ITEM 599.0604XX04 M ELECTRICAL DRIVE AND CONTROLS

DESCRIPTION

The work shall consist of removing, furnishing, installing, and placing in operating condition all electrical work as specified. This work shall include the span motor, secondary resistor bank, mechanical brakes, speed and limit switches, festoon system (hung power and control cable system within the equipment pits), control console and control panel.

MATERIALS

1. Span Motor

The span drive motor shall be a horizontal crane and hoist duty wound rotor motor. The motor shall be 20 HP for the Ingersoll Street Bridge and 25 HP for the Washington Street Bridge, built in accordance with NEMA publication MG-1. The operating characteristics shall be 3 phase, 60 hertz, 30 minute intermittent duty, 900 RPM nominal speed, 208 volt, with Class F insulation, 40°C temperature rise, 326U frame and capable of reversing operation. The motor shall be totally enclosed non-ventilated weatherproof construction, with regreaseable ball bearings, moisture resistant insulation, all copper windings, and internal space heater. The motor shall have a special double extended shaft as shown on the plans with machine cut keyways as recommended by the brake manufacturer.

The span motor shall be provided with enclosed secondary resistors as detailed below. The resistance calculations shall be performed by the motor manufacturer and submitted to the Engineer for review. The secondary voltage and current characteristics must meet NEMA MG 1-10.34 characteristics requirements.

The motor conduit boxes, one for the primary connections and one for the secondary connections of the motor shall be split, cast iron, fully gasketed with lead bushings, and a threaded conduit hole. The conduit boxes shall be sized and located to avoid interference with the machinery. The conduit boxes shall be minimum sized in accordance with NEMA requirements.

The motor frame shall be finished with a corrosion-resistant paint or coating. The finish coat shall be a light gray enamel in accordance with ANSI standards. Exposed unpainted metal surfaces shall be of a corrosion-resistant material.

The span drive motor supply system is designed to supply motor full load current in accordance with NEC Table 430-150. Deviation from these values by the motor manufacturer will impact the supply system and Contractor shall make necessary modifications at no additional cost to the State.

The span motors shall be subjected to a routine test in accordance with the current requirements of the NEMA MG-1, and IEEE STD 112. The data shall be certified and submitted to the Engineer on the IEEE forms. The Engineer shall be notified of the time and place of the testing at least three (3) weeks in advance of the testing.

The span motors shall be manufactured by Reliance Electric, Reuland, General Electric or approved equal.

2. Secondary Resistors

The span motor secondary resistors shall be selected for heavy intermittent duty conforming to NEMA Class 172 and shall be of the punched grid stainless steel type.

The resistance steps shall be adjustable and shall be proportioned such that the starting torque in percent of full load torque is as follows: first power point - 40 percent, second - 90 percent, third - 150 percent, and successively higher torques on the remaining steps. Under normal acceleration, with approximately 75 percent of full-load on the motor, the torque impulse at any acceleration step shall not exceed 200 percent of the full-load torque. Full load motor speed with all secondary resistance removed shall not be less than 855 RPM.

The resistor bank shall be assembled into a box to be mounted in the mezzanine level of the control tower as shown on the plans. The resistor bank shall be enclosed in a NEMA-1 enclosure allowing air circulation for cooling, but meeting all requirements for NEMA-1 including rod entry tests.

Wiring to the resistor banks shall be of the high temperature type and the connections shall all be corrosion resistant.

A resistor layout showing the resistance for each step of the controller, shall be prepared and submitted to the Engineer for approval. The resistance per leg, which will provide the rated full-load torque at standstill, shall be determined and included in the submittal. This information is to be supplied in addition to outline drawings and construction details of the resistance bank and enclosures.

The resistor shall be manufactured by Square D, General Electric or approved equal.

3. Mechanical Brakes

The braking system has been designed with two similar thruster actuated mechanical brakes. One designated as motor brake and one designated as machinery brake.

The span shall be capable of operation with one brake out of service by hand releasing the unused brake and moving the BRAKE HAND RELEASED bypass switch to the released position. The bypass switch shall bypass only one brake at a time and therefore prevent operation with more than one brake in hand released position.

The brakes are to be spring set, thruster released shoe and drum type and are to be provided with a “brake-set” limit switch, a “brake-release” limit switch and a “brake hand released” limit switch. All brakes shall be rated 827 N-m continuous, duty, factory set at 556 N-m, and shall be supplied with a 203mm brake wheel.

Each brake shall be supplied with the following modifications: drip tight enclosure with space heater, corrosion resistant fittings, hand release capable of being released without removing the cover, adjustable speed setting time (drop time) of 5 seconds minimum, cast iron conduit box and NEMA design 208VAC, 60 Hz, 3-phase thruster motor. The brakewheels shall be supplied with

parallel bores sized for a FN2 fit with the motor shaft. The brakewheels shall also have machined keyways as recommended by the manufacturer. Holes shall be drilled and tapped over the keyways for blind set screws to hold the keys in place. The motor and machinery brakewheels and brakewheel couplings shall be shop mounted. The brakes shall be manufactured by Mondel Engineering Type MBT-Ed 23/5c (AA) 203mm or equal by General Electric or Link Controls.

4. Span Limit and Speed Switch

The span limit switch shall be a cam type with 12 cams and single pole double throw snap action contacts rated 10 amps continuous at 120VAC.

The limit switch assembly shall be enclosed in a NEMA 4 watertight enclosure, have an internal timing dial, and an integral gear reducer with a ratio as shown on the Contract Plans. The cams shall be adjustable from 30 to 345 degrees.

The span control limit switch shall be Gemco Type 2000, General Electric Type DS9446, or approved equal.

The span speed switch shall be a surface mounted, NEMA 4X housing unit equipped with both normally open (N.O.) and normally closed (N.C.) field convertible contacts. The contacts shall be rated minimum 10A at 120VAC and configured to operate at minimum and maximum speeds of 250RPM and 900RPM respectively as per application design requirements. The speed switch shall be a Hubbell Series 2210, Type C, or approved equal.

5. Limit Switches

The over-travel limit switch and span manual operation interlock limit switch shall be heavy-duty lever arm type in a cast iron or cast aluminum NEMA-4 housing. The switch shall be provided with three field convertible contact blocks factory installed to produce the functions as shown on the plans. The switch shall be maintained position type and be operated by a roller type operating level. The contacts shall be rated minimum 10A at 120VAC. The over-travel limit switch shall be manufactured by General Electric Type 059445, Square D Type 9007, Cutler Hammer E50, or approved equal.

Limit switches for the machinery brakes shall be heavy duty, oil tight, and as recommended by the manufacturer. Other limit switches shall be track type, heavy duty, and oil tight limit switches rated with snap action contacts rated 10 amps continuous at 120VAC. The lever and roller shall be steel and sized as required by the application. They shall be provided with a threaded conduit entry. The limit switches shall be provided by Mondel Engineering as part of the brake system equipment.

The fully seated limit switches shall be of the buffered plunger type in a heavy galvanized steel housing rated NEMA 4. The housing shall be provided with a drain and vent. The contacts shall be double contact, bar type, snap action. The movable contacts shall be removable without tools and be driven by a vibration proof positive latching mechanism. The contact points shall be made of silver and be rated 20 amps. The actuator shall be made of stainless steel plunger in a powdered bronze oil impregnated bearing, sealing with an o-ring. The actuator, bearing and buffer springshall be covered by a bellow type rubber cover. The actuator end shall be a greaseable stainless steel ball type. The fully seated limit switch shall be Roadway Series LSP or approved equal.

6. Control Console

The control console shall be a console type with indicating lights and control devices mounted on the control surface, and instrumentation mounted on the pinnacle. It shall be located in the 2nd floor of the control tower as shown on the plans. Shop drawings shall be submitted to the Engineer for approval.

All devices and all wiring shall be accessible through gasketed, hinged, lockable doors with flush handles and 3 point latches. The pinnacle shall be hinged at the bottom to allow rear access to the instruments by tipping the pinnacle down. A tip limit chain shall be provided.

Mounting plate shall be permanently fastened in place. A gasketed removable bottom plate shall be provided to facilitate conduit entry. The entire control console, except the top panels, shall be constructed of hot-rolled, 11 gage minimum steel formed sheets and angles, welded to form a rigid, free standing structure. All welded seams shall be ground smooth and clean. All corners shall be rounded and extra stiffeners (flanges and angles) added on sides where necessary.

After completion of all cut-outs and all drilling, but before any equipment is mounted, the interior and exterior shall be given a minimum of one coat of rust-inhibiting primer. The interior shall be finished with two coats of gloss white enamel, and the exterior finished with two coats of gray baked enamel. Paint supplied must be as recommended by the console manufacturer.

The control surface with pinnacle shall be made of 10 gauge, Type 302 stainless steel with satin, non-reflective finish. It shall not be painted.

All devices, except nameplates, shall be mounted with machine screws and elastic stop nuts, if required, unless mounting is an inherent part of the component.

All interior wiring shall be stranded type 515, #14 AWG minimum. All wiring shall be carried in NORYL (95°C) type wire troughs (no PVC allowed), with wire numbers hot stamped into wire. The numbering shall be arranged as to be right reading. All wiring shall be terminated with ring tongue terminal lugs with insulation grip installed using the manufacturers approved tool. The terminal block shall have engraved numbering into the terminal marking strip as shown on the plans. Terminal blocks shall be rated 30 amps, 600VAC, shall be corrosion resistant and shall be Buchanan Type 2B112, Marathon 1500, or approved equal. At least 20 percent spare terminals shall be provided.

All devices shall be provided with nameplates engraved in accordance with the approved shop drawings. Nameplates shall be made of laminated phenolic material or non-corrodible metal; characters shall be 2.5 mm high minimum. These nameplates shall be attached with non-corrodible self-tapping screws. Nameplates shall be white background with black lettering.

The span motor control drum switch shall be a horizontal shaft surface mount enclosed mill duty type with ball and rod handle with “OFF” position latch and maintained positions. The switch enclosure shall have a cast iron base and cast aluminum cover. The drum switch shall have 14 positions in addition to the center “OFF” position and have the number of contacts and contact development shown on the plans. The contacts shall be rated 15 amp continuous, 600VAC. The drum switch shall be manufactured by Hubbell or approved equal.

All control console pilot devices shall be heavy duty industrial type rated 600VAC, 10 amp continuous and be oil-tight and corrosion resistant. Indicating lights shall be push-to-test transformer type with 6 volt bulb. Flashing red indicating lights shall be equipped with integral flashers. Miniature devices will not be accepted. The pilot devices shall be manufactured by Cutler Hammer, Square D, or approved equal.

Control switches shall be mounted on the Control console with instrument transfer switches for bridge control. Instrument transfer switches shall have knurled handles while switches used for bridge control shall have pistol grip. The contacts shall be silver plated and rated 20 amp minimum at 120VAC. The control switches shall be manufactured by American Solenoid, General Electric, or approved equal.

Bypass switches shall be specification grade, 20A minimum, tumbler type toggle switches with satin finish stainless steel switch plate. Bypass switch covers shall be key lockable, and have provisions for sealing with copper wire/lead type seal. All covers shall be unlocked with the same key. It shall be impossible for the switch to be operated with the cover closed. The cover shall have facilities to prevent it from reclosing with the switch in the "ON" or "BYPASS" position. The underside of the switch shall be painted red in order to help alert the bridge operator of the bypass condition. It shall be manufactured by Link Controls or approved equal.

The voltmeter shall be of the heavy duty switchboard type with 114mm scale and 270 degree dial. The meter shall be driven from potential transformers of a ratio to provide 120VAC full scale. The meter shall be manufactured by General Electric or approved equal.

The ammeter shall be of the heavy duty switchboard type with 114 mm scale and 270 degree dial. The meter shall be driven from current transformers of a ratio to provide 5 amps full scale. The meter shall be manufactured by General Electric or approved equal.

The wattmeter shall be of the heavy duty switchboard type with 114 mm scale and 270 degree dial. The meter shall be driven from potential transformers of a ratio to provide 120VAC full scale, and current transformers of a ratio to provide 5 amps full scale. A separately mounted transducer shall be provided. The meter shall be manufactured by General Electric or approved equal.

7. Control Panel

The control panel shall be furnished and installed in the control tower as shown on the plans. Construction of the control panel shall be in accordance with the NEC, NEMA, and UL requirements. Shop drawings shall be submitted to the Engineer for approval. The control panel shall be a two-door NEMA 12 enclosure for flange-mounted disconnect on right-hand side. The enclosure shall be free-standing with flange for bolting to the floor with size shown on the plans. The enclosure shall be constructed of minimum 11 gauge sheet steel with seams continuously welded and ground smooth and all corners and edges rounded. Body stiffeners made of flanges or channel shall be provided for extra rigidity and a heavy gauge continuous piano type hinge on doors. A heavy duty 3 point latching mechanism with padlocking handle on both doors shall be provided with rollers on the ends of latch rods for easier door closing. The handles shall be chrome plated. The enclosure shall have heavy duty lifting eyes anchored into a reinforced top. The top and bottom of the enclosure shall be provided with gasketed removable plates to facilitate conduit installation and to allow holes to be drilled and punched without debris entering the cabinet.

The enclosure shall have two coats of white enamel paint inside and two coats of ANSI-61 gray baked enamel paint outside over a rust-inhibiting primed surface. Paint supplied must be as recommended by the panel manufacturer. The door shall have an oil-resistant closed cell neoprene gasket attached with oil-resistant adhesive and held in place with steel retaining strips. The master door shall be on the right-hand side with a defeater requiring a screw driver to open. A mechanical interlock shall be provided preventing the second door to open before opening the master door. The panel interior shall have collar studs to accept the equipment mounting panel of a minimum of 10 gauge sheet steel with a white enamel finish.

A universal cut-out shall be provided on the right flange for a flange-mounted disconnect switch. The flange-mounted device shall be Square D, General Electric, Cutler-Hammer, or approved equal with size as shown on drawings.

Cut-out shall not be greater than 1.981 m above finished floor. Circuit breaker and all internal devices shall be mounted to the mounting panel in the enclosure. The enclosure shall be Hammond Manufacturing Hoffman Engineering or approved equal.

The Contractor shall check component sizes and make adjustments to the enclosure size if necessary. Size and layout are shown on the plans as a guide for design purposes. All interior wiring shall be stranded type SIS #14 AWG minimum. All wiring shall be carried in NORYL (95OC) type wire troughs (no PVC allowed), and each wire shall be permanently identified at each end, as shown on the plans, with wire numbers hot stamped into wire. The numbering shall be arranged as to be right reading. All wiring shall be terminated with ring tongue terminal lugs with insulation grip installed using the manufacturers approved tool. The terminal block shall have engraved numbering onto the terminal marking strips. Terminal blocks shall be rated 30 amps, 600VAC, shall be corrosion resistant and shall be Buchanan Type 2B112, Marathon 1500, General Electric Type CR151B, or approved equal. At least 20 percent spare terminals shall be provided.

All circuit breakers shall be thermal/magnetic type indicating common trips with size and ratings as called for on the plans. Manual operation shall be quick-make, quick-break type with molded case construction, non-interchangeable trip, surface mounted, and UL listed for copper conductors. All breakers shall be mounted with handle vertical and up for the “ON” condition. Acceptable manufacturers are General Electric Type TED, Square D, or approved equal. Motor circuit protectors shall be General Electric Type TEC, Square D, or approved equal.

The motor starters and contactors shall be a minimum of NEMA size 1, full voltage type, 600VAC, 60 Hz rated with 120VAC operating coil voltage. Contact ratings size and number of poles are shown on the plans. Starters shall contain overload relays with heaters sized according to the nameplate data on the motor. Reversing starters shall be mechanically and electrically interlocked. Acceptable manufacturers are General Electric, Allen-Bradley, or approved equal.

The span motor shall be provided with 3-phase instantaneous trip magnetic overcurrent relays. The instantaneous trip overcurrent relays will be used to limit the output torque of the span motor and shall be of the magnetic type with manual reset. Each relay shall be set to limit the torque output of the motor to 180 percent of motor full-load torque. The relay shall be Allen-Bradley Bulletin 809, General Electric Type CR124Y, Square D, Class 9055, or approved equal. All motors other than the span motor shall be provided with three-phase eutectic alloy type overload relay. It shall be ambient

compensated and manually reset. Thermal overload relays shall be Cutler Hammer Type C300, Square D Class 9065, Allen-Bradley Bulletin 592, or approved equal.

Time delay relays shall be pneumatic type, 120VAC rated with 10 amp contacts and number of contacts and timing range as shown on the plans. They shall be Agastat Pneumatic Series 7000, Cutler Hammer Type D80, General Electric CR122B, or approved equal.

Control relays shall be of the multi-contact machine tool type and have 600 volt, 10 amp convertible contacts and 120VAC, 60 Hz coils. The coils shall be epoxy encapsulated and the contact cartridges shall be individually enclosed. They shall be Cutler Hammer, General Electric, or approved equal.

The bus monitor shall be a phase failure/phase reversal/undervoltage relay which shall prevent the bridge control system from energizing in case of any one or more power failure conditions. It shall be rated for 208VAC, 3-phase and be provided with 10 amp, 120VAC contacts. The normally open contact shall close on normal condition and remain closed as long as correct phase rotation and phase voltage balance are maintained. It shall open with a phase unbalance of 10 percent and an undervoltage of 10 percent. It shall automatically reset and be provided with a built in time delay. The bus monitor shall be Cutler Hammer Type P Phase Monitoring Relay, General Electric Type ICR, Square D, Class 8340 Type MPD, or approved equal.

The current transformers shall be instrument type with a ratio as called for on the plans and of a burden coordinated with the equipment being driven. The transformers shall be panel-mounted and be provided with brass stud terminals. The transformers shall be rated 600V, 10kV BIL. They shall be manufactured to meet the requirements of Underwriters Laboratories. They shall be completely encased in reinforced polyester and epoxy resin. The current transformers shall be General Electric, Current Hammer, or approved equal.

All devices shall be identified by an individual nameplate. The nameplates shall be laminated phenolic material or non-corrodible metal and shall be furnished for all components and devices. All devices and equipment shall be identified by the device designations given in the control legend. Characters shall be 2.5 mm high minimum. All nameplates shall be attached with non-corrodible, self-tapping screws. Nameplates attached by the manufacturer of separately mounted items shall not be painted over; if painted, they shall be replaced at no additional cost. Nameplates are to have a white background with black lettering.

8. Festoon Cable System

The enclosures shall be NEMA 4 stainless steel and sized in accordance with the plans. The internal straps and brackets shall be standard supply by the enclosure manufacturer for the selected size enclosure. The enclosure shall be Hammond Manufacturing Co. Type 1418N4SS with Type 1418 straps and brackets, equal by Hoffman Engineering Co. or E.M. Wiegmann & Co., or approved equal.

Terminal blocks shall be rated minimum 30 amps, 600VAC, shall be corrosion resistant quantity of terminal points as shown on the plans, and shall be Buchanan type 2B112, General Electric type CR151B, Marathon 1500 Series, or approved equal.

Flexible cables shall be pendent and reeling type with conductor count shown on the plans. All cables shall be the same make-up in conductor size and count. Cables shall be made of stranded

copper with cross-linked polyolefin insulation with a nylon jacket. The jacket shall be Hypalon or sun-resistant neoprene. The cable shall be rated 600VAC, 90°C. The cable shall be Houston Wire & Cable Perfect-A-Flex, Anaconda, or approved equal.

All wiring shall be terminated in nylon pre-insulated, insulation grip, ring type terminal lugs and marked with the right reading numbering as it appears in the approved shop drawings. Terminal lugs shall be applied using the manufacturer's approved tool. Terminal markings shall be engraved and shall be identical to the wire numbers attached to that point. Terminal lugs shall be T&B, Amp, Burndy, or approved equal.

Strain relief fittings shall be watertight and oil-tight and fabricated from zinc coated malleable iron. The size shall be carefully selected for the cable. The cable grips shall be closed mesh single offset type support grips fabricated from stainless steel. Combination strain relief/grip will not be accepted. Strain relief shall be O.Z. Gedney Type SR, equal by T&B or Crouse-Hinds, or approved equal. Cable grips shall be Kellems Type 022-01, equal by T&B, Crouse-Hinds or approved equal.

CONSTRUCTION DETAILS

The Contractor shall be responsible for verifying space layouts. The Contractor shall submit shop drawings of all items in this specification.

1. General

Except as otherwise noted, all equipment, materials, installation and workmanship shall be in accordance with applicable requirements of the following organizations, codes and standards:

AASHTO; the American Association of State Highway and Transportation Officials. Standard Specifications for Moveable Highway Bridges.

NEC; the National Electrical Code (2002)

NFPA; the National Fire Protection Association.

National Electrical Safety Code.

NEMA; the National Electrical Manufacturers Association.

ANSI; the American National Standards Association.

NYSDOT - MUTCD; New York State Department of Transportation - MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES for Streets and Highways.

UL; Underwriters' Laboratories.

IEEE; Institute of Electrical and Electronic Engineers.

Any local electrical codes which apply and are more stringent than those mentioned above.

The codes and standards listed above are mentioned to call particular attention to them. It is not the intention of this paragraph to omit any other codes and standards which may apply but are not specifically listed.

Contractor shall furnish spare parts per AASHTO requirements.

All items and equipment shall be packed in sealed containers and stored indoors, in a dry location off the ground. All packages weighing more than 23 kg shall be provided with slings or lifting eyes, and crated to permit hoisting without damage to any components or any portion of the protective covering. The motor, brakes, motor control panel and the control console shall be crated and packaged as to permit hoisting to their approximate mounting locations, and not to be impaired if left exposed to the weather until installation at a later date. Space heating shall be provided, as necessary, during storage. All brakes shall be prepared for long-term storage and be filled with hydraulic fluid as recommended by the manufacturer of the thrustors.

The Contractor shall provide five (5) copies of an Operating Manual bound in a hard covered, piano hinged jacket containing a complete and detailed description of each method of operation. All pages shall be covered in plastic. The manual shall be operator-oriented and recognize the technical limitations of an average operator and shall be written to conform to a high school education for the operator. Grade level shall be determined by the use of the Lix readability index.

The operating manual shall be arranged in a number of logically arranged chapters, and shall contain both a Table of Contents and Subject Index. The sections shall include, but not be limited to, “Introduction”, “General”, “Operating Procedures” (step by step simplified raise and lower procedure, followed by control console surface component detail operation), “Bridge Drives and Functions”, “Instrumentation and Controls” (operating control devices, instruments, indicating lights, specified), “Sequence Interlocking and Bypass Switches”, “Normal Bridge Operation” (complete description of all operating steps and their corresponding physical responses by individual components of the bridge), “Abnormal Indications” (complete description of abnormal indications such as illuminated “Over-travel” indication), “Abnormal Operations” (use of traffic gate manual hand crank, etc.).

The Contractor shall provide five (5) copies of a “Maintenance” Manual and “Troubleshooting” Manual giving complete and detailed description of the recommended troubleshooting procedures, correct sequence for making the various adjustments required to obtain optimum performance of all equipment, scheduled lubrication and other recommended maintenance operations including periodic checks to maintain proper functioning for all equipment and emergency procedures in the event repair or replacement is required. The manual shall include but not be limited to “Troubleshooting Flowchart”; “Functional Description” of entire system, subsystems, and functional relationships; “Preventive Maintenance Index” with all components requiring maintenance listed with reference to section providing information, general overall maintenance with reference; “Maintenance Procedures” properly indexed and referenced with chronology chart for maintenance personnel; “Manufacturers Instructions and Installation and Maintenance Manuals” for all items included in the individual manual with all inapplicable items deleted; “Parts List” including component name, description, manufacturer’s drawing reference, pictorial views, test or calibration equipment necessary; set of “Drawings”, including legible copies of approved shop drawings reduced to 279 mm by 432 mm and folded to fit and be bound into the manual; “Vendor and Supplies” with names, addresses and telephone numbers; recommended “Spare Parts” properly identified with reference to the shop drawing nomenclature. The Maintenance Manual shall be

properly externally identified, with index tabs for quick reference. It shall not be combined with the Operating Manual. The Troubleshooting Manual shall be part of the Maintenance Manual.

Technically related information such as circuit and schematic descriptions referring to designed relay coils and contacts, limit switch contacts, all as specified, shall form part of the Troubleshooting Manual. The Maintenance Manual and Troubleshooting Manual shall be bound in a hard covered, piano hinged jacket of a solid color. All binders shall be of the same color, and the front and spine shall be permanently labeled with the project name, contract number, contractor's name and the date the bridge was turned over to the owner. All pages shall be covered in plastic.

Renewal parts data shall be supplied listing complete catalog and other information required for obtaining replacement parts for all items, and estimated cost for each item.

Recommended spare parts data shall be supplied clearly identified including detailed specifications, name of supplier, part numbers and descriptions.

2. Shop Drawings

Shop drawings shall be submitted to the Engineer for approval.

The submission shall consist of, but not be limited to, the following:

(a) Certified full commercial test of the span motor. It shall include the following curves: torque with rings shorted vs. speed, primary current, power-factor and efficiency; primary voltage with locked rotor vs. torque, current and power consumption; envelope of maximum torque vs. speed. Span motor complete nameplate data, including rated secondary voltage and current, and temperature rise.

(b) Three line power diagram.

(c) Complete wiring and interconnection drawings showing all termination identification of wires and cables, sizes and numbers of all cables and wires, and the manufacturer, catalog number, and any other additional data describing all apparatus and their ratings and capacities.

(d) Schematic diagrams showing the connection schemes including details of apparatus and complete schematic diagrams of the control panels and the control console. These drawings shall include the number of each wire and an individual designation of each electrical device and piece of equipment. These designations shall be carried completely through all other drawings such as assembly and installation drawings.

(e) Assembly drawings drawn approximately to scale detailing all external and internal components and terminal blocks for all control panels terminal boxes and the control desk.

(f) Installation drawings shall give the location of all control panels, disconnects and safety switches, conduits control console, and all other apparatus, and any addition equipment which may be necessary to properly identify the exact locations of the individual items.

(g) General construction, dimensions, and arrangement of internal equipment.

3. Span Motor

The span motor shall be provided without a machinery base, stored and protected from the weather and damage before and during installation. The Engineer shall be contacted three (3) weeks in advance to witness the operation of the motor and resistors under full-load.

The Contractor shall conduct field tests including, but not limited to, the following: check motor for secure mounting and free from undue vibration over the full range of operating conditions, check and coordinate rotation with controller and mechanical drive equipment, check for overloading and overheating during operation verify grounding has been installed in accordance with the NEC, Article 250.

The manufacturer shall supply five (5) copies of an Operating and Maintenance Manual with the minimum following information: locked rotor current, breakdown torques efficiency at 1/2, 3/4 and full load at rated voltage and frequency, bearing lubrication requirements, number of successive starts allowable, rotor and stator construction, and drawings outlining dimensions, location of connections, shaft size, shaft torsional spring constant, and shaft rigidity modules. The Contractor shall obtain these manuals from the manufacturer and insert them into a general Operating and Maintenance Manual as described earlier.

4. Secondary Resistors

The secondary resistors shall be mounted on the mezzanine level wall above the control panel as shown on the plans. The Contractor shall provide a mounting bracket and all fasteners required to securely mount enclosure to the wall. Once mounted, the Contractor shall install conduit and wire as shown on the plans and connect resistors to the control panel. Once installation is complete, the Contractor shall perform tests to demonstrate that the motor functions properly at all levels of operation.

5. Mechanical Brakes

The mechanical brakes shall be shop assembled and installed on the machinery platform prior to being mounted to the steel framing in the field. The Contractor shall coordinate installation, alignment and adjustment with the Contractor responsible for the mechanical drive equipment. The Contractor shall install conduit and wire as shown on the plans. Once installation is complete, the Contractor shall test the braking systems with the controller to verify brake release and closure is performed in the correct sequence as shown on the plans.

6. Span Limit Switch

The span limit switch shall be mounted to a base at locations as shown on the plans. The Contractor shall install conduit and wire connecting the cam switches to the control panel. Cam adjustments shall be as shown on the plans and the Contractor shall test each cam to assure proper closure at the settings.

7. Limit Switches

All limit switches shall be mounted as detailed on the plans or outlined in the specifications. The Contractor shall be responsible for mounting arrangements for the steel installation. Any mounting

plates or fasteners not shown shall be supplied by the Contractor. Once the switches have been mounted, the Contractor shall connect the wire and conduit and terminate wires in the control panel. The Contractor shall be responsible for testing each switch for contact closure at the appropriate settings. Any switch that fails or is damaged shall be replaced by the Contractor at no charge to the State.

8. Control Console and Panel

The control system manufacturer shall perform a complete shop test of the control equipment, witnessed by the Engineer, prior to shipment. The Engineer shall be notified in writing of the testing date at least two (2) weeks in advance of the test.

The Control Console, Control Panel and Equipment Brakes shall be interwired with limit switches and field device simulators to demonstrate complete system operation to the satisfaction of the Engineer.

The manufacturer shall detail the method of adjustment of the equipment brake system, motor and secondary resistor, and course adjust the systems for proper initial operation load control. A certified test report for adjustment of the secondary resistor and operation of the bridge control system in general shall be provided to the Engineer.

The control system manufacturer shall be responsible for field checking that all equipment has been properly installed and wired and shall perform the start-up operation of the bridge equipment. The manufacturer's field representative shall also be present during acceptance testing.

Upon delivery of the control console and panel to the site, and until the console is energized and placed in preliminary operating status, a thermostatically controlled temporary heater shall be placed within it, located near the bottom to prevent condensation. The control console and panel heater shall be UL listed and care shall be taken to prevent contact with any materials which may burn or be damaged by the heat during its use. One heater unit, sized approximately 100 watts, shall be located in the control console. In addition, the control console top shall be protected with plywood, until energization, to prevent damage during construction.

The Contractor shall be responsible for coordinating the size of the control console and panel with the entrance into the building. Once placed in final position, connect conduit to enclosure and terminate wiring into terminal blocks. All wiring shall be labeled with an adhesive type pre-marked tape on both sides of the terminal blocks. The Contractor shall test and check all terminals before energizing the System.

9. Festoon Cable System

The festoon cable system is used to transfer electrical power, control and lighting from the near side fixed structure to the moveable span, and from the moveable span to the equipment in the far pit and far side traffic control equipment. Each festoon cable system (two per bridge) is made up of two enclosures, internal straps and brackets, terminal blocks, multiple multi-conductor cables, strain relief fittings and cable grips.

The moving enclosures shall be mounted to the bridge steel as shown on the plans. The Contractor shall coordinate any field drilling or welding of the steel with the Contractor responsible for steel

fabrication. The stationary enclosure shall be mounted to the pit wall. Cables shall be cut such that they never touch the floor in any position or apply tension to either enclosure. Wires shall be terminated 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. All wiring and conduit connecting the panels and field equipment will be paid for under the Electrical Work item.

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

1. Partial payments for manufactured equipment furnished, delivered and stored on-site will be allowed in accordance with the requirements of Section 109-04 of the Standard Specifications.

2. Thirty percent (30 %) of the lump sum price per bridge will be paid upon completion of the control panel and control console installation.

3. Thirty percent (30 %) of the lump sum price per bridge will be paid upon completion of the span motor, brakes, span limit switch and tachometer/speed transducer.

4. Twenty-five percent (25 %) of the lump sum price per bridge will be paid upon completion of the overtravel limit switch, span manual operation interlock limit switch, fully seated limited switch, and festoon cable system have been mounted.

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 599.06040104 M Electrical Drive and Controls – Ingersoll Street
Item 599.06040204 M Electrical Drive and Controls – Washington Street