

**NEW HAMPSHIRE DEPARTMENT OF  
TRANSPORTATION  
AND  
MAINE DEPARTMENT OF TRANSPORTATION  
REQUEST FOR PROPOSAL (RFP)**

**DESIGN-BUILD SERVICES FOR**

**Memorial Bridge Replacement Project  
PORTSMOUTH, NH – KITTERY, MAINE**

**13678F, A000(911)**

**Volume II – Book 3**

**Special Provisions**



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**ADDENDUM NO. 3**

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**SECTION 26 24 19**  
**MOTOR CONTROL EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Motor control centers.
  - 2. Separately mounted motor starters (including those supplied with equipment).
  - 3. Manual motor starters.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. New Hampshire Department of Transportation Section 105 - Control of the Work.
  - 2. Section 01 25 13 - Product Substitution.
  - 3. Section 26 05 00 - Electrical: Basic Requirements.
  - 4. {Section 26 08 13 - Acceptance Testing. }
  - 5. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
  - 6. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
  - 7. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).
  - 8. Section 26 09 13 - Electrical Metering Devices.
  - 9. Section 26 09 16 - Control Equipment Accessories.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. International Electrotechnical Commission (IEC).
  - 2. National Electrical Manufacturers Association (NEMA):
    - a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
    - b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
    - c. ICS 3, Medium-Voltage Controllers Rated 2001 to 7200 V AC.
  - 3. Underwriters Laboratories, Inc. (UL):
    - a. 508, Standard for Industrial Control Equipment.
    - b. 845, Motor Control Centers.
- B. Miscellaneous:
  - 1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
  - 2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

**1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. See New Hampshire Department of Transportation Specification Section 105 for requirements for the mechanics and administration of submittal process.
  - 2. Product technical data:
    - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    - b. See Specification Section 26 05 00 for additional requirements.
  - 3. Fabrication and/or layout drawings:
    - a. Motor control center:

- 1) Elevation drawing with overall dimensions.
  - 2) Starter and component schedule.
  - 3) Identification of units and their location in the MCC.
  - 4) Location of incoming line terminals.
  - 5) Mounting dimensions.
  - 6) Available conduit entrance areas.
  - 7) Nameplate schedule.
  - 8) Assembly ratings (amps, volts, short circuit, etc.).
  - 9) Unit ladder logic wiring for each unit depicting electrical interlocking and wiring between units (NEMA ICS 3 Class II) and identification of terminals where field devices or remote control signals are to be terminated (NEMA ICS 3 Class II-S) as indicated on the Drawings and/or loop descriptions.
- b. Separately mounted combination starters:
- 1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.
- B. Operation and Maintenance Manuals:
1. See Specification Section 26 05 00 for requirements for:
    - a. The mechanics and administration of the submittal process.
    - b. The content of Operation and Maintenance Manuals.
    - c. Fabrication and/or layout drawings updated with as-built conditions.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Allen-Bradley.
  2. Cutler Hammer.
  3. General Electric Company.
  4. Square D Company.
  5. Siemens.
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

### **2.2 MOTOR CONTROL CENTERS**

- A. Ratings:
1. 600 V class, 3 PH, 60 Hz with operating voltage and number of wires as indicated on the Drawings.
  2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
  3. Service Entrance Equipment rated when indicated on the Drawings.
- B. Construction:
1. Standards: UL 845.
  2. Totally enclosed, dead front, free standing assemblies, bolted together to form a single assembly.
  3. Fabricate of not less than 14 GA steel with 16 GA steel doors in standardized units.
  4. Nominal size per section (minimum): 20 IN wide, 20 or 21 IN deep, and 90 IN high.
  5. Enclosure:
    - a. NEMA 12:



- 1) Dust-tight and drip-proof.
- 2) Gasketed material round all doors, door cutouts, cover plates, side, top and back sheets.
- 3) Gasketed bottom plate.
- b. NEMA 3R non-walk-in:
  - 1) Rainproof and sleet resistant.
  - 2) NEMA 1 gasketed enclosure with an outdoor house erected around it.
6. Horizontal wireways:
  - a. At the top, isolated from the main bus
  - b. At the bottom.
  - c. Easily accessible.
  - d. Full length of the MCC.
7. Vertical wireway:
  - a. Located in each MCC section that accepts plug-in units.
  - b. Connect to top and bottom wireways.
  - c. Isolated from the unit interiors.
  - d. Accessible through a separate hinged door.
  - e. Cable tie supports to hold wiring in place.
8. Unit doors:
  - a. Formed round corners and rolled edges.
  - b. Minimum of two (2) heavy-duty hinges or continuous piano hinge.
  - c. Held closed by means of captive fasteners.
  - d. Fabricate to be a part of the structure and not part of the starter.
9. Unit cubicles:
  - a. Draw-out type for motor starters through NEMA Size 5.
  - b. Guide rails for supporting and aligning starters.
  - c. Operating handle:
    - 1) With the unit stabs engaged and door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
    - 2) Circuit breaker and MCP operators includes a separate TRIPPED position.
    - 3) Mechanical interlock to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism.
    - 4) Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism.
    - 5) Non-defeatable interlock to prevent the installation or removal of a unit unless the disconnect is in the OFF position.
    - 6) Padlockable in the OFF position.
  - d. Control panel:
    - 1) Provide control devices (selector switch, indicating devices, etc.) as indicated on the Drawings per Specification Section 26 09 16.
  - e. Control power:
    - 1) Control power transformer:
      - a) 120 V secondary.
      - b) Fused on primary and secondary side.
      - c) Sized for 140 percent of required load.
  - f. Minimum of one (1) full size space unit (12 IN) for any combination magnetic motor starter or starter without overload relay.
  - g. One-half full size space unit (6 IN) for circuit breakers 100 A and less.
  - h. Effectively baffled to isolate any ionized gases which may occur within unit starter.
10. Externally mounted overload relay pushbutton.
11. Assemblies effectively ventilated to allow relocation of starters and other components:

- a. Within the assembly and with the same load.
  - b. Without having to compensate for changes in location.
12. Finish: Rust inhibited primer and manufacturer's standard paint inside and out.
  13. Provide ample unrestricted space for conduit entry from the bottom.
  14. Wiring: NEMA ICS 3 Class II, Type B-D.
- C. Buses:
1. Material: Tin-plated copper.
  2. Main horizontal bus:
    - a. 600 A unless otherwise indicated on the Drawings.
    - b. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
  3. Vertical buses:
    - a. 300 A minimum.
    - b. Securely bolted to the horizontal main bus with joint easily accessible for maintenance.
    - c. Completely isolated and insulated by means of a barrier.
    - d. Extended full length of vertical section to distribute incoming power to each circuit breaker and starter in structure.
      - 1) Starters NEMA Size 5 and larger and certain other components may be cable connected to the main bus with the approval of the Engineer.
    - e. Extend Vertical bus to spaces provided for future equipment.
  4. Ground bus:
    - a. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
    - b. 300 A tin-plated copper.
    - c. Solidly grounded to each structure.
    - d. Locate near bottom of structure.
    - e. Provide for lug connection of equipment ground wires.
- D. Overcurrent and Short Circuit Protective Devices:
1. Main device:
    - a. Molded case circuit breaker.
    - b. Fusible switch.
  2. Feeder devices:
    - a. Molded case circuit breaker.
    - b. Fusible switch.
  3. Motor protection with full voltage starters:
    - a. Motor circuit protector.
    - b. Molded case circuit breaker.
    - c. Class RK-1 fuse.
  4. Motor protection with reduced voltage starters:
    - a. Molded case circuit breaker.
    - b. Motor circuit protector.
    - c. Class RK-1 fuse.
  5. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
  6. Factory installed.
- E. Motor Starters: See requirements within this Specification Section.
- F. Surge Protective Device: Integrally mounted, see Specification Section 26 43 13.
- G. Power Monitor Metering:
1. Separate compartment.

2. See Specification Section 26 09 13 for meter requirements.

H. Miscellaneous:

1. See Drawings for items provided by other but factory installed (e.g., submersible motor temperature/leak controller, control system gateways or switches).

### 2.3 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:

1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Enclosure:

1. NEMA 4 rated:
  - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
  - b. No knockouts, external mounting flanges, hinged and gasketed door.
2. NEMA 4X rated:
  - a. Body and cover: Type 304 or 316 stainless steel.
  - b. No knockouts, external mounting flanges, hinged and gasketed door.
3. NEMA 7 and NEMA 9 rated:
  - a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
  - b. Drilled and tapped openings or tapered threaded hub.
  - c. Gasketed cover bolted-down with stainless steel bolts.
  - d. External mounting flanges.
  - e. Front operating handle padlockable in the OFF position.
  - f. Accessories: 40 mil PVC exterior coating.
4. NEMA 12 rated:
  - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
  - b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:

1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
2. Circuit breaker and MCP operators includes a separate TRIPPED position.
3. Mechanical interlock to prevent to the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
5. Padlockable in the OFF position.
6. Exceptions: NEMA 7 and NEMA 9 enclosures.

D. External mounted overload relay pushbutton.

E. Control Devices:

1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
2. Devices will be accessible with the door closed.

F. Control Power Transformer:

1. 120V secondary.
2. Fused on primary and secondary side.
3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

- H. Motor Starters: See requirements within this Specification Section.
- I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
  - 1. Motor circuit protector.
  - 2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
  - 3. Factory installed.

## 2.4 MOTOR STARTERS

- A. Standards:
  - 1. NEMA ICS 2.
  - 2. UL 508.
- B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
  - 1. NEMA full size rated contactor.
    - a. NEMA half sizes and IEC contactors are not permitted.
  - 2. Double-break silver alloy contacts.
  - 3. Overload relays:
    - a. Ambient compensated, bimetallic type with interchangeable heaters, 24 percent adjustability, single phase sensitivity, an isolated arm contact and manual reset.
  - 4. Interlock and auxiliary contacts, wired to terminal blocks:
    - a. Holding circuit contact, normally open.
    - b. Overload alarm contact, normally open.
    - c. Normally open auxiliary contact, for remote run status.
    - d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
    - e. Two (2) additional normally open spare field replaceable auxiliary contacts.
- C. Full Voltage Reversing (FVR) Magnetic Starters:
  - 1. Two (2) FVNR starters with one (1) overload relay assembled together.
  - 2. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.
  - 3. See FVNR paragraph for additional requirements.
- D. Full Voltage Two-Speed (FV2S) Magnetic Starters:
  - 1. Two (2) FVNR starters with two (2) overload relays assembled together.
  - 2. Configured for two (2) winding or one (1) winding consequent pole motors.
  - 3. See FVNR paragraph for additional requirements.
- E. Reduced Voltage Autotransformer (RVAT) Starter:
  - 1. Closed transition design using three (3) contactors and two (2) or three (3) autotransformers.
  - 2. Transformer taps: 50, 65 and 80 percent, factory set at 65 percent.
  - 3. NEMA full size rated contactor.
    - a. NEMA half sizes and IEC contactors are not permitted.
  - 4. Double-break silver alloy contacts.
  - 5. Overload relays:
    - a. Ambient compensated, bimetallic type with interchangeable heaters, 24 percent adjustability, single phase sensitivity, an isolated arm contact and manual reset.
    - b. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.
  - 6. Interlock and auxiliary contacts, wired to terminal blocks:
    - a. Holding circuit contact, normally open.
    - b. Overload alarm contact, normally open.
    - c. Normally open auxiliary contact, for remote run status.

- d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
- e. Two (2) additional normally open spare field replaceable auxiliary contacts.

F. Variable Frequency Drives: See Specification Section 26 29 23.

## 2.5 MANUAL MOTOR STARTERS

A. Standards:

- 1. NEMA 250, NEMA ICS 2.
- 2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:

- 1. Horsepower rated, for ON/OFF control.
- 2. Horsepower rated, for ON/OFF control and thermal overload protection.
  - a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:

- 1. NEMA 1 rated:
  - a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
  - b. With or without concentric knockouts.
- 2. NEMA 4 rated:
  - a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
  - b. No knockouts, external mounting flanges.
- 3. NEMA 4X rated:
  - a. Type 304 or 316 stainless steel.
  - b. No knockouts, external mounting flanges.
- 4. NEMA 7 and NEMA 9 rated:
  - a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
  - b. Drilled and tapped openings or tapered threaded hub, external mounting flanges.
  - c. Accessories: 40 mil PVC exterior coating.
- 5. NEMA 12 rated:
  - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
  - b. No knockouts, external mounting flanges.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.
- B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.
- C. Mount MCC on 4 inch vibration dampening pads at a height of 4 inches above the finish floor elevation.
- D. Overload Heaters:
  - 1. Size for actual motor full load current of the connected motor.
  - 2. For motors with power factor correction capacitors, size to compensate for the capacitors effect on load current.
- E. Combination and Manual Starter Enclosures:
  - 1. Permitted uses of NEMA 1 enclosure:
    - a. Surface or flush mounted in architecturally finished areas.
    - b. Surface mounted above 10 FT in areas designated as dry in architecturally and non-architecturally finished areas.
  - 2. Permitted uses of NEMA 4 enclosure:
    - a. Surface mounted in areas designated as wet.
  - 3. Permitted uses of NEMA 4X enclosure:
    - a. Surface mounted in areas designated as wet and/or corrosive.
  - 4. Permitted uses of NEMA 7 enclosure:
    - a. Surface mounted in areas designated as Class I hazardous.
    - b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
  - 5. Permitted uses of NEMA 9 enclosure:
    - a. Surface mounted in areas designated as Class II hazardous.
    - b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
  - 6. Permitted uses of NEMA 12 enclosure:
    - a. Surface mounted in areas designated as dry.

### **3.2 FIELD QUALITY CONTROL**

- A. {Acceptance Testing: See Specification Section 26 08 13.}{Test the ground fault protection system as indicated in Specification Section 26 28 00.}

**END OF SECTION**

**SECTION 26 40 10**  
**BRIDGE CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Motor Control Center (MCC).
  - 2. Control apparatus.
  - 3. Control cabinets.
  - 4. Control desk.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. New Hampshire Department of Transportation Section 105 - Control of the Work.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. American National Standards Institute (ANSI):
    - a. B40.100, Pressure Gauges and Gauge Attachments.
  - 2. National Electrical Code (NEC).

**1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. See New Hampshire Department of Transportation Specification Section 105 for requirements for the mechanics and administration of submittal process.
  - 2. Product technical data:
    - a. Provide submittal data for all products specified in PART 2 of this Specification:
    - b. See Specification Section 26 05 00 for additional requirements.
  - 3. Fabrication and/or layout drawings.
    - a. Nameplate drawing.
- B. Operation and Maintenance Manuals:
  - 1. See Specification Section 26 05 00 for:
    - a. The mechanics and administration of the submittal process.
    - b. The content of Operation and Maintenance Manuals.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. All equipment, materials and associated components shall be new.
- B. Furnish and install equipment, materials, and associated components as shown on Plans.
- C. Wiring and cable requirements: See Specification Section 26 05 19.
- D. Grounding requirements: See Specification Section 26 05 26.
- E. Raceways and boxes requirements: See Specification Section 26 05 33.
- F. Other basic electrical requirements: See Specification Section 26 05 00.

## 2.2 CONTROL SYSTEM VENDOR

- A. All apparatus and equipment comprising the bridge control system shall be manufactured or furnished and assembled by a single qualified and approved control system vendor. Equipment includes but is not limited to:
  - 1. Limit switches
  - 2. Motor controls
  - 3. Control cabinets
  - 4. Control panels
  - 5. Control desk
- B. Vendor shall assemble control cabinets and control desk at an Underwriter's Laboratory (UL) approved facility in accordance with UL 508.
- C. Vendor shall have experience in providing electrical control systems for movable bridges of various types.

## 2.3 SPAN MOTOR CONTROL SYSTEM

- A. Control system shall regulate the speed of operation of the motors.
- B. Power controlling elements shall be magnetic contactors operated by master switch position.
- C. Primary power circuit for each motor shall consist of:
  - 1. Circuit breaker
  - 2. Reversing starter
  - 3. Service disconnect switch
- D. Bridge control logic functions shall be performed by PLC system which shall provide for operation of the bridge and its auxiliaries in accordance with the system functionality specified herein and the control logic shown on the Plans.
- E. A complete spare set of contactors for use with the motor control system shall be provided for each set of motors.
- F. Span motors shall be operated from a single control switch located on the control desk.

## 2.4 SKEW CONTROL

- A. Control system shall include provisions for automatic and manual re-leveling.

## 2.5 LIMIT SWITCHES

- A. Rotary Cam-Operated Limit Switches
  - 1. Enclosure shall be NEMA 4X stainless steel.
  - 2. Shall be driven by gearing-furnished with the operating machinery, which shall rotate the input shaft.
  - 3. Shall allow for a + or - 1/4 degree contact operation repeatability.
  - 4. Each contact of the limit switch shall be SPDT precision-type, snap-action switches.
  - 5. Contacts shall have a minimum AC inductive continuous current carrying rating of 15A and a minimum DC resistive continuous current carrying rating of 15A.
  - 6. Switches
    - a. Span Motor Control Switch
      - 1) Shall have 8 circuits individually micro-adjustable and provisions for internal vernier adjustments.
      - 2) One shall be furnished and installed in the machinery enclosures and designated as position limit switch
    - b. Ultimate Skew Limit Switches



- 1) Shall have 6 circuits individually micro-adjustable and provisions for internal vernier adjustments.
  - 2) Two shall be furnished and installed in the machinery enclosures .
- B. Lever Type Limit Switches
1. Shall be heavy-duty, lever-operated, spring-return, two-circuit, snap-action .
  2. Bronze, watertight, NEMA 4X enclosure
  3. Shall be provided with regular straight type brass levers and appropriately sized rollers.
  4. Shall be shipped to the operating machinery supplier for shop mounting.
  5. Switches
    - a. Brake Limit Switches
      - 1) Three shall be mounted on each brake to indicate status (fully released, fully set or hand released) of each brake.
    - b. Over Travel Limit Switches
      - 1) Two shall be furnished and installed for over travel indication and interlocking purposes.
- C. Plunger Limit Switches
1. Heavy-duty, plunger operated, two-circuit, snap action
  2. Enclosure
    - a. Weather-sealed
    - b. Cover shall be designed to positively retain a gasket.
    - c. Drain plugs and a breather shall allow condensation to evaporate or drain from housing.
    - d. All materials shall be non-corrosive, such as aluminum, bronze, stainless steel or non-metallic.
    - e. Finish shall be painted safety orange.
  3. Plunger extension shall permit at least 0.75 inch (19 mm) field adjustment and shall have a rounded end.
  4. Design shall also allow for simple field swapping of service cover hand.
  5. Plunger shaft shall be stainless steel.
  6. Pre-travel shall be approximately 1.5 inch (38 mm) with a minimum over-travel of 2 inch (51 mm).
  7. Trip plate shall be spring loaded with an over-center mechanism to provide simultaneous, positive, accurate, and repeatable snap-action activation of all switches.
  8. Trip point shall be field adjustable by simple adjustment of plunger extension.
  9. Switches
    - a. Fully Closed Limit Switches
      - 1) Two shall be furnished and installed for fully closed indication and interlocking purposes.

## 2.6 CONTROL APPARATUS

- A. Shall conform to the applicable requirements of NEMA Publication No. ICS (Industrial Control and Systems).
- B. Circuit Breakers
1. Shall be equipped with adjustable instantaneous magnetic trip units.
  2. Trip ratings as shown on Plans.
  3. Shall have quick-make and quick-break contacts.
  4. Mechanism shall be trip-free and trip indicating.
- C. Motor Starters and Magnetic Contactors
1. Continuous current rating of contactors and starters shall be adequate for connected loads.
  2. Starters
    - a. Minimum size: NEMA size 1.
    - b. Full voltage type
    - c. Rated as required

- d. Operating coils rated as required
  3. Magnetic Contactors
    - a. All contact poles shall be provided with arc chutes.
    - b. Contactors rated 150A and above shall be equipped with magnetic blowouts.
  4. Overload protection shall be provided to protect each motor.
  5. Reversing contactors shall be electrically and magnetically interlocked.
- D. Selector Switches and Pushbuttons
1. Shall be heavy-duty, oil-tight, and operated by selector knobs and push operators.
  2. Selector switches shall have gloved or pistol-grip handles.
  3. Selector switches and buttons shall be minimum size 1 inch (22.5 mm).
- E. Bypass Switches
1. Shall be held in their open position by hinged plates at least 2 inches long.
    - a. Must be unlocked and turned over backwards to release the switch handles for bypassing
  2. Underside of the plates shall be painted bright red.
  3. Provisions to lock each bypass switch in the "Off" position by means of a lockable brass cover plate shall be included.
- F. Indicating Lights
1. Voltage source as supplied
  2. Mounted on the control desk and cabinets
  3. Shall be LED type, heavy-duty, and oil-tight.
  4. Illuminated lamps must be easily distinguished in sunlight from non-illuminated lamps.
  5. Indicating lights on the control cabinets shall be push-to-test type.
  6. Lenses shall be scratch-resistant with color and marking as shown on Plans.
- G. Terminal Blocks
1. Shall be one-piece blocks of phenolic material recognized under the UL Component Recognition Program for conductors sized as required.
  2. Barriers shall not be less than 1/2 inch high and 1/8 inch thick and shall be spaced 5/8 inch center-to-center.
  3. Straps and screws shall be of brass, nickel-plated for use in highly corrosive atmospheres, and shall be rated for 60A minimum.
  4. Shall provide nickel-plated brass screws suitable for use with ring tongue wire connectors.
  5. Corrosion-resistant marking strips shall be provided for conductor identification.
  6. Minimum 10% spare terminals shall be provided.
- H. Power Distribution Blocks
1. Shall be constructed from a single piece of hard-drawn copper, machined, and electro-tinned for all conductors larger than No. 8 AWG.
  2. Shall be mounted on heavy-duty phenolic material and furnished with safety cover kits.
  3. Number and size of primary and secondary wire openings will be selected by the Contractor/Vendor.
- I. Nameplates
1. Shall be provided for all aforementioned devices.
  2. Shall be made of laminated phenolic plastic with white front and back and black core.
  3. Shall be not less than 2.3mm thick.
  4. Shall be securely fastened to the equipment/cabinet back panel with stainless steel screws.
  5. Lettering
    - a. Shall be etched through the front layer to show black engraved letters on a white background.
    - b. Shall be not less than 6mm high.

- J. Drum Control Switches
  - 1. Shall be positive detect cam actuated with overlapping contacts to make before break.
  - 2. Shall be provided with a three inch lever handle and lock in the off position. The handle must be depressed to move from the "Off" position.
- K. Motor Disconnect Switches
  - 1. Shall be tag out lockable, non-fusible, heavy-duty, safety switches.
  - 2. Shall be within waterproof NEMA 4X enclosure.
  - 3. Shall be installed within the range of view of each span motor, brake thruster.
- L. Main Service Disconnect Switch
  - 1. Shall be fusible and supplied with fuses appropriately sized for the required main service as per NEC.
  - 2. Fuse type shall be as per manufacturer instructions.

## 2.7 BRIDGE CONTROL CABINETS

- A. Shall be NEMA Type 4X enclosure constructed of Stainless Steel.
- B. Shall be reinforced with steel angles or channels to provide a rigid, free-standing structure.
- C. Doors
  - 1. Each cabinet shall be provided with hinged doors on front of each panel section.
  - 2. Door panels shall be gasketed.
  - 3. Door panels shall be provided with three-point, vault-type latches.
- D. All hardware shall be corrosion resistant.
- E. Thermostatically controlled heaters shall be provided in each cabinet for anti-condensation.
- F. Each panel shall be provided with suitable interior light fixtures and one duplex receptacle.
- G. All cabinet wire shall be flame-retardant, ethylene-propylene insulated, switchboard wire, Type SIS. Conductors shall be stranded copper not smaller than No. 10 American Wire Gauge on the bridge. However, a minimum of 14AWG shall be used in the control cabinets.
- H. The troughs inside the panels shall be fabricated from heavy duty Noryl plastic shaped into a channel cross-section. The troughs shall be of sufficient cross section for both factory and field wiring.
- I. Control panels enclosed in freestanding cabinets shall be furnished and installed in the control house with the arrangement and line-up of the individual control cabinets as shown on the Plans.
  - 1. All circuit breakers, switches, contactors, relays, regulating equipment, and other apparatus for control of the span and its auxiliaries shall be mounted on these enclosed panels.
  - 2. All equipment in each control cabinet shall be mounted on stainless steel bases.
  - 3. Each device shall be front-connected, front-wired, and removable from the front.
  - 4. Equipment in all cabinets shall be arranged for ease of access and for safety and convenience of operation.
  - 5. A systematic and neat arrangement of the equipment shall be obtained.
  - 6. Nameplate
    - a. Each device shall be suitably named and plainly marked by a laminated nameplate mounted near the device on the panel.
    - b. Each nameplate shall show an approved descriptive title for the apparatus, together with the device designation appearing on the schematic wiring diagrams.
  - 7. All panel wiring shall be arranged systematically so that circuits can be readily traced. The wiring shall be installed in a network of troughs consisting of horizontal and vertical sections securely bolted to the panels. After installation of the wiring, an insulated, flanged cover shall be snapped over the open side of each trough section.

## 2.8 CONTROL DESK AND STATIONS

- A. The desk shall be fabricated from No. 10 gauge stainless-steel, properly formed and suitably reinforced to provide adequate strength.
  1. The desk top shall be constructed of 12 gauge Stainless Steel with a non-glare, satin finish and shall be reinforced to provide adequate support using Stainless Steel angles or channels.
  2. The desk shall be neatly fitted up with close joints, and all rough edges or corners shall be ground off smoothly, and all projecting edges rounded off.
  3. All metal hardware shall be of substantial construction and shall have a satin-chrome plate finish. All equipment mounting screws and bolts shall be stainless steel.
- B. Removable doors shall be provided in the front and side panels of the desk, pivoted on 90 degree hinges, and secured with flush type, three-point latches.
- C. Sockets for testing lamps used in meters and in the position indicator shall be installed inside the control desk. The desk interior shall be suitably lighted and controlled by a switch mounted near the front doors. One duplex receptacle shall be mounted in the desk.
- D. The wiring within the control console shall be insulated switchboard wire conforming to the requirements herein for wiring on the control panels. The wiring shall be arranged systematically so that all circuits can be readily traced. All conductors shall be terminated on easily accessible terminal blocks mounted inside the desk at the rear, with ring lug connectors. Wiring shall be identified at equipment terminals by marking the adjacent area with brightly painted numbers to correspond to conductor designations appearing on the Contractor's wiring diagrams.
- E. Spare terminals totaling at least 10 percent of those actually used shall be provided. Shorting terminal blocks shall be provided for all CT leads.
- F. On the console shall be mounted all devices for controlling operation of the lift span and its auxiliaries.
  1. Meters
    - a. Shall have uniformly spaced graduations in black on a white background.
    - b. Shall be dust-proof and splash proof switchboard type meters.
    - c. Shall be approximately 4.5 inch square, with circular scales about 7 inch long.
    - d. Shall be mounted semi-flush.
    - e. Shall be ANSI specified C39.1.
    - f. Shall be magnetically shielded to prevent interaction, and have accuracy of plus or minus 1.5% (maximum).
    - g. Shall also be provided with a 3-1/2 digit LED display to complement the analog scale and pointer.
  2. Indicating lights shall be mounted on the control console to show that the various steps in the sequence of operation have taken place so that the operator may proceed to subsequent steps at the proper time. The functions to be indicated and the color of the lenses shall be as shown on the Plans.
  3. The indicator assemblies and all meters and meter interlock bypass switches shall be mounted on the control desk.
  4. The inclined panel shall be hinged where it meets the bridge main control desk top, so it can be lifted (singly) for easy access to the components mounted through the inclined panel. Handles shall be provided on the inclined panel and control desk top for ease in opening them. The inclined panel door shall be held open with appropriate hardware for the load.
  5. All contact blocks for control switches, pushbuttons, and other control devices shall be mounted within the body of the control desk. The operators for these devices shall protrude through the control desk top. The indicating lights for each operation shall be mounted adjacent to the control device governing that operation.

## 2.9 HEIGHT AND SKEW INDICATORS

- A. Height Indicator
  - 1. Shall be mounted on the control desk and show the position of the span during operation.
  - 2. Shall have a black pointer driven by a controller which receives an input signal from a high accuracy encoder geared to the operating machinery.
  - 3. Indicator dial shall be approximately 9 inches (229 mm) in diameter and shall be internally illuminated.
  - 4. Scale
    - a. Shall be graduated in meters and feet of lift.
    - b. Interval from the fully open height to the maximum opening shall be marked in red, while the balance of the dial shall be marked in black.
  - 5. Verify the actual rotation at the encoder input shafts corresponding to the full-span opening and modify the height indicators' design as necessary.
- B. Skew Indicator
  - 1. Shall be mounted on the control console and show the skew of the span during operation.
  - 2. Shall have a black pointer driven by a controller which receives an input signal from a high accuracy encoder geared to the operating machinery.
  - 3. Shall function as a primary skew cutout
    - a. If the system reaches a skew of 20 inches (508 mm), the controller shall send a control output signal to the PLC which shall cut the control power.
  - 4. Indicator dial shall be approximately 9 inches (229 mm) in diameter and shall be internally illuminated.
  - 5. Scale
    - a. Shall be graduated in inches and mm of skew from 0 to 20 inches with figures for every 6 inches and with all graduations above the horizontal centerline.
    - b. Interval between 14 and 20 inches shall be marked in red, while the balance of the dial shall be marked in black.

## 2.10 MOTOR CONTROL CENTER (MCC)

- A. Shall be constructed to meet or exceed the requirements within NEMA ICS3-322, NEC, and UL845 for motor control centers.
- B. Shall be designed, manufactured, and tested in facilities registered to ISO 9001 quality standards.
- C. Enclosure shall be NEMA/EEMAC Type 3R or Type 12.
- D. Gasketing shall be closed cell neoprene material. Open cell gasketing shall not be acceptable.
- E. Shall be rated for a 480-Volt, 3-Phase, 3-Wire, 60 Hertz with a solid Neutral lug assembly system.
- F. Starter/contactors coils shall be rated 120 VAC.
- G. All mounting hardware and all wire and cable terminals shall be vibration proof.
- H. Shall be provided with factory installed, guarded anti-condensation heaters.
- I. Shall be of the back to back through the back splice type.
- J. Each vertical section shall be a rigid, freestanding structure. Vertical sections shall have internal base mounting angles at the bottom and external lifting angles at the top running continuous within each shipping block. Each vertical section shall have side sheets extending the full height and depth of the section.
- K. Incoming line breaker compartment shall be top entry.

- L. Horizontal wireways of standard sections, both top and bottom, shall be not less than 6 inch high. The wireway opening between sections shall have rounded corners and the edges shall be rolled back.
- M. A full height vertical wireway and hinged door shall be provided in each standard vertical section, and shall be isolated from the horizontal and vertical bus.
- N. The power bus system shall be copper, supported, braced, and isolated by a bus support molded of a high strength, non-tracking glass polyester material.
- O. The horizontal bus shall be continuously braced within each section. It shall be copper with silver plating. Splicing horizontal buses shall be accomplished using a splice kit of at least the same ampere rating as the horizontal bus bar. These horizontal bus splices shall have at least two (2) bolts, and each bolted connections, and shall be independently capable of handling the load.
- P. The horizontal ground bus bar shall be tin-plated copper and located in the top horizontal wireway. A mechanical screw-type ground lug shall be mounted on the ground bus in the incoming line section.
- Q. The vertical bus shall be continuously braced and sandwiched in a glass-filled polyester molding. The bus shall be isolated from the other phases. The vertical bus shall be copper with the same plating as the horizontal bus.
- R. The vertical ground bus bar shall be tin-plated copper and supplied in each standard section. The vertical ground bus bar shall be connected to the horizontal ground bus bar and shall form a continuous internal grounding system.
- S. A grounding stab shall be provided on each plug-in unit, such that the stab engages onto a tin-plated copper vertical ground bus before the power stabs are engaged. It shall be maintained as the unit is withdrawn until after power stabs are disengaged.
- T. A grounding point shall be provided at each starter unit for purposes of landing the ground wire coming from the motor. A vertical tin-plated copper unit load ground bus shall be provided and connected to the horizontal ground bus bar. The vertical load ground bus with the unit load ground connector shall provide a termination point for the load ground cable at the unit.
- U. Shutters shall automatically open when a unit is inserted and automatically close when a unit is removed.
- V. All units shall be plug-in type. Plug-in units shall consist of a unit assembly, unit support pan and unit door assembly. After insertion, each plug-in unit shall be held in place by a latch that is located at the front of the unit.
- W. Plug-in power stab assemblies shall be tin-plated copper and designed to tighten during heavy current surges. The stabs shall be backed by stainless steel spring clips to provide a high-pressure connection to the vertical bus. Wiring from the unit disconnecting means to the plug-in stabs shall be routed into this molding such that the wiring is not exposed at the rear of the unit. Stab assemblies shall be sized to match the rating of the units. Automatic shutters shall be made available for isolation of unused stab openings.
- X. The unit door shall be fastened to the stationary structure (not the unit itself), so that the door can be closed when the unit has been removed. The door shall be hinged on the left-hand side so that it opens away from the vertical wireway.
- Y. The operator handle of all units shall be interlocked with the MCC frame, so that a unit insert can not be withdrawn or inserted when the operator handle is in the ON position. An auxiliary contact shall be provided on the disconnect for purposes of isolating the external source of control voltage. One control circuit fuse shall be provided.

- Z. Terminal blocks shall be mounted within the unit and located near the front for accessibility. They shall not be located at the rear of the vertical wireway. Power terminal blocks shall be provided. Control terminal blocks shall be pull-apart style. CT terminal blocks shall be shorting type.
- AA. Wiring within the MCC shall be stranded copper with Type SIS insulation, 194° F rated minimum. Control conductor wiring shall be No. 10 AWG minimum. All wires and terminal blocks within the MCC shall be tagged by the vendor.
- BB. Wiring diagrams shall be provided at a centralized location in the MCC. Each modular unit shall also be supplied with wiring diagrams and product data. The diagrams shall show the exact devices inside the unit.

## **2.11 SPARE PARTS**

- A. Shall be supplied in accordance with AASHTO LRFD-2008 Article 8.14 Spare Parts.
- B. Spare parts supplied shall include, but not be limited to the following:
  - 1. One (1) limit switch of each type specified. In addition, a full set of contacts and contact fingers for each type of limit switch. For rotary limit switches, furnish twelve (12) contact assemblies
  - 2. Three (3) heater elements for overload protection apparatus of each size installed
  - 3. For the motor and machinery brakes:
    - a. Two (2) limit switches for hand-release mechanism.
    - b. Two (2) limit switches - brake released.
  - 4. For the control desk
    - a. Twelve (12) LED indicating lamps per each color
    - b. Four (4) indication lamp sockets / fixtures
    - c. Two (2) lens caps of each color installed
    - d. Two (2) of each type of switch / pushbutton switch units
    - e. One (1) Control Switch contact unit of each type installed
- C. Furnished and packed in suitable cartons for storage at the bridge
  - 1. Arrange the spare parts in uniform size cartons of substantial construction
  - 2. Typed and clearly varnished labels to indicate their contents

## **PART 3 - EXECUTION**

### **3.1 CONTROL SYSTEM VENDOR**

- A. Shall assume complete system responsibility for the integrated functioning of all components to provide a satisfactory assembled system operating in accordance with specified requirements.
- B. Shall be responsible for the detailed schematics and fabrication of the total control system to ensure compatibility of equipment and suitability for the intended system functioning.
- C. Shall provide supervisory assistance in the installation of equipment to ensure maximum reliability and ease of maintenance.
- D. Shall provide a field service staff having the capability of providing services for field coordination of construction and final adjustments to the drive system.

### **3.2 CONTROL AND OPERATION**

- A. Span operation shall be instituted from operation of pushbuttons, and selector switches on the control desk.
- B. The heating systems shall be de-energized when the bridge control is turned on.

- C. Both pedestrian gates must be closed and latched to permit the span drive to operate.
- D. The span cannot be operated electrically if any two service brakes or two drag brakes in any tower has been released by hand.
- E. Should a motor fault occur, the motor starter shall drop out and the span shall come to an emergency stop.
- F. Upon initiation of span movement, the span drives shall uniformly accelerate and decelerate.
- G. Sealable tumbler switches for bypassing the sequence interlocks in an emergency shall be provided and installed on the control desk.

### **3.3 FIELD QUALITY CONTROL**

- A. Acceptance Testing: See Specification Section 26 08 13.

**END OF SECTION**