat and impact resistant fluted glass. The guards shall be stainless steel. Ballast shall be of high power factor and rated for 120V operation. Fixtures shall be either wall or ceiling mountable as shown on the plans. Acceptable manufacturers are shown on the plans.

The lighting for the pits, exterior of the control tower, and basement shall be 200W incandescent vapor tight fixtures with heat resistant glass globes and cast aluminum guard. Fixtures shall be wall-mounted with gasketed backbox. Acceptable manufacturers are shown on the plans.

The control board lighting shall be an adjustable arm type fixture mounted to the wall and provided with a plug. Fixture shall be 60W incandescent with inner reflector and a permanently installed black louver to provide low brightness and shielding. Acceptable manufacturers are shown on the plans.

The lighting fixtures for the interior of the control towers shall be ceiling mounted with brass plated finish, clear simulated cut crystal glass, and a preheated, high power factor ballast. The fixtures shall have 22 gage steel enclosure and be UL listed. The lamp shall be 13 W compact fluorescent with a cool white spectrum. Acceptable manufacturers are Vista Company, Teron Lighting Company, Crouse Hinds or approved equal.

14. Air Terminals (Lightning Rods)

The air terminals shall be solid copper, 10 mm minimum diameter and 610 mm in length. They shall have mounting brackets capable of mounting to wood and concrete surfaces. A bronze clamp shall be provided to clamp the air terminal to the conductor. Acceptable manufacturers are Heary Bros., American Lighting Rod Co., Capital Lightning Protection Co., Independent Protection Co. or approved equal.

15. Smoke Detectors

The smoke detector shall be a photoelectric smoke alarm with 120V input voltage which meets all requirements of NFPA72-99. Detector shall have a test button on the front to test the overall operation and emit a piercing tone of 85 dB at 3.048 m. A red LED indicator shall be located on the face to indicate power is on. When smoke is sensed, the unit shall produce the tone until the smoke has cleared. All components shall be housed in a case capable of resisting accidental impact. The

detector shall have a tamper resistant locking tab to prevent accidental removal. Detector shall be UL listed. Acceptable manufacturers are Edwards, Electro Signal Lab, Honeywell or approved equal.

16. Portable Generator Receptacles and Enclosure

Single phase male connectors shall be 600V taper nose, colored according to the NEC code. Ground male connector shall be 600V taper nose, colored according to the NEC code. Cables and connectors shall be UL certified. Evidence of UL certification is to be submitted with the proposals. Cable connectors shall be enclosed in chambers which shall completely confine arcs if energized circuits are made or broken. Cable connectors shall be enclosed in a NEMA 4X box, manufactured as per this specification and capable of accommodating a padlock. Acceptable manufacturers are Leviton, Hubble or approved equal.

17. Non-Automatic Transfer Switch

Transfer switch shall be non-automatic, manually push-button initiated and provided with:

- Service disconnect function.
- Integral overcurrent protection.
- Visible indication of service disconnected.
- Lockout in disconnected position.
- Disconnecting neutral assembly.
- Molded case service breaker transfer switch.

Operation: Electrically actuated by push buttons designated "Normal Source" and "Emergency Source." Switch shall be capable of transferring load in either direction with either or both sources energized. In addition, removable manual handle shall provide quick-make, quick-break manual-switching action. Switch shall be provided with the following accessories:

- Pilot lights to indicate source to which load is connected.
- Source-available indicating lights: supervise sources via transfer-switch, normal- and alternate-source sensing circuits, respectively.
- Normal power supervision: green light with nameplate engraved "Normal Source Available."
- Emergency power supervision: red light with nameplate engraved "Alternate Source Available."
- Unassigned auxiliary contacts: one set of normally closed contacts for each switch position, rated 10A at 240VAC.
- Enclosure finish: manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

The switch shall be Cutler Hammer Model NT-V-E-KD-C-4-0225-B-S-U-16N, 37A or approved equal by ASCO, Square D or General Electric.

18. Navigation Lights

a. Navigation lights and signals shall be furnished and installed as noted on the plans and in accordance with the rules and regulations of the United States Coast Guard.

b. There shall be provided six channel navigation lights, three per each side, mounted pier, as shown on the plans. Each channel light shall be a single-unit, 203 mm, 180-degree, red Fresnel lens, and shall be mounted on a short section of bronze pipe with a flange at the

bottom. The channel lights shall be to the B & B Electromatic Type MS-53 or approved equal.

c. On each side of the movable span, there shall be mounted a navigational light with alternate red and green lens as shown on the plans. The lights shall be mounted so that the red lens will face marine traffic when the bridge is closed. Each navigation light unit shall be similar to the B & B Electromatic Type MS-54.

d. For all pier lights and navigation lights, the doors and lenses shall be gasketed, and each entire unit shall be completely weatherproof. Fittings shall be non-corroding and the sockets shall be of porcelain, mounted on shock absorbers. The housings for all units shall be cast bronze. Each pier and navigation light shall be furnished with dual lamps and transfer relay. Each lamp shall be a 100-watt, 120-volt, 5-year lamp with brass base.

e. An astronomical clock control unit shall be a completely self-contained weatherproof device rated 40A at 120 volts, and shall be provided with a time delay feature and a deluxe, encapsulated lightning arrestor for protection against surges and lightning. The unit shall provide turn-on of the navigation lighting system at 10 Lux, nominal. The unit shall be suitable for operation within a temperature range of 55 degrees below zero to 70 degrees centigrade above zero, and shall have a fail safe feature so that the lighting load remains energized in the event of component failure. The unit shall be suitable for installation in a twist lock receptacle with adapter for mounting on metal PVC coated rigid conduit. The astronomical timer shall be mechanical type, Tork General Purpose Model 1101 or approved equal.

f. A two-position selector switch shall be provided on the control desk for operating the navigation lights. In the “Auto” position, the lights shall be controlled by the astronomical timer control device. The “ON” position shall override the timer and turn the lights on.

19. Air Horns

a. For giving the necessary boat signals, two compressed air horns shall be furnished and installed on the control house, pointing in opposite directions and parallel to the navigable channel.

b. Each horn shall be a diaphragm-type, 100 millimeter, vibratory horn having a frequency of about 300 cycles per second and a sound output of 120 decibels. Each horn shall be of weatherproof construction with a projector of bell bronze or spun brass. Each horn shall be the Cunningham Air Whistle, Model 2L, or equal by Federal Signal Corporation. Each horn shall be provided with a special bracket for mounting on exterior house wall and shall be enclosed in a vandal-proof protective steel wire cage. Each compressed air horn shall be actuated by a rotary air compressor driven by an integral electric motor. Dual compressors directly coupled to a single motor are also acceptable. The motors shall be 208-volt, single-phase, 560 W, 60-cycle units. Each compressor unit shall be mounted inside the house on a suitable structural steel bracket, and a brass pipe shall be extended through the house wall to the horn. Each compressor unit shall be manufactured by Cunningham, Clark Cooper, or approved equal.

20. Barrier Flasher Lights

    Barrier gate lights shall be rated at 120VAC and be controlled by the manufacturer supplied motorized flasher system equipped with Mercury Rocking type switches. Barrier and Flasher gate lamps to be manufactured by Roadway, Semaphore, B & B, or approved equal.

21. Bridge in Motion Gong

    Bridge gong device shall be rated at 120VAC, 60Hz. The gong shall be mounted as shown on the plans. The housing and door shall be east aluminum. The door shall hinge on stainless steel hinge pins and have a provision for padlock. Al joints shall be sealed within neoprene gasket and non-hardening sealer. The housing and door assembly shall be weatherproof. The gong shall be 305mm O.D. constructed from hot pressed steel and protected by a cast aluminum weather guard.

CONSTRUCTION DETAILS

The Contractor shall submit shop drawings, including operation and maintenance manuals, for all items. They shall be submitted to the Regional Director for approval.

Operation and maintenance manuals shall also be provided in the bound Operating Manual required to be furnished under Item 599.0604nn04 Electrical Drive and Controls.

The Contractor shall be responsible for providing third-party electrical inspection and shall submit a certificate of electrical inspection to the EIC.

The Contractor shall be responsible for coordinating all temporary and new electrical service with the local electric utility companies.

1. Conduit System

   All conduit systems shall be installed and complete before any wire has been pulled. Cap ends of conduit during installation to prevent dirt or debris from entering. Drag lines shall be installed in all conduit systems before wire installation. Run all conduits parallel or perpendicular to structural elements of building or structure with minimum couplings and bends.

   Support all RGS conduits at a maximum spacing of 1.829 m and within 0.914 m of each outlet box, cabinet, fitting or junction box. Ream conduit and clean threads before assembly. Not more than two 90° bends in any run between two boxes allowed. All bends shall be either manufactured or field fabricated in a manual or hydraulic bender in accordance with NEC Articles 346 and 348. All conduits shall maintain a continuous ground in accordance with the NEC Article 250. Conduits shall not be smaller than 21mm and be sized in accordance to Chapter 9 of the NEC.

   All PVC conduit shall be installed in accordance with NEC Article 347. Separate ground wires shall be installed in all PVC conduit with size shown on the plans in accordance with NEC Article 250.

   All liquid-tight flexible conduit shall be installed in accordance with Article 351 of the NEC. A ground wire shall be installed in all flexible conduit and sized in accordance with Article 250-94 of the NEC.

2. Low Voltage Conductors - 600V and Under

Install conductors in conduit systems only after the system is completed including junction boxes and bushings. No grease, oil, or lubricant other than manufacturer's recommended pulling compounds shall be used to facilitate the pulling in of conductors. All splices shall be made in terminal or junction boxes and not inside conduits or fittings. Conductors shall be continuous from terminal to terminal. All splices and terminations shall be mechanically and electrically secure.

Provide number and size of conductors as shown on the plans. A common neutral may be used for 2 or 3 branch circuits enclosed within the same conduit provided each branch circuit is connected to different phase buses in the same panelboard. All wires shall be color coded or tagged before being pulled into the conduit system. An equipment grounding conductor shall be installed in all conduits in accordance with Article 250 of the NEC.

3. Boxes

All boxes shall be firmly mounted to structural members and shall be level and plumb. Unless otherwise indicated, install boxes so that the long axis of each device will be vertical. All boxes shall be accessible at all times and not hidden behind other equipment or devices.

Height of outlet boxes on walls shall be as listed below for devices being installed in them unless otherwise noted on the plans (height refers to top to box).

Interior Receptacles	457 mm above floor
Switches	1.219 m above floor on jamb side of door

Provide supplementary boxes to facilitate installing wiring. Total bends in any conduit shall-not-exceed 180° between boxes. Boxes shall be provided at intervals not exceeding 30.48 m.

4. Wiring Devices

Install all devices where called for on the plans. Adjust location as required to avoid interferences with existing equipment, windows, frames etc. Provide a green ground wire from source through the wiring system and connected to the ground terminal of every wiring device. Test all convenience receptacles for proper voltage, polarity and grounding. Test each GFI device for 6 milliamp leakage current rating. Replace all GFI units that fail to trip during testing. Rewire any receptacles that fail the voltage polarity or grounding tests at cost to the contractor.

5. Panelboards and Circuit Breakers

Install equipment such that the operating handles are not greater than 1.981 m and the bottom is not lower than 0.914 m from the floor. Locations of panelboards on the plans shall be verified by the Contractor prior to their installation and approved by the Engineer. Panelboards shall be surface mounted and shall be plumb and level with the panel and properly aligned inside the cabinet. All paint scratches, marks, etc. shall be repaired with matching paint. All directories shall be typed and placed in panels. Outside of panel shall be permanently labeled with an engraved nameplate indicating panel name, phase, and voltage rating. Panel shall have a minimum of 914mm of unobstructed clearance in front of device.

Circuit breakers shall be mounted inside the panel with all wiring termination on the load side terminals. All breakers shall be located in positions as shown in the panel schedules on the plans. Corresponding wiring shall be identified with that location.

6. Disconnects and Safety Switches

Install switches not exceeding a maximum height of 1.829 m above the floor as measured to the operating handle. Switches shall be supported independently of all conduits and shall be rigidly secured in place. Gaskets shall be used for conduit entrances in NEMA 3R enclosures to maintain rating. Provide miscellaneous bolts, washers, nuts, clips, etc. to complete the installation. Provide grounding as per Article 250 of the NEC. All switches shall have a minimum of 914 mm of unobstructed working clearance in front of device.

Install proper size fuses as shown on the plans. Replace all fuses that open or fail during construction activities at no cost to Owner. Deliver 3 spare fuses per disconnect to the facility.

7. Grounding

Ground all non-current carrying metal parts of all fixed equipment (electrical and mechanical), conduit systems, neutrals and ground buses of panelboards. Insulated ground bushings shall be provided for grounding the conduit system. Install cables with enough slack to prevent breaking stresses and protect grounding conductors subject to mechanical damage with RGS conduit or other suitable steel guards. Where RGS conduit protects the grounding conductor, permanently ground the steel conduit to the enclosure at each end of its length.

The sizing outlined in the NEC, Article 250 shall be minimum. Exterior conductors shall be buried 457 mm below grade. Top of ground rod shall be a minimum of 305 mm below grade and driven vertically at location shown on the plans. Splices in wire or cable grounding conductors are prohibited.

The service ground shall be bonded to the main ground bus in the service panelboard and connected to a ground rod outside the building. The neutral conductor of each and every low voltage single and/or polyphase system, unless otherwise noted, shall be solidly connected at one point only to the service ground.

Structural steel shall be bonded with equipment conductors at points not exposed and not subjected to damage of the conductor, but if possible where accessible for inspection. Bonding shall be by molded fusion welds.

Contractor shall drive two reference electrodes 1.524 m deep, spaced a minimum of 15.24 m apart in-line with the test points and employing a ground resistance megger, directly read the ground resistance values at all test points. Submit a test report outlining procedures, locations of test and results to the Engineer for review and approval.

8. Contactors and Motor Starters

Motor starters shall be mounted not greater than 1.981 m above the floor to the top of starter with 914 mm of clearance in front of enclosure. Wire control circuit as shown on the plans. Furnish and install fuses where necessary. Contractor shall size overloads in starters based on nameplate data from

motor land in accordance with NEC Article 430. Contractor shall verify control system operates and functions as shown in plans or specifications.

9. Photocontrol

The photocontrol shall be mounted in a gasketed enclosure on the north side of the building as shown on the plans. Wire photocontrol in series with lighting circuit.

10. Electric Heat

The Contractor shall mount all heaters 76 mm above the floor to the bottom of heater and wire to the panel board circuit as shown on the plans. Installation shall be in accordance with manufacturer's recommendations.

11. Sump Pump and Control

The Contractor shall place the pump into the sump pit and connect PVC Schedule 80 discharge pipe to discharge outlet as shown on the plans. Mount disconnect switch 1.524 m above pit floor and level controls on wall over sump pit and allow floats to hang into pit. Adjust first float for a level such that the water covers half the pump. This float will be considered the low level and turn-off pump. The second float shall be adjusted to a level equal to the top of the pit. This float will be considered the high level and turn on the pump. The third float shall be adjusted 305 mm above the pit floor and be considered the high water alarm float. Connect high water alarm control wires to float contact and send back to the control console. The Contractor shall interconnect all devices with control and verify operation meets this specification.

12. Electric Heat Lamps with Thermostat

Mount electric heat lamp above sump pit as shown on the plans. Mount metal hood above heat lamps to reflect heat. Locate thermostat adjacent heat lamps.

13. Lighting

The Contractor shall install light fixtures as shown on the plans. All fixtures shall be tested for operation and lamp's illumination. Any lamps burned out or damaged during construction shall be replaced by the Contractor at no cost to the State. All guards shall be secured in place and lenses shall be free from debris or cracks.

14. Air Terminal (Lightning Rod**)**

Air terminals shall be mounted at the highest point on the roof. Plans showing their relative location to be verified in the field by the Contractor. All conductors attached to the air terminals shall have direct paths while avoiding sharp bends or narrow loops.

15. Smoke Detectors

Mount detectors on ceiling in the center of the room in accordance with the requirements of NFPA72-99. After mounting and connecting unit to the power source, test by pushing the test button and verify tone is emitted.

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16. Portable Generator Receptacles and Enclosure

    The Contractor shall install the enclosure and receptacles on the exterior wall of the control tower, 1.219 m above grade.

17. Non-Automatic Transfer Switch

    The Contractor shall install the non-automatic transfer switch as shown on the plans.

18. Navigation Lights

    The Contractor shall install the navigation lights as shown on the plans.

19. Barrier Flasher Lights

    The Contractor shall install the barrier flasher lights as shown on the plans.

20. Beacon Flasher Light (For Washington Street Bridge Only)

    The flasher assembly shall include mounting hardware as required, solid state flasher circuitry, a terminal block, and a transformer when required. The flasher assembly shall be fully wired at the factory. All components shall be corrosion-resistant. The entire transfer relay assembly, including all electronic circuitry, shall be encapsulated in weatherproof, shock-resistant plastic enclosure to prevent possible damage from condensation or water buildup within the flasher.

21. Bridge in Motion Gong

    The Contractor shall install the bridge in motion gong as shown on the plans.

METHOD OF MEASUREMENT

The work of this item will be measured as a lump sum unit of work per bridge.

BASIS OF PAYMENT

The lump sum price bid per bridge shall include the cost of all labor, materials, and equipment required to complete the work of this item.

Progress payments for each bridge will be made for the work of this item in accordance with the following:

1. Ten percent (10%) of the lump sum price per bridge will be paid upon completion of all removals and the transfer of the listed equipment to the state.

2. Thirty percent (30%) of the lump sum price per bridge will be paid upon the completion of all electrical work inside or on the exterior of the control tower building.

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3. Thirty percent (30%) of the lump sum price per bridge will be paid upon the completion of all electrical work in the pit areas including connections to all equipment per payment item.

4. Fifteen percent (15%) of the lump sum price per bridge will be paid upon completion of all electrical work pertaining to the bridge steel structure per payment item.

5. The remainder (15%) of the lump sum price per bridge will be paid once the final testing, punchlist items and approval has been completed.

Payment will be made under:

Item 599.06030104 M	Electrical Work – Ingersoll Street
Item 599.06030204 M	Electrical Work – Washington Street