SPECIAL SPECIFICATION

2138

Electrical Construction for Moveable Bridge Rehabilitation

1. **Description.** This Item shall consist of furnishing all materials, equipment, labor and incidentals necessary for the construction of an Electrical Operating System for Moveable Bridge Rehabilitation with fully operational electrical components as specified in the Electrical Technical Specifications included as a part of this Special Specification.

2. **Materials and Construction Methods.** All materials furnished and all construction methods utilized shall be in accordance with the plans, TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges and the attached Electrical Technical Specifications included as a part of this Special Specification.

3. **Measurement.** This item will be measured by the each for the various electrical components of the type specified in the Electrical Technical Specifications and by the lump sum for the overall electrical construction for moveable bridge rehabilitation complete in place.

4. **Payment.** The work performed and material furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for as follows:

Payment for each of the electrical components necessary to complete the overall electrical construction will be made at the unit bid price by the each for the types of components as follows:

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Payment for the overall electrical construction necessary to install and operate the moveable bridge system and corresponding electrical components will be made at the lump sum bid for “Electrical Construction for Moveable Bridge Rehabilitation.”

This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary to remove and dispose of existing non salvageable materials, and to furnish, install, and test the new materials and
electrical assemblies described and specified in the plans and Electrical Technical Specification.

SH87

NB BRIDGE OVER COW BAYOU

ELECTRICAL TECHNICAL SPECIFICATION

ELECTRICAL CONSTRUCTION FOR MOVABLE BRIDGE REHABILITATION

Prepared by:
URS Corporation
1950 North Stemmons Freeway
Suite 6000
Dallas, Texas 75207

Engineer of Record:

Raymond G. Hentschel, P.E.
Texas P.E. No.104348
Date: May 1, 2013
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</table>
1. **Description**
   
   **A. General.** It is the intention of this Electrical Technical Specification and Plans to call for finished work, tested and ready for operation. Unless otherwise specified, all manufactured items, fabrications, components, pieces, assemblies and appurtenances that are to be removed, salvaged, rehabilitated, furnished new, installed, or reinstalled under this Special Specification and shown on the plans is included in the Bid Item for “Electrical Construction for Movable Bridge Rehabilitation.”

   The Electrical Technical Specification is organized by Items to provide individual specifications for the procurement and installation of discrete shop fabrications and modular assemblies that are not covered by the Standard Specifications or where the requirements of this project are more stringent than the Standard Specifications.

   Dimensions given on the Plans are nominal and intended for guidance. Make note of any variations from nominal dimensions on the Shop Drawings or provide written notice to the Engineer.

   Where additional information is required or changes must be made; prepare working, erection, and Shop Drawings and submit to the Department as specified.

   **B. Scope of Work:** The scope of this Item includes the following tasks:

   1. **General Electrical Construction for Moveable Bridge Rehabilitation.** Furnish all materials, equipment, labor and incidentals necessary for the construction of an Electrical Operating System for moveable bridge rehabilitation in accordance with the plans and as described in this Special Specification.

      **a. Incoming Service.** Remove and dispose of the existing service entrance meter enclosure, fused disconnect switch, and pole.

         Furnish and Install concrete pole electric meter boxes with grounding and lighting arresters and fused disconnect switches. System Characteristics: 240/120 volts, three phase, four-wire, 60 Hertz. Furnish and Install conduit and wiring in accordance with the utility requirements.

         Provide documentation showing arrangement with Utility Company for permanent Underground electric services, including payment of Utility Company charges for service.

         **Utility Company:**
         Entergy Distribution
         Josh Trevino
         (409) 485-2261
         (409) 748-0119
         j.trevin@entergy.com

      **b. Electrical Demolition.** Remove the following electrical materials, prior to the demolition of the operator’s house and roadway deck:

         Remove for rehabilitation, the existing control desk, resistor bank, and the signal siren. These materials will be reinstalled. **Note:** The drum switch in the control desk has asbestos insulated parts.

         Remove the existing lighting panel, control panel, generator receptacle, conduit and wire from the operator’s house. These materials shall belong to the contractor.

         Remove all conduit and wire, junction boxes, submarine cables, limit switches, and navigational lights from the swing span and piers.
These materials shall belong to the contractor.

Remove the manually operated traffic gates and the remains of the original motor operated traffic gates. These materials shall belong to the contractor.

c. **Bridge Electrical Distribution.** Furnish and install a lighting panel, generator receptacle, junction boxes, local safety disconnect switches, and conduit and wire for motors, wedges, traffic gates, traffic barrier, bridge stop signals, control panels, lighting and receptacles, as shown in the plans.

d. **Lighting and Receptacles.** Furnish and install lighting fixtures and receptacles as shown in the plans.

2. **Bridge Control System.** Refurbish and reinstall the existing control desk, including the drum switch and resistor bank. Furnish and install two control panels and field located limit switches as shown in the plans.

3. **Traffic Gate and Barrier Assemblies.** Furnish and install four traffic gates as shown in the plans. Furnish and install one resistive traffic barrier as shown in the plans.

4. **Moveable Bridge Signals.** Furnish and install flashing lights and signs as shown in the plans.

5. **Flexible Cables.** Furnish and install flexible cables and termination cabinet as shown in the plans.

6. **Navigational Lights.** Furnish and install 8 fender pier lights, four movable span signal lights, and two lighted clearance gauge signs as shown in the plans.

7. **Submarine Cable.** Furnish and install submarine cable and termination cabinets as shown in the plans.

8. **Flexible Cables.** Furnish and install flexible cables and termination cabinet as shown in the plans. The work performed, materials furnished, equipment, labor, tools and incidentals for this task will not be measured or paid for directly, but will be subsidiary to the various bid items of the Contract.

9. **Bridge Electrical Testing.** Upon completion of the work and prior to shifting traffic onto the bridge, demonstrate to the Engineer or authorized representative, that all equipment and assemblies are complete and functioning as required.

C. **References.** Except where additional references are listed in the individual articles, conform to the applicable sections of the following codes and standards:

- AASHTO Standard Specifications for Movable Highway Bridges.
- NFPA 70, National Electrical Code (NEC), 2011 Edition
- Item 618 Conduit
- Item 620 Electrical Conductors
- Item 624 Ground Boxes
- NEMA AB 1 - Molded Case Circuit Breakers.
- NEMA ICS 2 - Industrial Control and System Controllers, Contractors and Overload Relays Rated Not more than 200 VAC or 750 VDC.
- NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600V).
- NEMA PB 1 - Panelboards.
- NEMA PB 1.1 - Proper Installation, Operation and Maintenance of Panelboards Rated 600 V or Less.
- UL 943 - Ground-Fault Interrupters.
- Federal Specifications W-C-375b.
- UL 248-12- Low Voltage Fuses- Part 12: Class R Fuses.
- FS W-F-870 - Fuse Holders and Fuse Clips (For Plug and Enclosed Cartridge Fuses).
- FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.

D. Codes. Comply with all laws applying to electrical installations, in effect.

1. The on-site electrical supervisor shall be a TDLR licensed Master Electrician in accordance with Title 8 Occupation Code 1305.153

2. All electrical work shall be performed by TDLR licensed Journeyman or Master Electricians in accordance with Title 8 Occupation Code 1305.155. Apprentices may be allowed in accordance with Title 8 Occupation Code 1305.166.

E. Submittals

1. General. Provide a separate submittal package for each pay item unless otherwise indicated in this Article. Label each submittal package to indicate the Project Name, Pay Item number, Section number and Article number as listed in these Technical Special Provisions. Label data sheets for individual components such as motors, limit switches, etc. with the identification numbers shown in the Plans and the technical special provision.

Submit all electrical submittal items in an individual separate three-ring loose-leaf binder or binders suitable for letter size sheets with opening/closing mechanism. Provide a separate individual ring binder or binders for each set of submittal items. Include binder title sheet as first page having names of job and contractor with second page as table of contents listing each submittal item in same sequence as specified.

Piece-by-piece submission of individual components will not be acceptable. Submit all components of a pay item at the same time. Submittal approval shall be on an "all or none" basis.

Provide complete re-submittals even if some items on the original submittals may not have been marked deficient. Provide sufficient time in project schedule to allow for the possibility of repetitious submittals without creating delays to the project. The Department shall not bear any responsibilities for delays caused by repetitious submittals.

2. Shop Drawings. Include shop drawings drawn to scale and certified by the manufacturer for all submittals for major electrical equipment. Refer to individual Articles for specific shop drawing requirements of each pay item.

3. Working Drawings. Maintain, at all times, shop drawings and construction drawings as working drawings for the duration of construction. Working drawings shall be made available to the engineer, on request, for review of construction issues.

4. Manufacturer’s Data. Refer to individual Sub Articles for submittal requirements

5. As Built Drawings. At the completion of the project, provide complete as-built drawings as well as operations and maintenance instructions. Use the marked up working drawings to prepare the as built drawings. Provide the working drawings markups for checking purposes.


2. Materials
A. Quality Assurance. All materials shall be new and shall conform to the standards of the Underwriters' Laboratories, Inc., in every case where such a standard has been established for the particular type of materials in question.

B. Shipping and Storage. Protect electrical equipment from water damage, especially from rain, condensation, and water dripping or splashing on equipment and wiring, at all times during shipment, storage and construction (prior to final acceptance).

Thoroughly dry out and put through a special dielectric tests as directed by the Engineer at no cost to the Department, or replace if not tested to the satisfaction of the Engineer, any apparatus that has been subjected to possible injury by water or dampness (including the interiors of motor control equipment, submarine cable ends, or any other electrical devices).

C. Handling. Protect equipment from damage from mishandling, dropping, or impact. Do not install damaged equipment. Damaged equipment will not be accepted.

D. Guarantee the complete electrical installation to be free of defects in materials and workmanship for a period of one year from the date of final acceptance.

3. Equipment

A. Tooling and Procedure Requirements: Install, apply, or adjust all electrical equipment and materials in accordance with the manufacturer’s recommendations including the usage of the manufacturer specified tooling.

B. Quality Assurance:

1. Tooling Identification: When applicable, the approved tooling shall provide a suitable identification to the work to allow verification that the appropriate tool was used to perform the work. For example, crimping dies shall contain identification marks that emboss the crimps made with them with an identification embossment.

2. Quality Isolation: Where possible, the requirement to provide a level of workmanship quality will be transferred to the tooling rather than the skills of the workman.

3. Conductor Stripping: Prevention of wire nicking shall depend upon the use of approved non-nicking strippers rather than the operator’s skill with knife edged stripping tools.

4. Compression Tightness: Proper compression shall depend upon the exclusive use of controlled cycle compression tools that require the proper degree of compression before releasing the work rather than upon the operator’s judgment of how hard the tool handle is being squeezed.

5. Tie Tightness: Proper tensioning of cable and wrap ties shall be determined by the use of the manufacturers specified calibrated tensioning tool rather than the operator’s judgment of what is tight enough.

6. Fastener Torque: Fasteners with a recommended torque, where the proper tightness is important to the performance of the function (which includes all electrical terminals), shall be tightened with a calibrated torque (limiting) screwdriver or other torque indicating tool.

C. Tool Application. The journeyman electrician intending to operate such specialized tool must demonstrate his knowledge of, and skill in using, the tool including the knowledge and ability to judge the results produced by the tool and to recognize failure of the tool to perform satisfactorily.

4. Construction or Work Methods

A. Coordination of Electrical Work

1. Given that the work involved requires the fabrication and installation of new components into an existing installation under complex requirements, recognize that the Contract Documents will not contain all necessary requirements and procedures required to obtain a successful installation. The provisions of the Contract Documents were developed with the intent that experienced personnel in the type of work required will, through the process of field surveys, shop drawing, and procedure submittals, refine and supplement to complete the requirements in such a manner to provide a complete and satisfactory fitting and fully operational installation at no additional cost to the Department.
It is not the intent of this Article and the Contract Plans that the fabrication and installation of the work of this Article be performed relying solely on the provisions of this Article and the Contract Plans.

2. The Contract Documents are diagrammatic in showing certain physical relationships which must be arranged within the electrical work, and which must interface with other work including utilities and mechanical work. Coordinate as necessary between trades to allow for proper installation of all electrical work.

3. Schedule and arrange electrical work in a neat, well organized manner.

4. Locate operating and control equipment to provide easy access, and arrange entire electrical work with adequate access for operation and maintenance, as per the latest NEC requirements.

5. Coordinate electrical work with the work of other trades to eliminate conflicts. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical equipment. Electrical work must be considered in critical path scheduling.

B. Working Drawings

- Maintain a full set of working drawings on the jobsite at all times. Required working drawings include conduit routing plans, schematic diagrams, interconnection wiring diagrams, and conduit and cable schedules.

- Use a set of approved shop drawings (incorporate all review comments if approved as noted) and mark, in red all circuit changes made in the field.

- The working drawings must be available at the time of the Functional Checkout. Unavailability of the working drawings can cause the Functional Checkout to be postponed or canceled.

C. Verification Testing

Whenever verification testing is required in the performance of the work of other Articles, perform the tests and measurements in accordance with these requirements.

- Provide test and measurement instruments suitable to perform the required tests including ratings and measurement accuracy as specified by the manufacturer. Clearly indicate the exact make and model of instrument to be used and include manufacturer’s specification data indicating the suitability of the instrument’s application in all procedure submittals.

- No test instrument may be used unless it has been calibrated and certified by an independent certification laboratory to the required accuracy and in accordance with the instrument manufacturer’s requirements; provided that all instruments have been calibrated within a maximum interval of the preceding 12 months. Certify all calibrations as traceable to the NIST or other recognized standardization authority.

- Test instrument operating manuals and certification certificates must be available on the project site for reference by the Engineer whenever the instrument is being used or evaluated.

D. Test Result Reporting

- Where test or inspection data submittal is required by the provisions of other Articles of this technical special provision, insure the form(s) to be used for recording and submitting the data are approved prior to performing the tests. Record the test results directly upon the approved forms as the tests are performed, recopying the data onto the forms from informal field notes is not acceptable. Record all data with ballpoint pen or other non-erasable and non-water-soluble writing media; strike-thru and initial errors or corrections in such a manner that the original is still readable.

- Identify each measurement item or group of items with the measurement date and approximate measurement time to the nearest quarter hour.

END OF SECTION
2138.B CONDUCTORS

1. Description
   A. General: This article amends Item 620 – Electrical Conductors. Refer to Standard Electrical Details ED (2) -03, as amended herein.
   B. Submittals. Submit catalog data for each type of conductor.

2. Materials
   A. Prequalified Materials. Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   B. Single conductor insulated wire. Insulation shall be XHHW-2 rated 600 VAC unless otherwise noted.
   C. Conductors. Insulated conductors of seven or nineteen strand copper, minimum 98 percent conductivity and connector accessories for copper shall be furnished in sufficient quantities for a complete installation. No aluminum or solid copper conductors shall be used. In cases of low level audio or digital signals, twisted shielded pairs will be used when required.
   D. Minimum conductor size. Use no wire smaller than No. 12 AWG for power and lighting circuits and no smaller than No. 14 AWG for control wiring, except that control wiring within a cabinet may be No. 16 AWG. Minimum field wire size No. 12 AWG for control and No. 10 AWG for motor loads. Use No. 10 AWG for 20 A, 120 VAC, branch circuit home runs longer than 75 feet, and for 20 A, 240 VAC, branch circuit home runs longer than 200 feet.
   E. Flexible Cables. Use Type SOOW or Type W flexible cable with soft bare annealed copper conductor, with ethylene propylene-diene monomer (EPDM) rubber insulation and a black chlorinated polyethylene (CPE) rubber outer jacket. Use 4 Conductor, with ground, No.2 AWG, 36 conductor No. 12, and 20 Conductor No. 10. Connect the flexible cables to the junction boxes with hubs and watertight “CGB” type compression cable terminating hubs, with integral stainless steel, basket weave, strain relief grips.

3. Construction
   A. Field verification of lengths: Routing shown is approximate unless dimensioned. Route wire and cable as required for project conditions. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
   B. Continuous conductor. All conductors shall be continuous from termination point to termination point. No splicing will be permitted (except for “pigtail” leads and lighting circuits).
   C. Motor Connections. Use one or two hole compression lugs on both feeder and motor leads. Do not use split bolts. Lug connections shall be made with high pressure indent connector tools as recommended by the lug manufacturer. Tighten all connections to manufacturer’s recommendations. Identify each conductor with its circuit number or other designation indicated in the Plans.
   D. Splices. Use insulated, set screw type connectors for “pigtail” splices. Splices are allowed in outlet boxes and conduit bodies, only.
   E. Inspections. Inspect wire and cable for physical damage and proper connection. Each circuit shall be tested for continuity, short-circuits, and insulation resistance for its complete length before being connected to its load. Identification numbers shall also be verified for the entire length of the circuit.
F. **Testing.** The insulation resistance test shall be performed at 500 V<sub>DC</sub> for one-half (½) minute. Minimum insulation resistance for new cable shall be 5 mega-ohms or greater. Insulation resistance must be determined with all motor control centers, panelboards, switches, and over current devices in place; the insulation resistance when tested at 500 V<sub>DC</sub> shall be no less than 5 mega-ohms. Test results shall be recorded and witnessed by the Engineer. Submit test results to the Engineer for review, prior to energizing the circuit. A Table of the test results shall be included with the “as-built” drawings with additional columns left blank for future readings to be recorded.

END OF SECTION

2138.C GROUNDING

1. **Description**
   
   A. **General.** The electrical power and control system shall be grounded in accordance with the National Electrical Code. Furnish and install ground rods, and grounding conductors as shown in the plans. Refer to Standard Electrical Details ED-(3)-03, as amended herein.
   
   B. **Submittals.** Provide catalog data, including dimensions and drawings, for each type of ground rod, clamp, well, and associated hardware.

2. **Materials**
   
   A. **Prequalified Materials.** Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   
   B. **Grounding conductors** shall be insulated unless otherwise noted in the plans. Conductors shall be soft drawn annealed copper.
   
   C. **Ground rod** shall be 5/8 inch diameter, 8 feet, copper clad steel.

3. **Construction**
   
   A. **Ground Conductors.** Provide a dedicated ground conductor, with green insulation in each conduit in which voltage of the current carrying conductors exceeds 50 volts. Grounding conductors in any conduit shall be sized in accordance with NEC Table 250.122, or the same AWG as the largest current carrying conductor in the conduit, whichever is larger.
   
   B. **Ground Rods.** Provide a ground rod and well at the service entrance main disconnect switch in accordance with the National Electrical Code. Locate ground well within 10 feet of the main disconnect switch mounting support. Exothermically weld ground conductor to the ground rod.
   
   C. **Service Entrance.** The service entrance grounding conductor from the case ground to the well shall be No. 2/0 AWG minimum. Install the ground well so that the top of the well is ½ inches above the finished grade and the rod driven to just below the top. Fill well, halfway, with gravel.

END OF SECTION
SUPPORTING DEVICES

1. Description
   A. General. Provide hangers and supporting devices as required by the National Electrical Code and these Technical Special Provisions, where more stringent requirements are described.
   B. Submittals. Provide catalog data for each type of strut, clamp, insert, and associated hardware. Provide dimensional data for struts. Provide pullout data for anchors.

2. Materials
   A. Prequalified Materials. Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   B. Corrosion resistance. Use hot dipped galvanized steel, or stainless steel for all mounting bolts, nuts, washers, and other hardware used for fastening boxes, disconnect switches, devices, lighting outlet boxes, conduit clamps, and similar devices. Conform to requirements of ANSI/NFPA 70.
   C. Load capacity. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. Minimum safety factor is 2.0. Framework for supporting boxes, switches, and other externally mounted electrical devices shall be stainless steel.
   D. U-Channel. Use components of the same manufacturer for U-Channel strut systems utilizing bolted construction. Use stainless steel, 12 gauge and 1-½ inch width minimum.

3. Construction
   A. Cutting support steel. Cut square, grind smooth and de-burred all cut offs. Where galvanizing has been removed, coat with zinc rich, “Cold Galvanizing”, paint.
   B. Attachments. Attachment to steel or concrete shall be by 316 series stainless steel or hot dipped galvanized straps or hangers held at not less than two points by galvanized bolts or lag screws. Install surface-mounted cabinets and panelboards with minimum of four anchors. Do not use powder-actuated anchors. Do not drill or weld structural steel members.
   C. Spacing. Space conduit supports at no more than 5 foot intervals.
   D. Fasteners. Bolt heads and nuts shall be hexagonal with spring lock washers under all nuts. Bolts smaller than 3/8 inch in diameter shall not be used except as may be necessary to fit the mounting holes in small devices, outlet boxes, and similar standard equipment. Fasten hanger rods, conduit clamps, and outlet and junction boxes to structure using proper fasteners.
   E. Restrictions. Do not fasten supports to piping, ductwork, mechanical equipment, or other conduit. In addition, do not allow piping, or other trades to fasten to electrical conduits and supports.

END OF SECTION
1. **Description**
   A. **General.** This article amends Item 618 - Conduit.
   B. **Submittals.** Provide catalog data for each type of conduit and fitting. Provide conduit layout drawings, showing routing and penetrations.

2. **Materials**
   A. **Prequalified Materials.** Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   B. **Electrical Metallic Tubing.** Do not use non-metallic flexible conduit, aluminum conduit, or electrical metallic tubing (EMT).
   C. **Liquid-Tight Flexible Metal Conduit.** Furnish and install liquid-tight flexible metal conduit (UL 360) Interlocked galvanized steel construction with integral ground continuity and PVC jacket. Use only hot dipped galvanized or stainless steel fittings.
   D. **Nonmetallic Conduit.** Furnish and install Non-metallic Schedule 40 PVC conduit meeting the requirements of NEMA TC 2 and Fittings and Conduit Bodies meeting the requirements of NEMA TC 3.

3. **Construction**
   A. **Schedule 40 PVC.** Use 2” inch minimum size Schedule 40 PVC for underground installations, only.
   B. **Pull boxes.** Use pull-boxes wherever necessary to facilitate the installation of the conductors. Use conduit hubs to fasten conduit to sheet metal boxes. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system. Install conduits so that they will drain properly and provide drainage tees at low points, where required.
   C. **Conduit Fittings.** Conduits shall not be used for pulling more than ten conductors or for making such turns in conduit runs or for branching conductors, except for indoor wiring to lighting fixtures and receptacles. At any point where a conduit crosses an expansion joint, or where movement between adjacent sections of conduit can be expected, install bronze or alloy expansion fittings.
   D. **Arrangement.** Conduit and circuits indicated in the Plans, diagrams, and schedules may be recombined in the field where appropriate and as approved by the Engineer. Arrange conduit to maintain headroom and present neat appearance. Route exposed conduit parallel and perpendicular to the structure. Maintain adequate clearance between conduit and piping. Conduits mounted exteriorly on parts of the steel work shall be set not less than 1-1/2 inch clear from the supporting structure to prevent accumulation of dirt. Parallel horizontal conduit shall be spaced one inch apart and they shall be securely clamped to the steel work to prevent rattling and wear. The clamps, in general, shall consist of U-bolts attached to angle or channel iron supports bolted to the members. The spacing of the clamps shall not exceed 5 feet of spacing.
   E. **Flexible Conduit.** Use of flexible conduit is allowed only for the connection of motors, limit switches, and other devices that must be periodically adjusted in position. Use flexible conduit with couplings and threaded terminal fittings for all connections between the rigid conduit system and all movable motors, and movable limit switches. The flexible conduit shall be fully interlocked with integral grounding.
   G. **Joining Metallic Conduits.** Conduit sections shall be connected to each other with threaded couplings. Conduits shall be installed so as to be continuous and watertight between boxes or equipment.
H. Cutting. Cut conduit square using saw or pipe cutter; de-burr cut ends. Bring conduit to shoulder of fittings; fasten securely. Long running threads will not be permitted.

I. Joining Non Metallic Conduit. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum. Embedded conduit stub-outs shall be provided with threaded, 316 stainless steel.

J. Bends. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. All field bends shall be long sweep and free of kinks to facilitate the drawing in of conductors without injury to the conductors. Conduit runs shall be made with as few couplings as standard lengths will permit.

K. Cleaning. All conduits shall be carefully cleaned, before and after installation. Use suitable caps to protect installed conduit against entrance of dirt and moisture. Upon completion of the conduit installation, each conduit shall cleared with a tube cleaner equipped with a mandrel of a diameter not less than eighty percent of the nominal inside diameter of the conduit, and shall draw in the conductors. Provide suitable pull string in each empty conduit except sleeves and nipples.

L. Uses not permitted. Do not use plastic straps or plastic hangers. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary support. Do not use electrical equipment enclosures as pull boxes. Only conductors that are immediately associated with the enclosure circuitry may pass through it.

END OF SECTION

2138.F BOXES

1. Description
   A. General. Provide pull boxes and junction boxes as shown in the plans and at locations where more than 8 conductors are gathered.
   B. Submittals. Provide catalog data sheets, including dimensioned drawings, materials, and approvals.

2. Materials
   A. Prequalified Materials. Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   B. Outlet boxes. Wall mounted boxes for wiring devices (toggle switches, duplex receptacle, GFCL) shall be cast metal.
   C. Large Enclosures. All pull boxes, junction boxes, and all other miscellaneous housings used for pulling wires, terminating wires, or otherwise used to install electrical equipment, shall be NEMA 4X stainless steel. The enclosure opening shall be drip proof with a rolled edge. Cover shall be held closed with clamps. Enclosures larger than 12” in any dimension shall be provided with a hinged cover. Hinge shall be stainless steel, continuous, and cover shall be provided with a glued in neoprene gasket. Sheet metal enclosures shall be provided with O-ring sealing hub connectors. All boxes shall be provided with not less than four mounting lugs.
   D. Drain fittings. Provide NEMA 4X drain fittings in all junction boxes.
3. Construction

A. Conduit Entries. The conduit ends projecting into all boxes and enclosures shall be equipped with insulated bushings. No box or enclosure shall be drilled for more conduits than actually enter it. In locations exposed to weather, conduits shall enter boxes on sides or bottom only.

B. Minimum Size. Boxes shall be sized per NEC requirements for the size and number of conduits. Additionally, Junction Boxes shall be sized to include provisions for terminal block wiring clearance. Minimum size shall be 8” x 8” x 4”.

C. Support Framework. Provide support framework for boxes, switches, and other externally mounted electrical devices fabricated from series 300 stainless steel or from structural steel Type A36 not less than 3/8 inch thick, it shall be hot-dip galvanized.

D. Mounting. Device boxes shall be fastened to the mounting surface with not less than four bolts.

E. Fasteners. All mounting bolts, nuts, washers, and other hardware used for fastening boxes, disconnect switches, devices, lighting outlet boxes, conduit clamps, and similar devices shall be hot dipped galvanized, or stainless steel. Bolt heads and nuts shall be hexagonal, and bolts smaller than 3/8 inch in diameter shall not be used except as may be necessary to fit the mounting holes in small devices, outlet boxes, and similar standard equipment.

END OF SECTION

2138.G TERMINAL BLOCKS

1. Description

A. General. Provide terminal blocks for internal circuits, circuits crossing shipping splits, where equipment parts replacement and maintenance will be facilitated and to connect the temporary systems to the permanent systems during phased construction.

B. Submittals. Provide catalog data sheets for each type and rating of terminal blocks. Catalog data shall include voltage and ampere ratings, materials, and dimensioned outline drawings.

2. Materials

A. Prequalified Materials. Where applicable, provide electrical conductors from manufacturers prequalified by the Department.

B. Ratings. All terminal blocks shall be rated 300 V, minimum.

C. Terminal blocks for No. 8 AWG and smaller. Terminal blocks for No. 8 AWG and smaller conductors shall be channel mounted screw cage box clamp type, with vibration proof stainless steel or nickel plated brass screw. Terminal block shall be provided in groups of 12 with interlocking “finger safe” type barriers.
D. **Terminal blocks for No. 6 AWG and larger.** Terminal blocks shall be power distribution blocks, three-pole, suitable for copper conductors, with a UL rated for amperage equal to the largest conductor it accommodates.

E. **Corrosion Resistance.** All current carrying components shall be provided with corrosion resistant plating and nonferrous hardware.

F. **Identification.** Terminal blocks shall be provided with white marking strips.

3. **Construction**
   
   A. **Arrangement.** Group terminals for easy accessibility unrestricted by interference from structural members and instruments.

   B. **Working Clearance.** Provide two inch minimum on each side of each terminal block and between terminals and wire duct to allow an orderly arrangement of all leads to be terminated on the block and to allow for wire labels.

   C. **Number of conductors.** No more than two wires shall be terminated on any one terminal position.

   D. **Identification.** Each terminal block and both ends of each conductor shall be permanently labeled to coincide with the identification indicated on the approved shop drawing schematic and wiring diagrams.

END OF SECTION

2138.H **ELECTRICAL IDENTIFICATION**

1. **Description**
   
   A. **General.** Provide identification for each electrical component including, but not limited to, conduit, wire, panels, boxes, motors, motor controllers, disconnect switches, and control devices.

   B. **Submittals.** Provide catalog data for each type of identification device. Provide an engraving schedule for all laminated name plates.

2. **Materials**
   
   A. **Nameplates.** Provide legend nameplates, engraved three-layer laminate plastic, black letters on a white background, for all major pieces of equipment named in the Plans, and for all control devices.

      Provide nameplates of minimum letter height as scheduled below.

      Panelboards, Switchboards, and Motor Control Centers: ¼ inch; identify equipment designation. 1/8 inch; identify voltage rating and source.

      Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 1/8 inch; identify load served.

      Individual Circuit Breakers, Switches, and Motor Starters in Panelboards, Transformers: ¼ inch; identify equipment designation.
1/8 inch; identify primary and secondary voltages, primary source, and secondary load and location.

Switches, control relays, timers and other control devices: 1/8 inch; identify load and source and tag identification number.

Control Panel switches, pushbuttons, indicating lights, meters: 1/8 inch; identify function (Raise, Lower, Pull, Drive, etc.). These nameplates shall be in addition to the lettering provided on the switch, button or light face.

B. Conduit Identification. Provide adequate marking of primary conduits which are exposed, or concealed in accessible spaces, to distinguish each run as either a power or signal/communication conduit. Except as otherwise indicated, use orange banding with black lettering. Provide snap-on type plastic markers. Indicate voltage ratings of conductors where 240 V or above. Locate markers at both ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduits pass through walls, floors or into non-accessible construction, and at spacings of not more than 50 feet along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than one inch.

Both ends of each marked conduit run and on each side of wall or floor penetrations shall be provided with a brass tag having a number stamped thereon in accordance with the conduit diagrams. These tags shall be securely and permanently fastened to the conduit ends with bare copper or stainless steel wire.

C. Wire Identification. Furnish wire and cable markers of Vinyl cloth labels, split sleeve, or tubing type. Number shall be as indicated in the Plans or the approved shop drawings, if not shown in the plans. Provide wire labels on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Provide wire markers on each conductor at terminal blocks.

3. Construction

A. Preparation. Degrease and clean surfaces to receive nameplates and cloth labels. Install nameplates and cloth labels parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets, or approved adhesive.

B. Attachment. Secure nameplates to inside of recessed panelboard doors in finished locations. Use embossed tape only for identification of individual wall switches and receptacles, control device stations.

END OF SECTION
2138.I   PANEL BOARD

1.   Description

   A.   General. Furnish and install, a dead-front panelboard incorporating
switching and protective devices of the number, rating, and type
noted in this Technical Special Provision or shown on the Plans.

   B.   Submittals. Include catalog data for panel board and circuit
breakers. Dimensioned drawing for panel enclosure, detailing
mountings and door hardware, voltage, ampere, and short circuit
ratings for all circuit breakers and the overall panel board assembly.
Provide a circuit directory listing each branch circuit and the circuit
breaker rating.

2.   Materials

   Provide a Panel Board with readymade interlocking of alternate source main circuit breakers,
Reliance Controls T1R1010DR or approved equal.

   A.   Rating. The panelboard shall be rated for the intended voltage and shall be in
accordance with the Underwriters' Laboratories, Inc. "Standard for Panelboards"
and "Standard for Cabinets and Boxes" and shall be so labeled where procedures
exist.

   B.   Generator Ready. Panelboard shall be “generator ready” with two, mechanically
interlocked main circuit breakers; one for normal utility power and one for
generator power. Mechanical interlock shall assure that while one circuit breaker
is turned on the other is forced off.

   C.   Enclosure. Panelboard shall have general purpose enclosures and shall be surface
mounted. Enclosure shall be made from galvanized code gauge steel and shall be
of sufficient size to provide a minimum gutter space of six inches on all sides. At
least four interior mounting studs shall be provided.

   A hinged door covering all switching device handles shall be included. Door shall
have cylinder lock and catch. A directory frame and card having transparent cover
shall be furnished .

   D.   Nameplate. A factory nameplate shall be provided listing panel type and ratings.
Panelboard shall be rated for service entrance equipment and shall be so labeled.

   E.   Interior. Panelboard interior shall be completely factory assembled with switching
and protective devices, wire connectors, etc. All terminals shall be suitable for
copper wire of the sizes indicated.

   Interior shall be so designed that switching and protective devices can be replaced
without disturbing adjacent units and without removing the main bus connectors
and shall be so designed that circuits may be changed without machining, drilling,
or tapping. Branch circuits shall be arranged using double row construction. Bus
bars for the mains shall be copper and sized in accordance with Underwriters’
Laboratories standards. Unless otherwise noted, full size neutral bars shall be
included. Bus bar taps for panels with single pole branches shall be arranged for
sequence phasing of the branch circuit devices. The short circuit rating of the
assembled panelboard shall be 22k AIC in accordance with Underwriters’
Laboratories standards and their test verification. Phase bussing shall be full height
without reduction. Cross and center connectors shall be copper. Neutral bussing
shall have a suitable lug for each outgoing feeder requiring a neutral connection.
Spaces for future switching and protective devices shall be bussed for the
maximum device that can be fitted into them.
F. **Circuit Breakers.** Electrical circuits, including circuits shown on drawings, shall be protected by molded case circuit breakers. Each pole of these breakers shall provide inverse time delay and instantaneous circuit protection. The breakers shall be operated by a toggle type handle. They shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free from the handle. Include provisions so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping because of overload or short circuit shall be shown by the handle automatically assuming a position midway between the manual ON and OFF positions. Multi-pole breakers shall have a single operating handle. All poles shall be so constructed that they open, close, and trip simultaneously.

Breakers must be completely enclosed in a molded case, bolt-on type construction. Plug-in type circuit breakers are not acceptable. Tandem type circuit breakers are not acceptable.

3. **Construction**
   A. Install the panelboard in accordance with NEMA PB 1.1.
   B. Provide a typed circuit directory listing each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads. Each branch circuit in a panelboard shall be identified. Panelboards with covers and directory pockets shall have typewritten directories.

END OF SECTION
WIRING DEVICES

1. Description
   A. General. Furnish and install switches and receptacles as shown in the plans.
   B. Submittals. Provide catalog data sheets for each type of wiring device. Catalog data shall include voltage and ampere ratings, dimensions and outline drawing or photograph.

2. Materials
   A. Prequalified Materials. Where applicable, provide electrical conductors from manufacturers prequalified by the Department.
   B. Toggle Switches. Toggle Switches shall be rated Heavy-duty use, totally enclosed type with bodies and handles of thermosetting plastic, supported on a metal mounting strap. Wiring terminals shall be of the screw type, side-wired. Back-wired, stab in type terminals are not allowable. Switches shall be snap type with toggle handle, rated quiet type, AC only, 20 A, 120/277 VAC, single pole.
   C. Receptacles. All Receptacles rated shall be Ground Fault Circuit Interrupter (GFCI) receptacles duplex feed-through type, convenience receptacle with integral ground fault current interrupter rated 125 VAC and 20 A capable of detecting a current leak of 5 mA. Receptacles shall be connected to protect the local load without disruption of the rest of the circuits.

3. Construction
   A. Installation. Install switches and receptacles as shown in the plans. Install switches 42 inches above the finished floor and receptacles 14 inches above floor unless otherwise noted. Install switches with OFF position down. Install surface mounted devices in Type FS or FD boxes. Inside the control house, cover plates shall be 1/16 inch thick satin finished Type 302 stainless steel.
   B. Outdoor locations. For outdoor locations, provide weather proof, corrosion resistant, plates with spring loaded snap covers.

END OF SECTION
DISCONNECT SWITCHES

1. Description
   A. General. Furnish and install, where indicated, a heavy-duty disconnect switch having electrical characteristics, ratings, and modifications shown on the drawings. Provide a service entrance rated, fused disconnect switch for the main disconnect switch.
   B. Submittals. Provide catalog data, installation instructions, and replacement parts list. Catalog data shall include voltage and ampere ratings, construction material, NEMA classification, dimensioned outline drawing. Installation instructions shall include a replacement parts list.

2. Materials
   A. Prequalified Materials. Where applicable, provide a switch from manufacturers prequalified by the Department.
   B. Enclosures. Provide a NEMA Type 4X (stainless steel) enclosure, Equipped with metal factory nameplates, front cover mounted, that contain a permanent record of switch type, catalog number, and ratings.
   C. Interior Components. Switches shall include visible blades, line terminal shields, reinforced fuse clips, non-teasible, positive, quick make-quick break mechanisms with a handle whose position is easily recognizable and is padlockable in the OFF position. The switch assembly and operating handle shall be an integral part of the enclosure base. Switch shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the ON position. Heavy duty switches shall.
   D. Fuses. Fuses shall be time delay, current-limiting type with 200 kA interrupting rating at 600 VAC. Fuses shall be rejection type, UL listed to minimize short circuit damage and shall be applied as follows: UL Class RK1 - Service entrance, transformer feeder and panelboard feeder.

3. Construction
   A. Installation. Refer to Standard Electrical Detail ED (9)-03.

END OF SECTION
1. **Description**
   A. **General.** Furnish and install, lighting fixtures as shown on the plans.
   B. **Submittals.** Provide catalog data including dimensioned drawings, materials, application (indoor, outdoor, etc.) voltage, and wattage ratings.

2. **Materials**
   A. **Type A Fixture.** The fixture shall be a ceiling mount, vapor tight, corrosion resistant fixture with an integral surface mount junction box, a polycarbonate globe and guard. The lamp holder shall be a medium base, brass screw shell type with a nonmetallic enclosure. The lamp shall be a 26 watt, compact fluorescent with an integral 120 VAC ballast.
   B. **Type B Fixture.** The fixture shall be ceiling mount round fluorescent fixture with a white “school house” type globe. The lamp shall be a 26 watt, compact fluorescent with an integral 120 VAC ballast.

3. **Construction**
   A. **Installation.** Install Lighting fixtures plumb, square, level, and in alignment with the structure. Secure the fixtures in accordance with manufacturer's directions and approved shop drawings, complete with all equipment, materials, parts, attachments, devices hardware, hangers, cables, supports, channels, frames, and brackets necessary to make a safe, complete and fully operative installation.
   B. **Damaged Fixtures.** Blemished, damaged, or unsatisfactory fixtures shall be replaced or repaired in a manner satisfactory to Engineer.
   C. **Clean Fixtures.** Upon completion of the installation of the fixtures and at the time of final inspection, all fixtures must be clean and free from defects, and any parts broken prior to the final inspection shall be replaced. Clean paint splatters, dirt, and debris from installed lighting fixtures. Touch up lighting fixture finish at completion of Work.

END OF SECTION
1. Description

A. General. The work involves the partial restoration of the existing control desk, including refurbishing the drum control switch and torque control resistors replacement of indicator lights, pushbuttons, switches, and meters. Furnish and install two control panels and field located limit switches.

B. Design Detailing. The final detailed design of the control system shall be done by the contractor using the contract schematic diagrams, plans, and these Technical Special Provisions, with adjustments as required for the actual equipment being provided.

C. References. All materials and methods will comply with the applicable sections of the latest edition of the following:

- NEMA ISC 2 - Industrial Control Systems - General Standards.
- NEMA ISC 3 - Industrial Systems.
- NEMA ICS 1 - Industrial Control and Systems - General Standards.
- NEMA ICS 2 - Industrial Control and Systems - Controllers, Contractors and Overload Relays Rated not more than 200 VAC or 750 VDC.
- NEMA ICS 4 - Industrial Control and Systems - Terminal Blocks.
- NEMA ICS 5 - Industrial Control and Systems - Control Circuit and Pilot Devices.
- NEMA ICS 6 - Industrial Control and Systems - Enclosures.
- NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type).
- NEMA 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- UL 845 - Motor Control Centers.

D. Submittals. Submittals shall include the following:

Manufacturer’s data sheets for all components (terminal blocks, relays, timers, fuses, circuit breakers, sensors, etc.). Provide instructions for adjusting and resetting time delay relays and timers. Ensure all manufacturers’ data and recommended preventative maintenance procedures and materials are provided.

Dimensioned fabrication details for control desk, main control panel, and other enclosures including, to scale, equipment layouts, punch outs, nameplate schedules, and bill of materials. All components, for which identification numbers have been provided in the Contract plans and Technical Special Provisions, shall be labeled with that number.

A bill of materials. Some means of cross referencing the item identification numbers to the materials list shall be provided; either by schedule or labeling the applicable catalog data sheets.

Engraving schedule for nameplates.

Schematic diagrams including field wiring. Wire numbers shall be assigned and shown for each wire. Field terminals on wiring diagrams shall also indicate these numbers.

Dimensioned details for mounting of limit switches and field control devices.

Procedures for shop test and functional acceptance testing.
2. **Materials**

A. **Control Desk.** The existing control desk is considered to be historic and is to be refurbished using the control devices and indications described in this article.

B. **Cabinets**

1. **Main Control Cabinet, CP-1,** shall be freestanding, NEMA 12 stainless steel enclosure with two doors. Interior surfaces and back panel shall be finished with gloss white lacquer applied over suitable primers. After punching for control devices the top shall be brushed.

2. **Wedge Control Panel, CP-2,** shall be a NEMA 4X stainless steel (12 gauge) enclosure with a pad lockable external circuit breaker operator handle. The doors shall be mechanically interlocked to prevent opening when the operator handle in the closed position. The door shall be provided with a continuous hinge on one side and stainless steel screws and clamps on three sides with oil-resistant gasket all around. A swing out panel shall be provided for local control devices and the door shall conceal the controls. Provide body stiffeners on door for added strength.

C. **Wiring.** Provide interconnection wiring between all electrical devices mounted in the panels and enclosures. If the devices are to be connected to external equipment, they shall be connected to terminal blocks. Conductors shall be UL listed type THWN-MTW. Minimum field installed control wire size within the control console shall be No. 16 AWG, everywhere else use No. 14 AWG minimum wire size. All interior wiring shall be installed neatly and carefully, and shall be terminated on UL approved terminal blocks as per manufacturer's instructions.

Wiring to each control switch shall be individually bundled and shall be installed with a "drop loop" of sufficient length to allow its removal for maintenance without disconnecting the wiring. Plastic wireways (open slot type) shall be used for routing all internal wiring in the panels.

D. **Terminal Blocks**

1. **Terminal blocks.** Provide terminal blocks all for conductors requiring connection to circuits external to the specified equipment. Terminal blocks shall be rail mounted tubular screw clamp type. Terminal blocks shall be grouped for easy accessibility unrestricted by interference from structural members and instruments. Sufficient space (2 inch minimum) shall be provided on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block. No more than two wires shall be terminated on any one terminal position.

2. **Identification.** Identify each terminal block, device, fuse block, terminal, and both ends of each conductor with permanent labels to coincide with the identification indicated on the manufacturer's wiring diagrams. The marking shall be done on a sleeve not less than ½ inch long. Each sleeve shall be marked so that the identification shall be permanent and waterproof. Adhesive type labels are not acceptable.

E. **Indicating Lights:**

1. **Control Desk Indications:** Replace light jewels with salvaged Westinghouse parts. If replacement parts are not available use 120V, candelabra holder for 1” mounting hole with round, faceted lens cap, Dialight Series 031 or approved equal

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2. **CP-1 Indications:** 120V, LED indicator lamp, 30.5mm, corrosion resistant, Allen-Bradley 800H-QRH** or approved equal

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<tr>
<th>Tag</th>
<th>Color</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-TGS1GU</td>
<td>GREEN</td>
<td>TG-S1 UP</td>
</tr>
<tr>
<td>IL-TGS2GU</td>
<td>RED</td>
<td>TG-S2 UP</td>
</tr>
<tr>
<td>IL-TGN1GU</td>
<td>GREEN</td>
<td>TG-N1 UP</td>
</tr>
<tr>
<td>IL-BGU</td>
<td>GREEN</td>
<td>BARRIER UP</td>
</tr>
<tr>
<td>IL-ME</td>
<td>WHITE</td>
<td>SPAN MOTOR ENABLED</td>
</tr>
</tbody>
</table>

3. **CP-2 Indications:** 120V, LED indicator lamp, 30.5mm, corrosion resistant, Allen-Bradley 800H-QRH** or approved equal

<table>
<thead>
<tr>
<th>Tag</th>
<th>Color</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-CTRW1D</td>
<td>GREEN</td>
<td>IN</td>
</tr>
<tr>
<td>IL-CTRW1P</td>
<td>RED</td>
<td>OUT</td>
</tr>
<tr>
<td>IL-CTRW2D</td>
<td>GREEN</td>
<td>IN</td>
</tr>
<tr>
<td>IL-CTRW2P</td>
<td>RED</td>
<td>OUT</td>
</tr>
<tr>
<td>IL-EWBC1D</td>
<td>GREEN</td>
<td>IN</td>
</tr>
<tr>
<td>IL-EWBC1P</td>
<td>RED</td>
<td>OUT</td>
</tr>
<tr>
<td>IL-EWBC2D</td>
<td>GREEN</td>
<td>IN</td>
</tr>
</tbody>
</table>
F. **Control Desk Lighted Pushbutton**: 120V, bright LED type, 30.5 mm, corrosion resistant, heavy duty, oiltight, NEMA 13, with momentary NO contacts. Lens color as indicated. Allen-Bradley 800HC-QRBH2** or approved equal.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Color</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-FC/PB-BS</td>
<td>GREEN</td>
<td>SPAN FULL CLOSED PUSH TO SEAT</td>
</tr>
</tbody>
</table>

G. **Desk Selector Switches**: Switch board type selector switches to match style of the existing. Use Electroswitch Series 25G, or approved equal, with grey escutcheon plate and pistol grip handle. Where possible, use the handles from the existing switches. Provide contact decks as required for switch function.

1. **Two Position, maintained position.**

<table>
<thead>
<tr>
<th>Tag</th>
<th>Legend</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-TL</td>
<td>OFF/ RED</td>
<td>TRAFFIC SIGNALS</td>
</tr>
</tbody>
</table>

2. **Three Position, momentary contact, spring return to center.**

<table>
<thead>
<tr>
<th>Tag</th>
<th>Legend</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-TGSOC</td>
<td>UP/ DOWN</td>
<td>ONCOMING GATES</td>
</tr>
<tr>
<td>SS-TGNOG</td>
<td>UP/ DOWN</td>
<td>OFF GOING GATES</td>
</tr>
<tr>
<td>SS-BG</td>
<td>UP/ DOWN</td>
<td>BARRIER GATE</td>
</tr>
<tr>
<td>SS-GRP</td>
<td>UP</td>
<td>GROUP RAISE</td>
</tr>
<tr>
<td>SS-CTRW</td>
<td>IN/OUT</td>
<td>CENTER WEDGES</td>
</tr>
<tr>
<td>SS-EWBC</td>
<td>IN/OUT</td>
<td>B.C. WEDGES</td>
</tr>
<tr>
<td>SS-EWORG</td>
<td>IN/OUT</td>
<td>ORG WEDGES</td>
</tr>
</tbody>
</table>

H. **Control Desk Meter Switches**: Switch board type selector switches to match style of the existing. Use Electroswitch Series 25G, or approved equal, with grey escutcheon plate and knurled handle. Where possible, use the handles from the existing switches.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Legend</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMS</td>
<td>OFF/ L1-L2 / L2-L3 / L1-L3 / L1-G / L2-G / L3-G</td>
<td>VOLTS</td>
</tr>
<tr>
<td>AMS</td>
<td>OFF / L1 / L2 / L3</td>
<td>AMPERES</td>
</tr>
</tbody>
</table>

I. **Control Desk Momentary Toggle Switches**: Industrial grade, three position, single pole double throw, momentary contact with spring return to center “off” position. 15 amp, 120 VAC, Brown toggle. Bryant 4821 or approved equal. Provide metal, three gang cover plates, with raised switch guards.
### J. Control Desk Maintained Toggle Switches

Industrial grade, single pole, single throw, maintained position. 15 amp, 120 VAC, Brown toggle. Bryant 4801B or approved equal.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Legend</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-TGBY</td>
<td>UP / DOWN</td>
<td>GATE BYPASS</td>
</tr>
<tr>
<td>SS-BGBY</td>
<td>UP / DOWN</td>
<td>BARRIER BYPASS</td>
</tr>
<tr>
<td>SS-EWBY</td>
<td>IN / OUT</td>
<td>END WEDGE BYPASS</td>
</tr>
<tr>
<td>SS-CTWBY</td>
<td>IN / OUT</td>
<td>CENTER WEDGE BYPASS</td>
</tr>
<tr>
<td>SS-BSBY</td>
<td>CLOSED</td>
<td>SPAN BYPASS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tag</th>
<th>Legend</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sb</td>
<td>ON / OFF</td>
<td>MACHINERY LIGHTING</td>
</tr>
<tr>
<td>N/A</td>
<td>SPARE</td>
<td>FUTURE</td>
</tr>
<tr>
<td>N/A</td>
<td>SPARE</td>
<td>FUTURE</td>
</tr>
</tbody>
</table>

### K. Control Panel Selector Switches

Three position, momentary, spring return to center, gloved hand type lever operator, one N.O. and one N.C. contact in each position, 30.5mm corrosion resistant, heavy duty, oil tight. Allen Bradley 800H-JR91** or approved equal.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-CTRW1</td>
<td>CENTER WEDGE 1 OUT/AUTO/IN</td>
</tr>
<tr>
<td>SS-CTRW2</td>
<td>CENTER WEDGE 2 OUT/AUTO/IN</td>
</tr>
<tr>
<td>SS-EWBC1</td>
<td>B.C. END WEDGE 1 OUT/AUTO/IN</td>
</tr>
<tr>
<td>SS-EWBC2</td>
<td>B.C. END WEDGE 2 OUT/AUTO/IN</td>
</tr>
<tr>
<td>SS-EWORG1</td>
<td>ORG END WEDGE 1 OUT/AUTO/IN</td>
</tr>
<tr>
<td>SS-EWORG2</td>
<td>ORG END WEDGE 2 OUT/AUTO/IN</td>
</tr>
</tbody>
</table>

### L. ON – OFF /Emergency Stop

Key Released mushroom button operator, 30.5 mm, corrosion resistant, heavy duty, oil tight, with maintained contacts, 2 contact (min), closed when button pulled out, open when button pushed in, 1 contact (min), open when button pulled out, closed when button pushed in. Allen-Bradley 800T-E1544M6A or approved equal.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Color</th>
<th>Nameplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB-ESTOP</td>
<td>RED</td>
<td>CONTROL POWER/EMERGENCY STOP</td>
</tr>
</tbody>
</table>

### M. Ammeter and Volt Meter

4-1/2”, Rectangular style analog meter with iron vane movement.

Ammeter 5 amp movement, with 0-150 Amp range and 30:1 ratio, external donut current transformer. Simpson Model 59-01410 or approved equal.

Voltmeter 0-300 volt range. Simpson Model 59-08810 or approved equal.
1. Machine Control Relays:

Contacts: NEMA ICS 1, Form C, 2 or 4 pole double throw, horsepower rated.
Contact Ratings: NEMA ICS 1; Class A300, 10 amps, or 1/3 horsepower at 120 VAC.
Coil Voltage: 120 VAC, 60 Hz.
Provide indicating lamp or LED across coil.
Provide push-to-test button.
Clear dust cover and spade terminals.
Socket mounted. Socket shall be track mounted.

2. Contactors:

Lighting type contactors
Open frame type
Electrically held
20 amps contacts min., (field convertible) other rating as show in Plans
Coil voltage: 120 VAC, 60 Hz.

3. Combination Motor Circuit Protector and Motor Starter

All motor starters shall be Combination Motor Starters with disconnecting means. Disconnecting means shall be a Motor Circuit Protector (MCP), or MCP with Current Limiter. Motor starters shall be built and tested in accordance with the latest NEMA standards. Combination motor starters shall be equipped with three NEMA Class 20 overload relays. All AC magnetic controllers shall be designed for full voltage or across-the-line, reversing or non-reversing, starting of induction motors rated in horsepower. Starter shall provide for field installation of up to 3 N.O. and 4 N.C. NEMA ICS 2, Class A300, auxiliary contacts in addition to the hold-in interlock. A minimum of two Normally Open and two Normally Closed contacts shall be supplied with each magnetic motor starter. Provide additional contacts if required. Provide starters with encapsulated coils and enclosure as required to meet conditions of installation. Overload relays should be block-type with a push-to-test feature.

O. Solid State Time Delay Relays

NEMA Class A300 solid-state time-delay relay with adjustable time delay on energization or time delay on deenergization, as indicated in Plans. Contacts rated 10 amps minimum, 240 VAC resistive.
Time adjustment - knob type.
Coil voltage as indicated on the drawings. Furnish and install surge suppressor on each coil.
Socket mounted. Socket shall be track mounted.

P. Limit Switches

Use magnetically actuated, hermetically sealed limit switches. Contacts shall be double pole, double throw and rated for 10 amps at 120 volts a.c. Enclosure housing may be stainless steel or brass. GO Switch Series 81 or approved equal.

3. Construction

A. Control Desk. The control desk requires special instructions due to its historic significance.
1. **Enclosure.** Carefully remove the control desk and resistor bank from the operator house. Remove all of the components from the control desk. Strip paint from the metal enclosure to bare metal, prime, and then paint with a matte finish, black enamel. Paint the interior of the enclosure white. Clean, but not paint the slate top. Polish the brass manufacturer’s nameplate. Install new components and devices. Where large cover plates must be used, (such as for the meters and switches that are smaller that the originals) use 1/8 inch acrylic sheet. Bevel the edges.

2. **Panel Board Switches.** Replacement panel board switches must have operator shafts the same length as the existing switches. It is desirable to use the pistol grip handles from the original switches for historic reasons.

3. **Drum Controller.** Disassemble and clean the drum controller mechanism and contacts. Replace the asbestos shields with a suitable insulating material.

4. **Indicator lights.** Replace indicator light jewels. If replacements cannot be found, the replacement indicator lights are intended to replicate the original with faceted jewel lenses. Some modifications to the holes in the slate may be required to accommodate the new lamp holders.

5. **Meters and switches.** Install meters and switches as shown on the plans. Cover plates may be required to compensate for differences in dimensions.

6. **Toggle Switches.** Install toggle switches and 3-gang face plates as shown on the plans. Some modifications to the holes in the slate may be required.

7. **Siren Button.** Reuse the existing push button and cover plate. Clean and paint the cover plate.

8. **Terminals.** Mount terminal blocks on the back wall of the enclosure. Provide a terminal for each interconnecting wire from outside the control desk.

B. **Control Panels CP-1 and CP-2.** Fabricate control panels CP-1 and CP-2 as shown on the plans.

C. **Limit Switches.** Install limit switches in accordance with manufacturer's instructions. Provide all mounting hardware and supports as required. Method of mounting and hardware shall allow for field adjustment at construction and for future maintenance. Terminate all limit switches on terminal blocks. Drainage “T” shall be installed below takeoff for limit switches on all applicable conduit runs. Limit switch target materials, shapes, and mounting methods shall be submitted to the Engineer, for review, prior to installation. After installation, test switches, in the presence of the Engineer, to determine if operation is as intended. Switches should relay signal to the control console at intended "point of operation." Switches should provide positive indications with no intermittent signals or flickering of lights on control console. Adjust position of switches as required.

D. **Shop Testing.** Prior to shipment, functionally test the complete control system (control desk and both control panels) together to assure completeness and correct operation of the entire bridge control system. The Engineer will witness the testing as a complete control system. Testing shall include simulation of all control functions.
Field input devices shall be simulated with toggle switches and output devices shall be verified with indicator lights. The testing will be under the direction of the control system vendor, but shall be paced by the Engineer or his representative.

Prepare and submit a complete set of test procedures and schedules for approval. Sufficient notice of 30 days prior to testing will be given to the Department so that the arrangements may be made. Procedure shall be a step-by-step description of all semi-automatic actions or simulations and the expected control response, output, or sequence of outputs.

All discrepancies or other non-conformance issues, as determined by the Engineer or his representative, shall be corrected prior to shipment at no cost to the Department. If retesting is required, it shall be performed at no additional cost to the Department. A full set of “As-Shipped” schematic drawings and software listings shall be furnished to the Engineer prior to shipment to the Bridge site.

E. Operating Sequence

1. Fully Closed, Static Condition

   - Traffic Gates and Barrier up and open.
   - Wedges are driven.
   - Leaf is fully closed.

2. Opening Sequence

   a. Turn control Power On.
      (1) Indicating lights turn on as follows:
         - Traffic Lights: OFF.
         - Traffic Gates: UP
         - Barrier Gate: UP
         - Wedges: DRIVEN
         - Leaf: FULL CLOSED.
   b. Press SIREN pushbutton to sound siren.
   c. Turn traffic signal selector switch to Red.
      (1) Gate lights flash and gongs start.
      (2) After a 15 second delay, oncoming traffic gates may be lowered.
   d. Turn and hold the on coming traffic gate selector switch to DOWN position.
      (1) Traffic gates begin to lower. If selector switch is released, the gates will stop.
      (2) Red closed indicator lights (on CP-1) turn on when on coming gates are not fully up.
      (3) Green open indicator lights (on CP-1) turn off when on coming gates are fully down.
      (4) When oncoming traffic gates are fully down, the off going gates may be lowered.
      (5) When oncoming traffic gates are not fully up, the traffic signals may not be turned off.
   e. Turn the off going traffic gate selector switch to DOWN position, momentarily.
      (1) Traffic gates begin to lower.
      (2) Red closed indicator lights (on CP-1) turn on when off going gates are not fully up.
      (3) Green open indicator lights (on CP-1) turn off when off going gates are fully down.
      (4) When off going traffic gates not fully up, the oncoming traffic gate may not be raised.
(5) When off going traffic gates are fully down, the gates down light on the control desk lights, the gates up light turns off, the gongs turn off, and the barrier gate may be lowered.

f. Turn the barrier gate selector switch to DOWN position, momentarily.
   (1) The barrier gate begins to lower.
   (2) Red closed indicator light (on control desk) turns on when the barrier gate is not fully up.
   (3) Green open indicator light (on control desk) turns off when the barrier gate is fully down.
   (4) When the barrier gate is not fully up, the off going traffic gates may not be raised.
   (5) When the barrier gate is fully down, the center wedges may be pulled.

g. Turn Center Wedges selector switch to OUT position, momentarily.
   (1) The Center Wedges begin to pull.
   (2) Red PULLED indicator lights turn on when the wedges are not fully driven.
   (3) Green DRIVEN indicator lights turn off when the wedges are fully withdrawn.
   (4) When either wedge is not fully driven, the barrier may not be raised.
   (5) When the center wedges are fully withdrawn, the center wedge control is enabled.

h. Turn B.C. End Wedges selector switch to OUT position, momentarily.
   (1) The Bridge City end wedges begin to pull.
   (2) Red PULLED indicator lights turn on when the wedges are not fully driven.
   (3) Green DRIVEN indicator lights turn off when the wedges are fully withdrawn.
   (4) When either wedge is not fully driven, the center wedges may not be driven.

i. Turn ORG End Wedges selector switch to OUT position, momentarily.
   (1) The Orange end wedges begin to pull.
   (2) Red PULLED indicator lights turn on when the wedges are not fully driven.
   (3) Green DRIVEN indicator lights turn off when the wedges are fully withdrawn.
   (4) When either wedge is not fully driven, the center wedges may not be driven.
   (5) When all of the end wedges are fully withdrawn, the span motor is enabled and the white “SPAN MOTOR ENABLED” light is turned on.

j. Turn the drum switch to slowly, (one step per second) in the OPEN direction to accelerate the bridge.
   (1) Step 1 releases the motor brake.
   (2) Each successive step increases the motor torque and the span is accelerated accordingly.
   (3) The span will turn at a constant speed until the drum switch is turned back toward the center. With each step down, torque is reduced and the span will decelerate.
   (4) At the nearly open position, the motor will de-energize, the brake will set and the span will stop.
   (5) Turn the drum switch back to center to reset the span relay, and then slowly turn to open again, but no more than Step 4 or the span will stop and must be reset again.
   (6) The span will operate at reduced torque and speed until it reaches the fully open position, where a limit switch de-energizes the motor. The brake does not set until the drum switch is returned to center position.

3. Closing Sequence
   a. Press SIREN pushbutton to sound the siren.
b. Turn the drum switch to slowly, (one step per second) in the CLOSE direction to accelerate the bridge.

(1) Step 1 releases the motor brake.
(2) Each successive step increases the motor torque and the span is accelerated accordingly.
(3) The span will turn at a constant speed until the drum switch is turned back toward the center. With each step down, torque is reduced and the span will decelerate.
(4) At the nearly closed position, the motor will de-energize, the brake will set and the span will stop.
(5) Turn the drum switch back to center to reset the span relay, and then slowly turn to close again, but no more than Step 4 or the span will stop and must be reset again.
(6) The span will operate at reduced torque and speed until it reaches the fully closed position, where a limit switch de-energizes the motor. The brake does not set until the drum switch is returned to center position.
(7) The span fully closed light is also the span seating button. If the drive motor de-energizes and the span drifts away from the fully closed position before the brake sets, turn the drum switch to Step 1 to release the brake then press the fully closed lighted pushbutton. The span motor will energize at reduced torque to jog the span into the fully closed position. If the span motor needs more torque the drum switch may be stepped up but no more than Step 4. When the fully closed light turns on, quickly turn the drum switch to center position and then release the button.

c. Turn ORG End Wedges selector switch to IN position, momentarily.

(1) The ORG End Wedges begin to drive.
(2) Green DRIVEN indicator lights turn on when the wedges are not fully withdrawn.
(3) Red PULLED indicator lights turn off when the wedges are fully driven.
(4) When either end wedge is not fully pulled, the span motor control is disabled and the white “SPAN MOTOR ENABLED” light is turned off.

d. Turn B.C. End Wedges selector switch to IN position, momentarily.

(1) The B.C. End Wedges begin to drive.
(2) Green DRIVEN indicator lights turn on when the wedges are not fully withdrawn.
(3) Red PULLED indicator lights turn off when the wedges are fully driven.
(4) When the end wedges are fully driven, center wedges may be driven.

e. Turn Center Wedges selector switch to IN position, momentarily.

(1) The center wedges begin to drive.
(2) Green DRIVEN indicator lights turn on when the wedges are not fully withdrawn.
(3) Red PULLED indicator lights turn off when the wedges are fully driven.
(4) When either center wedge is not fully pulled, the end wedges are disabled.
(5) When the center wedges are fully driven, the barrier and traffic gates may be raised.

f. Turn the Group Raise selector switch to UP position, momentarily.

(1) The barrier gate begins to rise. Gongs turn on.
(2) Green open indicator light turns on when the barrier gate not fully down.
(3) Red closed indicator light turns off when the barrier gate is fully up.
(4) When the barrier gate is not fully down, the center wedges may not be pulled.
(5) When the barrier gate is fully up, the off going traffic gates begin to rise.
(6) Green open indicator light turns on when the off going gates are not fully down.
(7) Red closed indicator light turns off when the off going gates are fully up.
(8) When the off going gates are fully up, the oncoming traffic gates begin to rise.
(9) Green open indicator light turns on when the oncoming gates are not fully down.
(10) Red closed indicator light turns off when the oncoming gates are fully up.
(11) When the oncoming gates are fully up, the gongs turn off and the flashing red signals may be turned off.

g. Turn traffic signal selector switch to off.
   (1) Flashing red signals lights turn off.
   (2) Traffic gates may not be operated.

h. Turn control Power Off.
   Indicating lights turn off.

4. **Bypass Switch Operation**

Bypass switches are key operated, selector switches with momentary contact, spring return to center. Bypass switches are to be used only in the event of a limit switch failure.

a. **Traffic Gate Bypass**
   (1) Traffic gate down bypass allows:
      (a) Off going gates to be lowered in the event of gate down limit switch failure on the complementary oncoming gate.
      (b) Barrier to be lowered in the event of a gate down limit switch failure on an off going gate.
      (c) Wedges to be pulled in the event of a gate down limit switch failure on any gate.
   (2) Traffic gate up bypass allows:
      (a) Oncoming gates to be raised in the event of gate up limit switch failure on the complementary off going gates.
      (b) Traffic signals to be switched off in the event of failure of any traffic gate up limit switch.

5. **Barrier Gate Bypass**
   a. Barrier gate down bypass allows the end wedges to be pulled in the event of a gate down limit switch failure on any gate.
   b. Barrier gate up bypass allows off going traffic gates to be raised in the event of barrier up limit switch failure.

6. **Wedge Bypass**
   a. Wedges pulled bypass allows the span drives motors to be operated in the event of a wedge pulled limit switch failure.
   b. Wedges driven bypass allows the barrier gate to be raised in the event of a wedge driven limit switch failure.

7. **Bridge Seated Bypass**
   Allows the wedges to be driven in the event of a leaf fully closed limit switch failure.

8. **Emergency Stop**
   The lighted emergency stop button removes control power from all motor driven bridge system equipment.
If the emergency stop button is pushed during a leaf movement, the motors will immediately be de-energized and the brakes will automatically set. The button must be pulled back out to restore control power.

END OF SECTION
1. Description
   A. General. Furnish and install 4 traffic gates, and 1 traffic barrier at locations shown on the Plans. Furnish and install warning Gongs on traffic gate assembly enclosures on the right side of the roadway.
   B. References. All materials and methods will comply with the applicable sections of the latest edition of the following:
      AASHTO Standard Specifications For Movable Highway Bridges
   C. Submittals. Submit Manufacturer's data sheets for each gate assembly, including arms, gongs, and lights. Include drawing for dimension and interconnect wiring for each gate. Submit installation instructions, operation and maintenance data. Submit foundation designs, including anchor bolt sizing calculations, signed and sealed by a Texas register Professional Engineer.

2. Materials
   A. Traffic Gates. Traffic gates shall be vertical to horizontal type. B&B Roadway Model VW-4, or approved equal. Operating machinery shall be electrically operated with manual cranking ability at locations shown in the Plans.
      1. Operating arms. Furnish and install operating arms equipped with steel, hot-dip galvanized, sectional bolt-on counterweights with at least 10 percent adjustment. Anchorages for new gate installations on gate pilasters shall be sized per Manufacturer's recommendations and made by drilled anchor bolts, set with epoxy adequately sized to support all attachments.
      2. Operating time. During the opening and closing cycles, the gate arm shall begin with zero velocity and accelerate smoothly, reaching maximum velocity at mid stroke (45 degrees) then decelerating smoothly to zero velocity at full stroke (90 degrees) without whip or bounce. Standard operating time is 13 seconds for full opening or closing cycle. Sized to handle the weight of the arm used and be able to operate against a wind speed of 50 mph.
      3. Machinery. Furnish and install main arm shafts with a minimum of two inch diameter, ASTM A311 Class B high strength steel, mounted in heavy duty ball bearings and lubricated from inside. Furnish and install a fully enclosed, all gear, direct drive unit running in oil bath and ductile iron gear case. Non-metallic gears, belts, cams, pulleys, linkages, chains or connecting rods are not acceptable in drive train.
      4. Motor. Furnish and install totally enclosed, Class F insulation motors specifically designed for gate actuator capable of operating at full load when the voltage to the motor is ±10 percent of rated voltage; 240 VAC, 3 phase. Ensure the motor has the capacity to perform all necessary functions to the satisfaction of the Engineer based on torque required for gate arm and accessories. Ensure the braking mechanism is equipped with a solenoid release, automatic motor brake that automatically releases when hand crank is inserted. Provide a hand crank to manually raise or lower gate arm in event of power failure. Provide a limit switch that interrupts the control power circuit whenever the hand crank is engaged.
      5. Housing. Fabricate the operator housing from ¼ inch thick welded plate aluminum. Housing shall be painted inside and outside with a coat of zinc chromate primer and finished with baked epoxy resin paint. Equip housing with four one-inch holes and provide anchor bolts and template for installation. Provide front and rear access doors hung on bronze, slip-off type full cross hinges with stainless steel hinge pins.
Doors shall be held in place with padlockable door locks and shall be sealed with neoprene strip gaskets. Limit switches shall be provided on both doors. Door limit switches shall disconnect the control circuit, but shall be defeated (circuit closed) by pulling the plunger out. The limit switch shall automatically reset when the door is closed.

6. **Limit Switches.** Furnish and install limit switch unit assemblies consisting of eight individual switches with one set of normally open and one set of normally closed contacts each. Furnish and install contacts with a UL rating of not less than 10 A at 120 VAC. Use corrosion resistant non-ferrous materials for limit switch body, shafts and cams. Ensure that gear limit switches to the drive mechanism are in step with the actual gate position at all times, whether operation is by power or manual mode. Do not use cams or screws to set the limit switches or designs requiring battery back up methods to ensure position control in the event of power failure.

7. **Electrical Controls.** Equip gate with a manual disconnect switch, reversing full voltage motor starter, and local raise and lower control station.

8. **Terminal blocks.** Install screw clamp, pressure plate type terminal blocks inside the housing on the roadway side and terminate all control wires on terminal blocks and clearly label all circuits. Use No.16 AWG stranded or larger wire. Ensure that the color code or number conductors to match wiring diagram. Complete all electrical connections required to provide proper operation of the traffic gates, lights, gongs, etc.

9. **Gate arms.** Furnish and install gate arms to lengths in the Plans constructed of 6061-T6 rectangular aluminum tubing and fiberglass with ultra-violet treatment. Ensure that the gate arm is covered on both sides with alternating 16 inch reflective red and white engineering grade sheeting. Provide a break-away shear pin base for each gate arm so that when excessive force is applied to arm, the pin shears, the arm shall then swing 45 degrees horizontally and drop free of the gate operator thus minimizing damage to operator. Design shear pin base and lightweight arm assembly for easy, rapid reinstallation or replacement by one person.

10. **Warning lights.** Provide three (3) warning lights on each gate arm with the housing constructed of molded plastic; moisture and corrosion proof with 2 way visibility, seven inch diameter red lenses powered by an LED array. Provide a heavy duty, solid state, fully factory wired, with two alternately flashing circuits and one steady burn circuit with a flash rate of 0.50 seconds ON, 0.50 seconds OFF. Provide all mounting hardware, solid state flashing circuitry, a clearly labeled terminal block, a heat sink, and a transformer when required.

11. **Gongs.** Gongs shall be provided on the sidewalk side traffic gates. Gongs shall be 8 inch bronze or hot dipped galvanized steel shells with motor driven clapper and operate on 120 VAC. Gongs and motor housing shall be designed to be mounted on the top of the gate operator enclosure without brackets or additional fittings and be watertight.

B. **Barrier Gate.** Barrier gates shall be vertical to horizontal type. B&B Roadway Model VR-6 or approved equal.

1. **Barrier arm.** Provide an energy absorbing barrier arm, capable of stopping a 5,000 pound vehicle traveling at up to 50 mph. Arm construction shall be a double rail aluminum tube with three 0.5 inch diameter, 6x25 stranded, series 300 stainless steel cable. The anchorage system shall be a passive design with the entire impact load transferred into the guard rail structure and not into the housing. Anchorage fixtures shall be welded plate carbon steel, hot dipped galvanized after fabrication and
finished with baked epoxy resin paint. Barrier cable anchorage bolts shall be sized by the manufacturer and shall be cast into the guard rail. Cover both sides of the arm with alternating 16 inch reflective red and white engineering grade sheeting.

2. **Mounting tube.** Barrier arm mounting tubes shall be rectangular tube steel sections, hot-dip galvanized with sectional bolt-on counterweights with at least 10 percent adjustment and lights. Attachments for the barrier to the mounting arms and truss cables shall be stainless steel.

3. **Operation.** During the opening and closing cycles, the gate arm shall begin with zero velocity and accelerate smoothly, reaching maximum velocity at mid stroke (45 degrees) then decelerating smoothly to zero velocity at full stroke (90 degrees) without whip or bounce. Standard operating time is 16 seconds for full opening or closing cycle. Sized to handle the weight of the arm used and be able to operate against a wind speed of 50 mph.

4. **Machinery.** Furnish and install main arm shafts with a minimum of 2.25 inch diameter, AISI 4150 steel with a minimum tensile strength of 140,000 psi, mounted in heavy duty ball bearings, lubricated from inside with an o-ring seal on the outside. Furnish and install a fully enclosed, all gear, direct drive unit running in oil bath and ductile iron gear case. The connecting rod shall be AISI 4150. Non-metallic gears, belts, cams, pulleys, linkages, chains or connecting rods are not acceptable in drive train.

5. **Motor.** Furnish and install totally enclosed, Class F insulation motors, operating on 480 volts, 3 phase, and specifically designed for gate actuator. The motor shall be capable of operating at full load when the voltage to the motor is ±10 percent of rated voltage. Ensure the motor has the capacity to perform all necessary functions to the satisfaction of the Engineer based on torque required for gate arm and accessories. Ensure the braking mechanism is equipped with a solenoid release, automatic motor brake that automatically releases when hand crank is inserted. Provide a hand crank to manually raise or lower gate arm in event of power failure. Provide a limit switch that interrupts the control power circuit whenever the hand crank is engaged.

6. **Housing.** Fabricate the operator housing from 0.375 inch thick welded plate carbon steel, hot dipped galvanized after fabrication. Housing shall be finished with baked epoxy resin paint. Equip housing with four one-inch holes and provide anchor bolts and template for installation. Provide front and rear access doors hung on bronze, slip-off type full cross hinges with stainless steel hinge pins. Doors shall be held in place with pad lockable door locks and shall be sealed with neoprene strip gaskets. Limit switches shall be provided on both doors. Door limit switches shall disconnect interrupt the control circuit, but shall be defeated (circuit closed) by pulling the plunger out. The limit switch shall automatically reset when the door is closed.

7. **Anchorage.** Anchorages for the barrier operating housing on gate pilasters shall be sized per Manufacturer's recommendations and made by drilled anchor bolts, set with epoxy adequately sized to support all attachments.

8. **Limit Switches.** Furnish and install limit switch unit assemblies consisting of eight individual switches with one set of normally open and one set of normally closed contacts each. Furnish and install contacts with a UL rating of not less than 10 A at 120 VAC. Use corrosion resistant non-ferrous materials for limit switch body, shafts and cams. Ensure that gear limit switches to the drive mechanism are in step with the actual gate position at all times, whether operation is by power or manual mode.
9 **Electrical controls.** Equip barrier with a manual disconnect switch, reversing motor starter, and local raise and lower control station.

10. **Terminal Blocks.** Install screw clamp, pressure plate type terminal blocks inside the housing on the roadway side and terminate all control wires on terminal blocks and clearly label all circuits. Use No. 16 AWG stranded or larger wire. Ensure that the color code or number conductors to match wiring diagram. Complete all electrical connections required to provide proper operation of the traffic gates, lights, gongs, etc.

11. **Warning Lights.** Provide four (4) warning lights on the barrier arm with the housing constructed of molded plastic; moisture and corrosion proof with 2 way visibility, seven inch diameter red lenses powered by an LED array or strobe. Provide a heavy duty, solid state, fully factory wired, with two alternately flashing circuits and one steady burn circuit with a flash rate of 0.50 seconds ON, 0.50 seconds OFF. Provide all mounting hardware, solid state flashing circuitry, a clearly labeled terminal block, a heat sink, and a transformer when required.

3. **Construction**

   A. **Installation.** Verify system voltage matches gate requirements, Install in accordance with manufacturer's instructions, Make connections to control system, manually test hand crank, and Power test traffic gates to ensure proper operation of gate operator, gate arm lights and gate interlock.

   B. **Adjustments.** Adjust gate arm lengths and heights as shown in the plans.

   C. **Traffic Gates.** Traffic gates shall be vertical to horizontal type. Operating machinery shall be electrically operated with manual cranking ability at locations shown in the Plans.

**END OF SECTION**
1. Description
   A. General. Furnish and install two “Stop Here on Red” signs, each with two
      flashing red signals as shown in the plans.
   B. References.
      Item 636. Aluminum Signs
      Item 643. Sign Identification Decals
      Item 644. Small Roadside Sign Supports and Assemblies
      Item 685. Roadside Flashing Beacon Assemblies
   C. Submittals. Provide catalog data sheets, including dimensioned drawings, materials,
      and approvals.

2. Materials
   Furnish new materials in accordance with the appropriate referenced Item. Where applicable, provide
   materials from manufacturers prequalified by the Department.

3. Construction
   Construct the road side supports, signs, and flashing beacon assemblies in accordance with the
   appropriate referenced Item.

END OF SECTION
NAVIGATION LIGHTS AND SIGNALS

1. Description

A. General. Furnish and Install a navigation lighting system per the Plans and these Technical Special Provisions including the following:

   6 Red Fender Lights.
   2 Red only Span lights
   2 Red and Green sectored swing bridge lights.
   2 Clearance Gauge Floodlights.

B. References. All materials and methods will comply with the applicable sections of the latest edition of the following:


C. Submittals. Submit Manufacturer's data sheets for each light to be provided. Provide dimensioned outline drawings for mounting detail and any mounting/adapter assembly or component.

2. Materials

A. Provide self-contained, solar charged, battery operated, LED navigational lights. Use only USCG 33 CFR Part 66 compliant 2 nautical mile lights.

   1. Red Pier Lights. Fixture shall be a sealed polycarbonate unit with molded in fluted lens, solar charger and bird deterrent. Battery shall be replaceable. Light source shall be ultra-bright red LEDs with a shield to show light in a 180° sector. Use Sealite SL60 or approved equal.

   2. Red Span Lights. Fixture shall be a sealed polycarbonate unit with molded in fluted lens, battery charger and bird deterrent. Battery shall be replaceable with modification for connection to a remote charger. Light source shall be ultra-bright red LEDs showing 360°. Use Sealite SL60 or approved equal.

   3. Red and Green Sectored Span Lights. Fixture shall be a sealed polycarbonate unit with molded in Fresnel lens and bird deterrent. Battery shall be replaceable with modification for connection to a remote charger. Light source shall be ultra-bright red and green LEDs with shield to provide alternating 90° sectors. Use Sealite SL07 sectored light head with SL23 solar charger and battery pack or approved equal.

   4. Gauge Lights. Fixture shall be a flood light type with ultra-bright white LEDs. Fixture housing shall be polycarbonate and shall include a battery compartment. The solar charger may be integral with the fixture or mounted separately. Use Silicon Solar Inc. 54 LED Genlight or approved equal.

3. Construction

Install navigation lights and signals as shown in the plans.

END OF SECTION
1. Description
   A. General. Furnish and install a bridge submarine cable assembly including, submarine cable termination cabinets complete with disconnect type terminal blocks, cable supports, and anchor brackets. Bridge submarine cable installation shall include trenching and backfill.

   The submarine cable assembly will consist of three types of cable: main power cable (4 Conductor No. 2 AWG with ground), motor feeder and control cable (37 No.12 and 18 No.10 AWG). Draka or other approved manufacturer.

   B. Submittals. Prior to obtaining the cables, submit data to the Engineer showing the length needed, minimum bending radius, confirmation that the cables described in this technical special provision have sufficient conductors for the actual needs of this bridge, and certification that cables to be furnished satisfy these Technical Special Provisions. Wiring diagrams shall be included in the submittal.

   Submit drawings showing configuration of conduits entering submarine cable termination cabinet, and details and layout of terminal strips within submarine cable termination cabinet. Submit details of termination cabinets, showing dimensions and mounting arrangement, include calculation for space heaters.

   Submit a certified test report showing that the cable supplied has been tested at the factory and meets all the requirements of this Technical Special Provision.

2. Materials
   A. Submarine Cable.
      1. Conductors. Conductors shall be annealed uncoated copper in accordance with ASTM B-3. Conductors shall be stranded in accordance with ASTM B-8, class "B" concentric stranding.

      2. Insulation. Conductor insulation shall be chemically cross-linked polyethylene (XLPE) compound, meeting the requirements of ICEA (Insulated Cable Engineers Association) Publication #S-66-524 (2nd edition), NEMA Publication WC7-1988. Thickness of the insulation shall be designated by utilizing the following table (Table 3-1 of ICEA S-66-524, NEMA WC7) selecting from the appropriate voltage. The insulation shall be concentrically applied over the copper.

      3. Conductor Identification. Conductor identification of insulated conductors shall be accomplished by surface printed legends consisting of consecutively numbering all conductors of each wire type in each cable. All numbering sequences shall start with the number 1 (one). The marking shall consist of the appropriate number followed by the corresponding spelled-out word or words. Repeat coding sequence at intervals of not more than 2 feet, along the entire length of each conductor. Begin sequence from the inner conductor layer and progress to the outer conductor layer. Employ contrasting color print and be legible after normal handling during installation.


      5. Fillers. The various cable components shall be cabled together and filled if necessary to give the completed cable a substantially circular cross section.
6. **Binder.** Cover the cable assembly with a 20 mil corrugated polyester film separator applied helically with minimum of 25% overlap.


8. **Steel Armor.** The cable armor shall consist of high-density polyethylene coated strands of galvanized plow steel wires. The size and number of strands shall provide a percent coverage of 91% to 97%. Apply the coated armor wires in a left lay helix. Apply cable armor at a nominal lay angle of 18 degrees to 25 degrees in a preformed helix.


10. **Packaging and Shipping.** Packaging of the finished cable shall be on suitable non-returnable reels capable of supporting the weight during transportation and normal handling. Cable ends shall be suitably sealed to prevent moisture from entering the conductor core area during shipment, storage and installation.

B. **Submarine Cable Termination Cabinet.** Submarine cable cabinets shall be NEMA Type 4X, Type 316 stainless steel, constructed of ample size per the National Electric Code, and arranged so that terminal strips, supports and other devices are readily accessible for maintenance, repair, and replacement. Furnish cabinet with hinged doors and stainless steel hinges. The general arrangement and shape of the cabinet shall be such as to fit in with the scheme of installation, which shall be approved by the Engineer. Provide adequate grounding lugs or bus to accept the No. 4/0 AWG Ground cable and other bonding conductors as required.

C. **Cable Support.** Provide submarine cable support assemblies for each power and control sub-cable. Each support assembly shall consist of a galvanized base, ring and associated fasteners. The opening shall be of ample size for submarine cable to pass through (typically twice the cable diameter). Submarine cables (less outer jacket material and armor wire) shall enter the termination cabinet through sealed fittings. Provide basket-weave type cable strain relief fittings.

3. **Construction**

A. **Manufacturer Supervision.** The cable manufacturer shall have a company employee present during the installation procedure to insure that the cable is installed in a manner that will not damage the cable, who can certify that the cable was installed in a manner approved by the manufacturer. A representative of a supplier will not be acceptable.

B. **Trenching.** The cables shall cross the channel permanently buried in trenches. Lay power, signal and control, and ground cables in the same trenches as shown on the plans. Provide adequate equipment for installation of the cables. The bottom of the trench shall be 6 feet below the channel bottom between the fenders or at a depth as required by the US Army Corps of Engineers whichever is greater.

C. **Anchoring and support.** Fasten anchor bases to the pier walls, splay cable armor wire and attach ring. Fasten ring to base to clamp armor wire. The purpose of this assembly is to provide support for the vertical portion of the submarine cable above the channel bottom.

D. **Termination Cabinets.** All cable bends shall be of large easy curvature well within that recommended by its manufacturer (minimum radius of 12 cable diameters). Ends of cable shall not be under water at any time. Provide sealing gland type cable grip for all cable entries into the termination boxes. Terminate all spare conductors within the submarine cable on terminal strips and properly identify.
Make all cable entries in the side or the bottom of the termination cabinets.

**E. Testing.** Test insulation resistance wire-to-wire and wire-to-ground. Testing will be witnessed by the Engineer. Furnish a copy of the test results to the Engineer. Include an additional copy, in tabular format, the O and M manuals to provide a baseline for future measurements.

**END OF SECTION**
1. Description.
   A. General. Refer to the Sections under “Verification Testing” and “Test Result Reporting” in this Electrical Technical Specification for additional details and information on this item.

2. Materials
   A. Not applicable to this section.

3. Construction
   A. Clean, polish and make ready all fixtures, equipment, system components and materials thoroughly in preparation for verification testing. Remove all excess material, debris and unnecessary supplies from the project site. Place all electrical and mechanical systems in complete working order before requesting or performing final verification testing from the Engineer.
   B. Assure mechanical and electrical systems function completely and interface correctly with all other systems. Make good on any faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and to the complete satisfaction of the Engineer.

END OF SECTION