CHAPTER 8—ELECTRICAL DESIGN

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8.1—GENERAL DESIGN REQUIREMENTS

8.1.1—Scope, Codes, and Standards

C8.1.1

The following shall supplement *A8.1.1*.

This chapter contains information and criteria related to the design of movable bridge projects. It sets forth the basic LADOTD design criteria exceptions and/or additions to those specified in *AASHTO LRFD Movable Highway Bridge Design Specifications*, Second Edition, 2007, including all interim revisions.

Construction specifications shall be the latest edition of *Louisiana Standard Specifications for Roads and Bridges (Standard Specifications)*. *Standard Specifications* are subject to amendment whenever necessary by supplemental specifications and special provisions to specific contracts. In the absence of specific information in *Standard Specifications*, follow the latest edition of *AASHTO LRFD Bridge Construction Specifications.*

The electrical design engineer shall follow all applicable codes when designing the movable bridge electrical system and shall get approval from the Bridge Design Engineer Administrator prior to final design for exceptions. All approved exceptions shall be explicitly stated in the plans.

All of the control logic shall be depicted on one sheet, unless otherwise approved by the Bridge Design Engineer Administrator. If the control logic cannot feasibly be put onto a single sheet, the Designer shall put the overall control philosophy on a single sheet.

Power and controls shall be separated on movable bridge electrical systems. No conductors designated for controls shall be routed through the same conduits or terminated in the same box as conductors designated for power transmission.

An insulated partition may be used for instances where available space does not permit two junction boxes (one for power and one for controls).

All electrical equipment supports shall be suitable for the environment and shall be capable of supporting a person standing on the equipment, or 5 times the actual load of the equipment, whichever is greater, along with any additional loads likely to be encountered.

All mounting hardware shall be of marine-duty stainless steel.

The Consultant shall obtain an example of the

final plans from Bridge Design Engineer Administrator. Refer to Appendices for required electrical plan sheets and sheet organization.

The following general requirements shall be stated on the contract drawings.

Scope of Work

The work covered by this section shall include furnishing, installing, connecting, and placing into satisfactory operating condition the electrical system as indicated in the plans, specifications, or as directed by the Project Engineer. The work shall be in accordance with plan details and specifications and the Contractor shall make any necessary modifications or fabrications required for a complete, operational, and safe system. The contractor performing the work is assumed to be skilled in the trade, capable of understanding the intent of the plans and specifications, and constructing the electrical system in accordance with the best practice of the trade.

Any modifications or changes to the electrical plans shall be submitted to the Project Engineer for approval by the Bridge Design Engineer Administrator prior to any work being performed.

Plans and Specifications

All work shall be performed in accordance with the latest edition of *Louisiana Standard Specifications for Roads and Bridges*, hereinafter called *Standard Specifications*, and the latest edition of the *AASHTO LRFD Standard Specifications for Movable Highway Bridges* and any interim revisions thereafter.

Equipment and Materials

The Contractor shall submit brochures and installation instructions for all electrical equipment, materials, and apparatus to be furnished on the project to the Bridge Design Engineer Administrator.

Equipment and material shall be suitable for the intended use and shall be furnished with all necessary hardware and components. The

Contractor shall be responsible for all modifications or fabrications necessary for proper installation and operation of the equipment. All equipment and material shall be new and of best quality. All like equipment and materials shall be of the same manufacturer, unless indicated otherwise in the plans. Reference to a specific manufacturer's name and/or catalog number is intended to denote the quality of the equipment or material and not to specifically exclude other acceptable products. All parts/equipment specified on the plans shall be considered to be followed by the phrase "Or Approved Equal" unless otherwise specified on the plans. Descriptive specifications, plans, and system compatibility shall govern over specified manufacturer's names, model numbers, or catalog numbers. The Contractor shall check all equipment catalog numbers and availability with suppliers and coordinate with all other subcontractors. All materials, equipment, and accessories installed under this contract shall conform to the rules and codes as recommended by the national governing associations. The Contractor shall protect the entire system and all parts thereof from injury during the installation process and up to the acceptance of work.

Existing Conditions

The Contractor shall visit the construction site to determine existing conditions and shall allow for such conditions when computing the bid. The Contractor shall thoroughly inspect the site and the surrounding vicinity for evidence of underground facilities and shall contact companies or agencies likely to have underground facilities in the vicinity of the project before digging or trenching. The Contractor will be held responsible for any damages to existing underground facilities.

Coordination

The Contractor shall coordinate the work to avoid interference and conflicts.

Verification

The Contractor shall verify mounting space, equipment dimensions, and installation requirements before ordering equipment. The

Contractor shall verify the electrical circuit requirements of all equipment to be served before ordering material. Where circuits are to serve specific equipment or feeders, the Contractor shall verify the electrical requirements and the exact location of connections before installing service to the equipment.

Warranties and Guaranties

The Contractor guarantees, by his signing of this contract, all equipment, apparatus, materials, and workmanship for a period of one (1) year after the date of final acceptance of this project. Prior to final acceptance of the project, the Contractor shall furnish to the Bridge Design Engineer Administrator the following additional warranties and guaranties pertaining to each piece of mechanical and electrical equipment furnished:

The manufacturer's standard written warranties apply on all equipment furnished on the project; the Contractor provides a written guarantee that, during a period of one (1) year after final acceptance of the project, all necessary repairs to or replacement of said warranted equipment shall be made by the Contractor at no cost to LADOTD; and other warranties and guarantees apply, as required under the specific items elsewhere herein.

Electrical, Operation & Maintenance Manuals

a. Submit the Operation and Maintenance (O&M) Manual electronically to the Bridge Design Engineer Administrator for review. The electronic file shall be a single PDF file, and shall be organized and formatted to present itself as a finished O&M manual. The entire O&M manual will be considered one Item. Only the title sheet shall be stamped “Returned for Corrections” or “Accepted in accordance with 105.02.” If the O&M manual is rejected after review, comments will be marked in red and will be returned electronically. Correct errors and resubmit electronically to the Bridge Design Engineer Administrator for review. This process will repeat until the Bridge Design

Engineer has no further comments.

After the electronic submittal process has been completed, provide two paper reproductions of the O&M manual to the Bridge Design Engineer Administrator for review. Provide each manual with a white, premium, heavy-duty, three D-ring binder with a title sleeve. Binders shall be appropriately sized to hold enclosed material. Binders shall not be larger than 3 in. Use multiple binders if necessary. Fold half-scale sheets in half with printed material facing out. Provide tab index sheets labeled to delineate sections. If the paper reproduction of the O&M manual is rejected after review, the title sheet of both copies will be stamped "Returned for Correction," and 1 copy will be returned to the Contractor with instructions for corrections. Correct errors and resubmit two copies to the Bridge Design Engineer Administrator for review. This process will repeat until the Bridge Design Engineer has no further comments. Once this process is completed, four additional copies shall be sent to the Bridge Design Engineer Administrator. The title sheet will then be stamped “Accepted in accordance with 105.02,” initialed and dated by the reviewer, and distributed by the Department.

b. Finished Electrical Maintenance Manuals shall be arranged as follows: Each section shall be constructed from the original PDF files reviewed by the Bridge Design Engineer.
    1) A title sheet showing “Louisiana Department of Transportation and Development,” “Electrical Operation & Maintenance Manual,” the project name, project number, parish name, the year the project was completed, and the name of the general and electrical subcontractors and contact information for each.
    2) A “Table of Contents” sheet listing all of the sections below and their sub-categories.
    3) A “Sequence of Operations” section that contains sheets with numeric lists

of the steps required for normal, partial, and fault-clearing operation of the electrical and electro/mechanical systems, including instructions for operating all by-pass switches. Note: The Contractor should contact the Bridge Design Engineer Administrator to obtain a normal operation draft for his consideration.

4) A "Maintenance Schedule" section that contains all equipment maintenance requirements and recommended practices.

5) An "Equipment List" section that contains a table of all electrical items installed. The table shall be as follows: 1st column – item numbers found in the plans, 2nd column – manufacturer's name, 3rd column – catalogue number. A note shall be added to each As-Built equipment list plan sheet as follows: "REFER TO PART 5 OF THE OPERATION AND MAINTENANCE MANUAL FOR THE UPDATED LIST OF INSTALLED EQUIPMENT".

   Exception: If the contractor chooses to (clearly and legibly) edit the actual equipment list on the As-Built drawings, this section will not be required.

6) A "Cut Sheets and Shop Drawings" section that contains all electrical Cut Sheets and Shop Drawing sheets generated from the original PDF files stamped by the Bridge Design Engineer with the "Accepted in accordance with 105.02" stamp, the reviewer's initials, and the date of the review. Organize this section into the following 3 parts: 100, 200, and 300 Items. Shop drawings shall be formatted for printing 11 in. x 17 in.

7) An "Equipment Settings" section that contains all of the electrical equipment settings sheets. The following shall be included where applicable along with any other adjustable settings:

   - The "name plate full load amps

and over load sizes" sheet stamped by the Bridge Design Engineer.

- All time delay and interval settings (examples: relays, brakes, light flashers).
- Resistor bank(s) adjustable tap ohm settings at each power point for each phase.
- Span skew cut out settings (skew in feet and inches).
- Ground Fault Relay milliamp and time delay settings.

8) A "Test Results and Initial Bridge Readings" section that contains the following (when applicable), along with any other readings desired by the Bridge Design Engineer:

- Reading of all motor amps. Where the load varies during operation shall be taken near the beginning, middle, and the end of travel for both opening and closing (examples: span heavy vertical lift bridges, leaf heavy bascule bridges). Exception: For typical warning gates and traffic barriers, the amp readings can be taken near the middle of travel for both opening and closing.
- Conductor Megger readings as required by the plans.
- Span tachometer readings near the middle and ends of travel for both opening and closing the bridge.

9) An "As-Built" section that contains all electrical "As-Built" sheets containing the Project Engineer's signature. These sheets shall be scanned, at high quality, from the full size original drawings and formatted for printing 11 in. x 17 in.

10) A "Warranties" section that contains the Contractor's one year warranty followed by any warranty information for the manufactured items.

Record As-Built Drawings

Upon completion of the project, the Contractor shall furnish one (1) full size (22 in. x 34 in.) complete set of redlined as-built drawings to the Project Engineer reflecting the final as-built condition of the project. The drawings shall reflect all plan and field changes and shall include a complete equipment list showing the manufacturer's name and catalog (or shop drawing) number for each piece of equipment furnished. The drawings shall show the exact location of all installed equipment. All sheets of the as-built drawings shall include the project name, project number, parish, Contractor's name, address, and phone number (with area code). Once the Contractor and the Project Engineer are in agreement that the as-built drawings reflect the as-built conditions, the Contractor shall submit the as-built drawings electronically to the Bridge Design Engineer Administrator for review. The electronic file shall be a single PDF file. After review, only the first sheet shall be stamped "Returned for Corrections" or "Accepted in accordance with 105.02." If the as-built drawings are rejected after review, comments will be marked in red and will be returned electronically. The Contractor shall correct errors and resubmit electronically to the Bridge Design Engineer Administrator for review. This process will repeat until the Bridge Design Engineer Administrator has no comments. Upon completion of the review process, the Contractor shall submit all of the redlined as-built drawings to the Project Engineer for final approval, stamping, signature and date. The Project Engineer shall return the as-built drawings back to the Contractor in order to make one (1) full-size bond set and the required half-size (11 in. x 17 in.) copies of the Installation, Operation and Maintenance manuals, all to be provided to the Bridge Design Engineer Administrator upon final project acceptance.

Codes and Fees

All material and construction shall be in accordance with all building codes, sanitary codes and ordinances in force in the locality in which the work is to be done. In any case where the design

herein differs from the minimum requirements set down by the National Electrical Code (NEC), or any other codes or ordinances in force where work is being done, the Contractor shall maintain the highest level. The Contractor shall make arrangements with all utilities and pay for any service/hookup fees in order to provide power, water, sewage, and/or gas, as specified in the plans.

Quantities

Estimated quantities are given on the plans for informational purposes only. The Contractor shall compute and furnish the quantity of materials necessary to complete the work as detailed on the plans and specified herein.

Tests

The Contractor shall furnish all testing equipment and conduct the following tests:

Performance Test:

All equipment shall be given a two-week (minimum) performance test before final acceptance.

Receptacle Test:

After completion of the electrical system, the Contractor shall test each receptacle for proper polarity and ground continuity; GFCI receptacles test for proper operation.

Special Tests:

Special tests shall be conducted where equipment or systems are suspected of improper operation, or where additional data is necessary to determine conformance with the plans and specifications.

Insulation Test:

Megohm tests shall be conducted on all conductors AWG #10 and larger after the conductors are installed in place, but before connecting equipment that may be damaged by the test. Conductors with readings below

50 megohms, when measured with a 1,000 volt DC insulation tester, will be considered defective.

Generator Testing Requirements:

See *A8.3.9* and *D8.3.9* for information on generator testing.

Contractor must show conclusive evidence of adequate parts and accessories available in Louisiana. Contractor shall provide with the submittals a listing of the Louisiana locations where parts and service can be obtained.

Underground Utilities

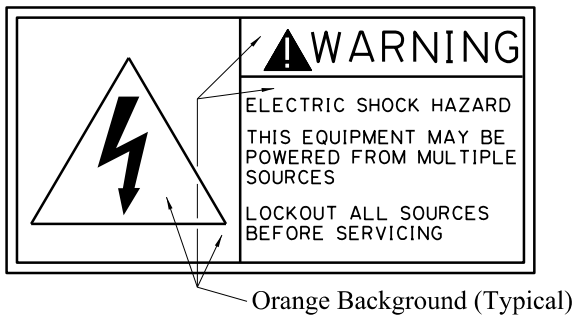
LADOTD does not list its underground utilities with any local one-call type organizations; therefore, in addition to other sources, Contractor must contact LADOTD district utilities representative to obtain information concerning LADOTD underground utilities. Contact information may be obtained from the Project Engineer or from the pre-construction meeting. The responsibility for damage and for workplace safety remains with the Contractor.

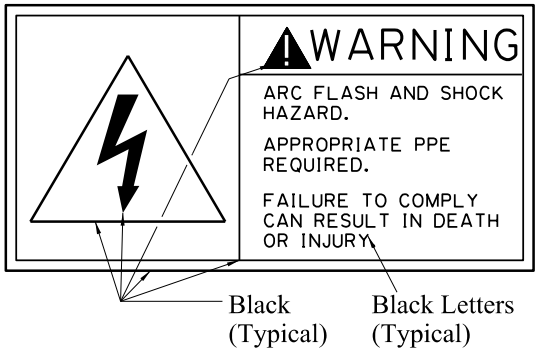
8.1.2—Safety

The following shall supplement *A8.1.2* and shall be stated on the contract drawings.

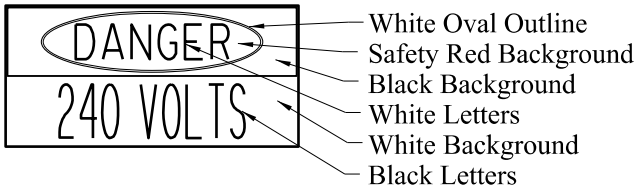
All doors of control cabinets, consoles, gate housings, switchboards, control desks, disconnects, junction boxes containing terminal blocks, enclosures containing movable contacts or copper wire size #2 or larger, all similar equipment, and, where specified by the LADOTD Project Engineer, shall be field marked with a label(s), in accordance with NEC, to warn qualified personnel of potential electric arc flash hazards. Label(s) shall be 5 in. x 7 in. and shall be made of high-quality, self-adhesive, water-resistant, and chemical-resistant flexible vinyl. Label(s) shall be outdoor-rated and protected from UV radiation, moisture, oxidation, and other pollutants. Label(s) shall be surface mounted and suitable for installing on flat, round, or irregular surfaces of metal, fiberglass, or paint. Label(s) shall be over-laminated with clear film to provide print protection. Labels shall comply with the

minimum requirements set forth by OSHA 29 CFR part 1910, NFPA 70E, arc flash protection (see NEC 110.16). Any variations to the aforementioned label size must be submitted to the Bridge Design Engineer Administrator for approval. See details below:

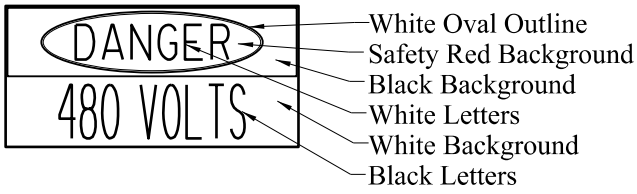




The switchboard, all enclosures, disconnects, junction boxes, etc. that contain service voltage of 120/240 shall have one or more labels with ½ in. high (minimum) letters and shall read as follows:



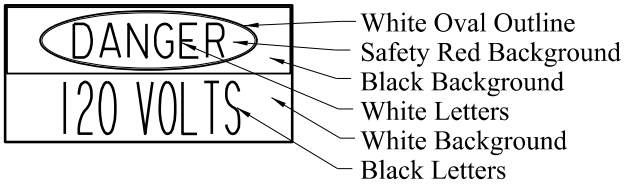
The switchboard, all enclosures, disconnects, junction boxes, etc. that contain service voltage of 480/277 shall have one or more labels with ½ in. high (minimum) letters and shall read as follows:

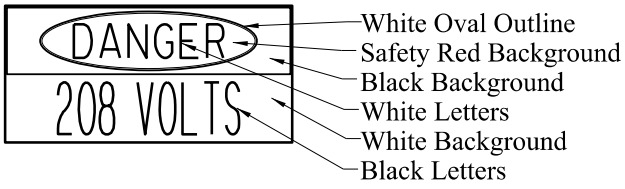


Voltage equal to or above 480 volts shall

require approval from the Bridge Design Engineer Administrator.

The switchboard, all enclosures, disconnects, junction boxes, etc. that contain the service voltages below shall have one or more labels with ½ in. high (minimum) letters and shall read as follows:





The contract drawings shall clearly indicate NEC clear working space required around all electrical equipment. This includes disconnects, switchboard, control desk, junction boxes, engine generator sets, and any other equipment where NEC requires work spaces.

8.2—DEFINITIONS

The following shall supplement *A8.2.*

Height Selsyn Transmitter—Control device used to transmit the angular rotation of the sheave to the control desk readout. The readout displays the height of the lift span in real time. This device is located on the sheave trunnion closest to the operator's house.

Selsyn Drive Motor—A wound rotor motor used as a power-synchro tie on a tower drive vertical lift bridge. This motor has the same horsepower and frame size as the traction motor. There are two traction motors and two selsyn drive motors incorporated on a tower drive vertical lift bridge utilizing this motor arrangement.

Skew Selsyn Differential—Control device located on the "near tower" diagonally across from the skew selsyn transmitter. This device takes the angular rotation of the sheave and subtracts it from the angular rotation obtained by the skew selsyn transmitter. The difference is transmitted to the control desk and displayed on the skew indicator. The purpose of the Skew Selsyn Transmitter, Skew Selsyn Differential, and Skew Selsyn Indicator is to detect the skewing of the lift span and shut down span movement before any binding occurs among the span, rollers, roller guides, guard rails, and bridge structure.

Skew Selsyn Transmitter—Control device used to transmit the angular rotation of the sheave during the span operation. This device is located on the "far tower" diagonally across from the skew selsyn differential.

Traction Motor—A wound rotor motor used to power a tower-drive vertical lift bridge.

Traffic Barrier—This device is designed to physically stop vehicular traffic from entering the movable

span. The barrier is continuous from curb to curb.

Traffic Gate—Also known as a traffic warning gate. This device is used to stop traffic by swinging down gate arms with flashing lights. This device is not capable of physically stopping a vehicle from crossing the bridge. The gate is not continuous from curb to curb.

8.3—ELECTRIC SUPPLY AND POWER DISTRIBUTION

8.3.1—Commercial Electric Service

The following shall supplement *A8.3.1.*

LADOTD does not list its underground utilities with any one-call type organizations. Therefore, in addition to other sources, the contract documents shall state that the Contractor must contact a LADOTD utilities representative to obtain information concerning LADOTD underground utilities.

Voltage equal to or above 480 volts shall require approval from the Bridge Design Engineer Administrator.

C8.3.1

Contact information may be obtained from the Project Engineer or during the pre-construction meeting. The responsibility for damage and for workplace safety remains with the Contractor.

Calculations shall consider infinite bus for available fault current from the utility service to the transformer.

Available fault current shall only be at the primary coming to the disconnects.

8.3.2—Circuit Breakers

The following shall supplement *A8.3.2.*

Where circuit breakers are to serve specific appliances or equipment, the trip rating and number of poles shall match the requirements of the exact appliances or equipment served. Where breakers are used to control lights or other loads, the breakers shall be approved for switching duty. Where breakers serve new or existing equipment, the contract documents shall state that the Contractor shall verify the requirements of the equipment and submit for approval by the Bridge Design Engineer Administrator, the type and size of breakers required. Where breakers serve existing feeders, the contract documents shall state that the Contractor shall field verify all feeder conductor sizes and shall submit for approval by the Bridge Design Engineer Administrator, the breakers sized in accordance with NEC.

8.3.3—Fuses

The following shall supplement *A8.3.3*.

Spare fuses shall be used in cases where specific wiring devices require reduced-size conductors. All fuse devices shall contain a spare fuse holder.

8.3.3.1—Fuses Rated 20 Amps and Higher

C8.3.3.1

The following shall supplement *A8.3.3.1*.

Fuses rated 20 amps and higher should not be used on movable bridge electrical systems unless deemed necessary by the Bridge Design Engineer Administrator or required by the equipment manufacturer.

8.3.3.2—Fuses Rated Below 20 Amps

C8.3.3.2

The following shall supplement *A8.3.3.2*.

Fuses rated 20 amps and below should not be used on movable bridge electrical systems, unless deemed necessary by the Bridge Design Engineer Administrator, or required by the equipment manufacturer, or an integral part of a commercially manufactured piece of electrical equipment.

8.3.4—Disconnect Switches

The following shall supplement *A8.3.4.*

Disconnect switches shall have provisions to be tagged and locked out. Disconnect switches shall have a metal disconnect arm. The arm may have an electrical insulated handle which, in some cases, can be plastic.

Disconnects:

Each disconnect shall have a permanently engraved plate attached to the cover or housing with stainless-steel hardware. The plate shall clearly identify the components' function and the specific equipment served.

Nameplate Specification:

Satin-black outer layers with white inner

layers, phenol plate engraving stock, 1/16 in. thick with 45° beveled edges, 3/16 in. high letters, stainless-steel mounting screws.

8.3.6—High Voltage Switch Gear (600 Volts and Above)

The electrical design engineer shall request permission from the Bridge Design Engineer Administrator to use 480 volts and greater.

8.3.8—Transfer Switches

8.3.8.2—Automatic Transfer Switches

The following shall supplement *A8.3.8.2.*

Automatic transfer switches shall have individual fully enclosed arc chutes providing rapid arc quenching, without cross arcing. A sturdy safety enclosure shall surround areas of arcing and mechanical hazard. Manual operation shall be provided to allow safe manual operation of switching speed and precision. Manual operation shall be a permanent part of the operation mechanism. It shall be capable of being switched manually while under load.

The transfer switch shall have auxiliary contacts on both normal and generator side, offering the option of signal to pilot circuits or remote indication. It shall have a neutral bar for ease in tying the neutral conductors. It shall have a ground bar for ease in tying the grounding conductors.

Control accessories shall mount on a dead-front, switch-out control accessory panel mounted on the enclosure back plate, protected to avoid shock hazard while adjusting control functions, but shall provide access to wiring to facilitate servicing. Indicating lamps shall be set in a front-mounted panel. It shall monitor each underground line with adjustable solid-state under-voltage sensors to sense a decrease of voltage below a set point, or a loss of voltage on any phase of the normal power source.

When using an automatic transfer switch in conjunction with a standby generator, provide the following design:

Signal the engine generator set to start in the event of power interruption. A solid-state time-

delay start, adjustable from at least 1 to 6 seconds, shall delay this signal to avoid nuisance startups. Specify the time delay to be factory set to 2 seconds.

Transfer the load to the engine generator set after an adjustable time delay of at least 5 to 180 seconds to allow the engine generator set to reach proper voltage and frequency. Specify that this time delay be factory set to 5 seconds.

Re-transfer the load to the line after normal power restoration. A time delay on re-transfer, adjustable from 1 to 30 minutes, shall delay the transfer to avoid short-term power restoration and allow it to carry load for a set period of time.

Specify an automatic-transfer time-delay bypass to re-transfer the load from the engine generator set to normal source if the generating set output interrupts after normal source restores voltage.

Signal the engine to stop after load re-transfer to normal source. A solid-state time delay stop, adjustable from at least 1 to 10 minutes, shall permit engine to run unloaded in order to properly cool prior to shutdown. Specify the time delay to be factory set to 5 minutes.

Specify a keyed test switch or manual provision to simulate an interruption of power from the normal source.

Specify a solid-state exercise clock to automatically start the engine generator set at regular intervals and to allow it to run for a preset time period for exercise purposes.

Provide a "Without Load" selector switch to be mounted inside of the cabinet to select, test, or exercise as follows:

1. Without load, the engine generator set runs unloaded.
2. With load, the automatic transfer switch transfers the load to the engine generator set time delay, the same as it would for normal source interruption.

Provide a control disconnect to electrically disconnect the control section from the transfer switch for maintenance services during normal operation.

The automatic transfer switch shall be a UL 1008 listed, NEMA rated enclosure for its environment, start delay, NEMA 3R meters

indoor, auxiliary relay, and battery charger that has voltage-regulated current-limited battery float charge (minimum 2 amps). The automatic transfer switch shall be compatible with the controls and programming of the engine generator set. Additional indication lights include lamps for which power source to which it is supplying power (standby generator or utility) and which power sources are available (standby generator and/or utility). The manufacturer shall furnish schematics and wiring diagrams. The transfer switch shall be warranted for a period of five years or 1,500 hours. Parts and labor warranty to begin when the system is first placed into service, as defined by *A8.3.9.a & b*. The firm engaged in supervising the installation of and servicing the transfer switch shall be a factory-authorized service organization in Louisiana and must maintain a stock of standard parts, maintain a staff of experienced technicians specifically trained in servicing engine generator sets, and be available on a 24-hour–per-day, 7-days-per-week on-call basis. A licensed copy of all software and codes required to program the transfer switch shall be supplied by the Contractor as part of this Item.

8.3.8.3—Non-Automatic Transfer Switches

With prior approval from the Bridge Design Engineer Administrator, a “manual” transfer switch may be used to switch between normal power and standby generator power. The transfer switch shall only be operable by qualified personnel. This will require a means of padlocking or locking the transfer switch within a room or building. For portable standby generators, connection devices shall be amp-, voltage-, and weather-rated for the application and must comply with all applicable codes. The manual transfer switch shall provide safe transfer and re-transfer under full load and shall be UL 1008 listed.

8.3.9—Engine Generator Sets

The following shall supplement *A8.3.9.*

The contract drawings shall specify the following engine generator set testing requirements:

a. Check out and startup: The supplier of the electric generating plant and associated items shall provide factory-authorized and trained technicians to check out the completed installation and perform the initial startup of the system. They shall meet with LADOTD personnel to discuss installation and shall provide operating and maintenance instructions at the time of startup.

b. Load bank testing: Shall be performed at the time of the initial startup and check out of the standby power system by the supplier. The supplier shall furnish load banks as required with an operator to perform the following:

   1. Test speed and voltage regulation for instantaneous on- and off-load changes with loads of ¼**,** ½**,** ¾**,** and full load ratings.
   2. Continuous operational test at full load for not less than five hours with voltage, frequency, oil pressure, and engine temperature being recorded at no load, beginning of test, and hourly thereafter through duration.
   3. After the above tests have been performed, reconnect the engine generator set to the bridge loads and test complete system for proper operation.

The contract documents shall state that the Contractor must show conclusive evidence of adequate parts and accessories available in Louisiana. Also, the Contractor shall provide with these submittals a listing of the Louisiana locations where parts and service can be obtained.

The use of engine generator sets for standby or backup power is to be determined by the Bridge Design Engineer Administrator. The frequency of openings and type of marine traffic as well as provisions to operate the bridge after a hurricane will determine if the bridge is qualified to have a standby or backup engine generator set.

Where practical, natural gas engine generator sets are preferred; however, this will require a natural gas line to be located near the bridge. Also, natural gas engine generator sets are usually larger than the diesel/gas type and will require special consideration when designing the machinery house (explosion-proof equipment).

8.3.9.1—General

C8.3.9.1

The following shall supplement *A8.3.9.1*.

The standby engine generator set shall be designed as a separately derived system. Standby engine generator set specifications are as follows:

UL 2200 listed, KW/KVA standby rating @ 125° Celsius rise alternator, 3 phase, 60 hertz, inline circuit breaker, direct injection diesel engine, sound-attenuated (76 DBA or less) outdoor protective housing where required, thermostatically controlled 120 volt, 1000 watt coolant heater, 120 volt, 150 watt oil heater (required on generators north of Interstate 20), control panel with remote NFPA 110 monitor mounted flush on the top surface of the control desk in the control room (see additional requirements in *A8.3.9.3*), vibration isolators mounted beneath the electric plant skid and mounting surface properly anchored to the mounting surface, residential grade muffler with the muffler and all of its piping thermally insulated inside of the operator's house or other enclosure or building housing the engine generator set. The muffler insulation and piping shall be according to manufacturer recommendations; muffler shall have a minimum of two supports. Battery rack built into the electrical plant with maintenance-free lead-acid batteries rated 600 cold-cranking amps at 24 volts, radiator dust flange with flexible section, UL-listed dual-wall sub-base fuel tank (minimum 24-hour full-load fuel capacity) with fuel level indicator, low fuel level and leak alarms; a licensed copy of all software and codes required to program the engine generator set shall be supplied by the Contractor as part of this item. The performance of the engine generator set shall be certified by a factory test as to the set's full power rating, stability, voltage, and frequency regulation; documents of these tests shall be provided.

The standby electrical power system shall be warranted for a period of five years or 1,500 hours. Parts and labor warranty shall begin when the system is first placed into service as defined by *A8.3.9.a & b*. The firm engaged in supervising the installation of and servicing of the engine generator set shall be a factory-authorized service organization in Louisiana and must maintain a

stock of standard parts, maintain a staff of experienced technicians specifically trained in servicing engine generator sets and be available on a 24-hour per day, 7-day per week on-call basis. All equipment needed shall be included in the Contractor's bid price.

8.3.9.3—Generator Instruments and Controls

The following shall supplement *A8.3.9.3.*

The Designer shall include the following additional indication lights on the generator control panel and remote NFPA 110 monitor:

1. When electrically operated louvers are used in conjunction with the engine generator set, provide an additional green and an additional red LED light for both the control panel and 110 monitor (spares can be used or replaced to provide the correct color). Make sure that Mechanical and/or Architectural Design Unit will provide a damper motor with at least one Single-Pole Double-Throw (SPDT) switch activated when the louvers are fully open. The damper motor SPDT switch and LED lights shall be wired into the generator controls, programmed such that only when the engine generator set is running, the red LED will illuminate when the damper louvers are not fully open and the green LED will illuminate when the damper louvers are fully open. Permanently label the green LED "LOUVERS FULLY OPEN" and the red LED "LOUVERS NOT OPEN."
2. Provide a red light indicating "GENERATOR SUPPLYING LOAD" and a green light indicating "NORMAL POWER SUPPLYING LOAD." Provide and install all equipment required for the light to operate correctly.
3. Provide a green light indicating "Utility Power Available." Provide and install all equipment required for the light to operate correctly.

All equipment needed shall be included in the Contractor's bid price.

8.3.9.4—Supplemental Generator Loading

C8.3.9.4

The Designer may propose to use a second smaller standby generator to accommodate the minimal required loads, e.g., navigation lights, operator's house lights, or other minimal loads necessary when not opening or closing the bridge.

8.4—ELECTRICAL CONTROL SYSTEMS

8.4.1—Operating Sequence and Interlocking Requirements

8.4.1.1—Bascule Bridges, Single Leaf, and Double Parallel Leaf

The following shall replace *Step 3* and *Step 7* under "Lower Span" in *A8.4.1.1*.

Step 3: Accelerate drive motors to running speed.

Step 7: With permissive interlock from locking devices, operator raises, i.e. opens, traffic barriers, followed by warning gates. First the oncoming gates, then the off-going gates. Gates and barriers may not be raised simultaneously.

8.4.1.3—Vertical Lift Bridges

C8.4.1.3

The following shall supplement *A8.4.1.3:*

The sequence of operation for a tower drive vertical lift bridge is as follows:

Actions marked with an "*****" are initiated by the operator. All actions listed in one step and separated by a "**:**" occur simultaneously.

1. *Turn on control circuit
    a. Energizes the control circuit. Turns on vehicular traffic stop lights.
    b. Vehicular traffic comes to a stop.
2. *Lower oncoming vehicular traffic gates upon the completion of step "1-b."
3. *Lower off-going vehicular traffic gates after traffic clears for each gate.
4. *Lower movable barriers (dependent on completion of steps "2" and "3").
5. *Raise span (dependent on completion of step "4")

This vertical lift bridge sequence of operation is what is considered to be LADOTD standard design. LADOTD prefers the tower drive vertical lift bridge design utilizing four wound rotor motors (two motors are the traction motors and the other two are selsyn drive motors). One traction motor drives each end of the span, while the selsyn drive motors tie both traction motors together.

This design keeps each end of the bridge level while operating.

a. Span locks retract: span gear box clutch engages (low speed shafts are locked together), span brakes release.
b. Selsyn drive motors synchronize (dependent on release of all span brakes from step "5.a").
c. Span drive traction motors energize (dependent on completion of steps "5.a" and "5.b").
d. Span rises to "Fully Raised" position.
e. Span drive traction motors reverse (plug) to begin slowing span: span brakes begin setting according to built-in time delays.
f. Span drive traction motors de-energize when motors drop below pre-set rpm (plugging switches) or when any span brake sets: span selsyn drive motors de-energize when any span brake sets.
g. One of the span brakes mounted to the span motors on each tower sets after a 1-second time delay.
h. The other span brake mounted to the span motors on each tower sets after a 5-second time delay.

6. *Lower span (dependent on completion of step "4")
   a. All span brakes release.
   b. Span selsyn drive motors synchronize (dependent on span brake release from step "6.a").
   c. Span drive traction motors energize (dependent on completion of steps "6.a" and "6.b").
   d. Span lowers to a position just above the "Nearly Lowered" limit switch position where a contact in the span control rotary limit switch is made that enables (but does not energize) the clutch mechanism.
   e. Span lowers to the "Nearly Lowered" position.
   f. Span drive traction motors reverse (plug) to begin slowing the span: Span brakes begin setting according to the built-in time delays. Span drive traction motors de-energize when

motors drop below preset rpm (plugging switches) or when any span brake sets.

g. When one of the span brakes sets, the span gear box clutch begins to disengage; six (6) seconds total disengagement time.

h. When the span reaches a position just below the “Nearly Lowered” limit switch position, a contact in the span control rotary limit switch opens and restricts the span drive traction motors to use only the lowest of the four (4) power points.

i. One of the span brakes mounted to the span motors (on each tower) sets after a one (1) second time delay.

j. The other span brake mounted to the span motors (on each tower) sets after a five (5) second time delay.

k. Span stops approximately 2 ½ ft. above the “Span Seated” position.

l. Span gear box clutches, one on each tower, become fully disengaged (low speed shafts can rotate independently).

m. All span brakes release (dependant on "6.l”).

n. Span floats down, due to weight imbalance between span and counterweight: plugging switches prevent span from exceeding preset rpm. The drive motors shall not plug at this step under normal operation.

o. At approximately 2 ft. above the “Span Seated” position, the span reaches the “Nearly Seated” snap action limit switch. This is an emergency backup limit switch that initiates the braking procedure if the “Nearly Lowered” limit switch fails. If the “Nearly Lowered” limit switch has not failed, this limit switch will have no effect on the span operation.

p. Span air buffers control seating of the span.

q. Span seats.

r. When all four (4) span seated limit switches are engaged, span locks return

to latching position: span brakes engage. Note: when both of the near side latches are fully driven, the near side brakes will set. When both of the far side latches are driven, the far side brakes will set.

7. *Raise movable barriers (dependent on completion of step "6").
8. *Raise off-going vehicular traffic gates (dependent on completion of step "7").
9. *Raise oncoming vehicular traffic gates (dependent on completion of steps "7" and "8").
10. *Turn off control circuit:
    a. Deactivated control desk: turns off vehicular traffic stop lights.
    b. Vehicular traffic returns to the movable span.

8.4.1.4—Swing Spans

The following shall replace *A8.4.1.4*.

The sequence of operation for a swing span operated by hydraulic cylinders is as follows:

Actions marked with a **"*"** are initiated by the operator.

All actions listed in one step and separated by a colon **":"** happen simultaneously.

1. *Turn on control circuit
    a. Energizes the control circuit. Turns on vehicular traffic stop lights.
    b. Vehicular traffic comes to a stop.
2. *Lower oncoming vehicular traffic gates upon completion of step "1-b."
3. *Lower off-going vehicular traffic gates after traffic clears for each gate.
4. *Lower movable barriers (dependent on completion of steps "2" and "3").
5. *Withdraw lifts
    a. Span pump motor(s) energize (dependent on completion of step "4").
    b. Lifts (and wedges) fully withdraw.
6. *Pause/Start
    a. Span hydraulic pump arm(s) move to the neutral position.

b. Span control relays prepare the control system for span operation.

7. *Open span (dependent on completion of step "4" and the span control limit switch(es) being in the neutral position)
   a. Span "opening" hydraulic valve(s) open.
   b. Span pump stroke arm(s) move from neutral to full flow: span ramps up to running speed.
   c. Span opens to the "Nearly Open" position.
   d. Span pump stroke arm(s) move from full flow to creep speed: span ramps down to creep speed.
   e. Span opens to the "Fully Open" position.
   f. Span "opening" hydraulic valve(s) close: span stops.
   g. Marine traffic passes through waterway.
8. *Pause/Start
   a. Span hydraulic pumps arm(s) move to the neutral position.
   b. Span control relays prepare the control system for span operation.
9. *Close span (dependent on completion of step "8")
   a. Span "closing" hydraulic valve(s) open.
   b. Span pump stroke arm(s) move from neutral to full flow: span ramps up to running speed.
   c. Span closes to the "Nearly Closed" position.
   d. Span pump stroke arm(s) move from full flow to creep speed: span ramps down to creep speed.
   e. Span closes to the "Fully Closed" Position.
   f. Span "closing" hydraulic valve(s) close: span stops.
10. *Drive lifts & wedges (dependent on completion of step "9.e").
11. *Raise movable barriers (dependent on completion of step "10"). Note: Span

motor(s) de-energize(s) when the span control switch (SW-SC) is moved into "Raise Barriers" after leaving the "Drive Lifts" position.

12. *Raise off-going vehicular traffic gates (dependent on completion of step "11").
13. *Raise oncoming vehicular traffic gates (dependent on completion of step "11").
14. *Turn off control circuit
    a. Deactivates control desk: Turns off vehicular traffic stop lights.
    b. Vehicular traffic returns to the movable span.

8.4.2—Control Logic

The following shall supplement *A8.4.2*.

The control system shall be of a relay logic design. Programmable logic controls (PLCs) shall not be used to control the movement of the span or other items on the project. PLCs are only allowed for acquiring information which does not affect the control or operation of the bridge (e.g., span position).

8.4.2.1—General

The following shall replace the 3rd paragraph in *A8.4.2.1*.

The supply voltage to the control system shall not exceed 240 volts between any two conductors or 120 volts between any conductors and ground, and shall be derived from a solidly grounded system, as defined by the NEC.

8.4.2.3—Programmable Logic Controllers (PLC)

The following shall supplement *A8.4.2.3*.

Programmable Logic Controllers (PLC) shall not be used in electrical systems for movable bridges in the State of Louisiana unless specifically requested and/or approved by the Bridge Design Engineer Administrator.

The Designer shall not use PLC unless they are used for monitoring.

8.4.2.6—Normal Stop

The following shall supplement *A8.4.2.6*.

If the span control system uses a multi-position "Span Control" Switch on the control desk and there is a "Pause/Start" or "Off" position between "Open" and "Close" span or "Lower" and "Raise" span that is designed to bring the span to a normal stop, then a push button will not be required.

8.4.3—Bypass Switches

The following shall supplement *A8.4.3*.

The Designer may also include bypass switches for the end rollers and center wedges on swing span bridges.

8.4.4—Limit Switches

8.4.4.2—Lever Arm Limit Switches

The following shall supplement *A8.4.4.2*.

Lever-arm limit switches shall have a submersible rating (for storm surges, etc.).

8.4.4.3—Rotary Cam Limit Switches

The following shall supplement *A8.4.4.3*.

Rotary cam limit switches shall have individual adjustable lobes.

The rotary cam limit switch design having set screws on each lobe is preferred.

8.4.5—Position Indicator Systems

8.4.5.1—General

The following shall replace the 1st paragraph in *A8.4.5.1*.

Position indicators shall be sufficiently accurate to provide indication of span position and skew angle to the bridge operator within:

- 0.5° for bascule and swing bridges
- 6 in. for vertical lift bridges
- 1 in. for skew of vertical lift bridges

For vertical lift bridge skew, there must be a point of maximum skew which is manually set at

the control desk skew readout dial indicator. This will shut down the moving span whenever the maximum amount of skew has been reached. The maximum amount of skew is dependent on factors such as: skew which will cause binding at the roller and guides and/or skew which will cause the span to contact and damage the handrails or guard rails. A good rule of thumb is to not allow more than 2 ft. of skew, provided there are no interferences between the moving span and the stationary structure.

8.4.5.2—Synchronous Systems

C8.4.5.2

The following shall replace *C8.4.5.2*.

Synchronous systems shall be used in the control path of movable bridges until such systems are no longer available. When synchronous system components are no longer available, alternatives to synchronous systems may be employed.

8.4.6—Control Console

8.4.6.3—Control Console Construction

The following shall supplement *A8.4.6.3*.

The control desk shall be designed using:

- GE SB-9 switches for the operation of the span, gates, and movable barriers.
- Electro Switch or GE SB-9 switches for the Voltmeter and Amp meter selector switches.
- Equal to GE CR104 push buttons and indication lights.
- 20 amp-rated toggle switches for lighting and by-pass switching.

Nameplates shall be affixed to all components on the control desk, identifying the purpose and function of each, e.g., indicator lights, SB-9 switches, dial indicators, dimmer switch, all switches, voltmeter selector, emergency stop, navigation light switches, flood light switches, bypass switches, navigation horn, manual span latching, control circuit switch, etc.

These nameplates shall be satin-black outer layers with white inner layers, phenol plate engraving stock 1/16 in. thick with 45° beveled edges, 3/16 in. high letters with stainless-steel

mounting screws.

The span shall be capable to be operated on the center pier when the controls in the operator's house are turned on, left in the lower barriers position, traffic warning signals are on, the gates are lowered, and the barriers are lowered. The control station on the center pier shall consist of switches, push buttons, and indication lights equal to GE CR104P. It shall be covered with an aluminum or stainless-steel cover with a weather resistant seal and pad locked attachment.

8.5—ELECTRIC MOTORS

8.5.1—General Requirements

The following shall supplement *A8.5.1*.

For wound rotor motor general requirements, see *A8.5.2.2.2*.

8.5.2—Application-Specific Criteria

8.5.2.2—Span Drive Motors

8.5.2.2.2—AC Wound Rotor Motors

The following shall supplement *A8.5.2.2.2*.

Wound rotor motors having the power synchro tie shall be used on tower drive vertical lift bridges and may be used on double leaf bascule bridges having a rack and pinion drive.

The following is the general specification for wound rotor motors which shall be used for movable bridge drive systems, namely the tower drive vertical lift and the rack and pinion driven double leaf bascule. All other drive motor type and configurations must be approved by the Bridge Design Engineer Administrator:

Wound rotor type, 900 rpm, NEMA-X, 460 volts or 240 volts, 3 phase, 40° Celsius ambient, 30 minute duty, 1.0 service factor, class H insulation, copper coils (coated windings), severe/marine duty construction with appropriate seals.

Primary full load amps shall be restricted by the motor specifications/description with a ± allowance of no greater than 10 percent and based on a practical and efficient motor standard. Secondary full load amps and open circuit voltage

shall comply with NEMA MG1. The motor specifications shall include: totally enclosed non-ventilated (TENV) housing, oversized frame appropriate for 900 rpm, all hardware and conduit boxes shall be stainless steel, regreasable ball bearings, stainless-steel double shaft extensions (both drive shaft and plugging switch shaft), non-tapered drive end with keyway, non-tapered plugging switch end without keyway. Coordinate with the mechanical design engineer for motor mounting details.

Provide two motors with conduit boxes on opposite sides. Provide two oversized conduit boxes for each motor: one for the primary conductors and one for the secondary conductors.

Submittal shall contain all options/features/specifications listed above, and the following electrical data:

Full load torque, stall torque, slip or full load rpm, secondary internal resistance, secondary open circuit voltage, and power factor.

For parameters that must be estimated before actual motor is built, a guaranteed maximum allowable tolerance for each estimated value must be stated on the submittal. The Contractor shall coordinate the assembly of the motor, brake, motor coupling, plugging switch, and main gear reducer within a single shop.

Alternate frame size must be submitted for approval.

Motor Installation Requirements: The Contractor shall coordinate the assembly of the motor, brake, motor coupling, plugging switch, and main gear reducer within a single shop.

Motor Testing

Motor testing requirements and data presentation: The motor manufacturer shall provide the following data and perform the following motor test for one of the span motors, assuming that all the span motors provided are of equal design and construction:

1) One assembled motor shall be bench-tested and the following data shall be provided: full load torque, stall torque, slip or full load rpm, secondary internal resistance, secondary open circuit voltage, and power factor.

2) One assembled motor shall be bench-tested and the actual value of the 100 percent external resistance required to limit the full load rotor torque to 50 percent of the full load torque shall be determined and submitted. This value will be referred to as Rx in this document.

3) One assembled motor and its associated resistor bank is to be bench-tested at several resistor settings. The data is to be delivered to the Electrical Design unit for evaluation. Data to be collected is as follows: Provide torque, primary current, and rotor current values at 36 rpm intervals, beginning at 0 and proceeding to 900, or maximum obtainable, rpm (a minimum of 25 data points) for each of the following percent ohms of Rx: 100 percent, 71 percent, 63 percent, 52 percent, 35 percent, 18 percent, 9 percent, 4 percent, and 0 percent. Provide the following graphs for the data obtained:

   a. Torque vs. RPM: Display the points obtained for each external resistance on one sheet. Each external resistance point shall be distinguished from the others by color and plotting point symbol and shall be connected by a continuous line from the first point to the last point.

   b. Primary Current vs. RPM: Display the points obtained for each external resistance on one sheet. Each external resistance set of points shall be distinguished from the others by color and plotting point symbol and shall be connected by a continuous line from the first point to the last point.

   c. Secondary Ohms vs. Full Load RPM (for each value of external ohms): plotted points shall be connected by a continuous line from the first point to the last point.

   d. Torque vs. Full Speed (for each value of external ohms): plotted points shall be connected by a continuous line from the first point to the last point.

   e. Ohms vs. Zero Speed Torque (for each value of external ohms): plotted points

shall be connected by a continuous line from the first point to the last point.

Data acquired in #3 above shall be specified to be provided in table form and submitted to the Bridge Design Engineer Administrator on paper and as an electronic file (on CD or email attachment) in a format recognizable by Microsoft Excel.

8.5.2.3—Skew Control or Synchronizing Motors

C8.5.2.3

The following shall supplement *C8.5.2.3*

For tower drive vertical lift bridges designed by the LADOTD, the use of wound rotor motors having the power synchro tie is preferred. This design has been proven to be more reliable and durable than DC drives and AC flux vector drives. Also incorporated into this design is the ability to open and close the bridge only using one motor in the event of a motor failure, and therefore requiring no auxiliary or backup drive.

8.6—ELECTRIC MOTOR CONTROLS

8.6.1—Speed Control of Span Drive Motors

8.6.1.2—Stepped Resistance Control

C8.6.1.2

The following shall supplement *C8.6.1.2*.

Stepped resistance control is preferred where wound rotor motors are to be used.

8.6.1.3—SCR (AC Thyristor) speed control

C8.6.1.3

The following shall supplement *C8.6.1.3*.

SCR speed control should be avoided.

8.6.3—Resistors

C8.6.3

The following shall replace the 2nd paragraph in *C8.6.3*.

Resistance values should not be used that result in less than 50 percent starting torque at zero speed.

8.6.5—Motor Control Centers

The following shall replace *A8.6.5*.

The switchboard (SB) enclosure and doors shall be of 11 gauge sheet steel welded construction. Paint system shall be: two coat, high-gloss, light gray, polyamide cured epoxy with an organic zinc primer. General plan detail shall be provided and give the layout of the equipment from the front of the SB on ¾ in. thick continuous sheets of Arboron mounting boards. Door width shall not be greater than 3 ft. (preferably 2 ½ ft.). Doors shall be on the front and the back of the switchboard. Each door shall have a minimum of 3 hinges (stationary door mount and pin). Each single door or doors that are paired shall have 3-point latch assembly and the door latch handle shall be a flush chrome plated cup and handle. All doors and both ends of the SB enclosure shall have vent louvers and protected screens at both the top and bottom. Switchboard wire shall be Type SIS, 90° Celsius, 600 volt, meeting the requirements of VW-1, IEEE 323-74 and 383-74, copper conductors, with the exception of higher heat-resistant wires for the resistor banks. If bus bar is required, it shall be tin-plated copper. Wire shall be neatly bundled. Molded case panel mount circuit breakers with back-connected studs and padlock attachment shall be operational with the SB door closed. Nameplate shall be provided on the door to identify these circuit breakers. All equipment on the mounting boards (with the exception of circuit breakers) shall have nameplates inside the SB on the mounting boards. Nameplate shall be made of satin black outer layers, white inner layers, phenol plate engraved stock 1/16 in. thick with 45° beveled edges, 3/16 in. high letters, and stainless-steel mounting screws. All hardware shall be marine duty stainless steel.

8.6.6—Contactors

The following shall supplement *A8.6.6.*

Only use NEMA-rated contactors. IEC contactors are not allowed.

8.7—ELECTRICALLY OPERATED BRAKES

The following shall supplement *A8.7*

For more information on electrically operated brakes see *A6.7.13.2.*

8.8—CONTROL CABINETS

The following shall supplement *A8.8.*

The components found in the control cabinet shall be included as part of the switchboard (see *A8.6.5*) unless a compelling reason to use separate "control cabinets" is warranted. The use of separate control cabinets must be approved by the Bridge Design Engineer Administrator.

8.9—ELECTRICAL CONDUCTORS

The following shall supplement *A8.9*.

All conductors shall be installed in raceways and shall conform to ICEA class B stranded copper. Insulation shall be the type suitable for the environment encountered. Where conductors are connected to or installed near heat-producing equipment (luminaries, heaters, motors, etc.), the conductor insulation for the affixed conductors shall have a temperature rating in excess of the temperature expected to be encountered. Where suitable for the environment and installed in raceways, conductor insulation shall be rated 600 volts and shall conform to UL type XHHW-2.

Cable shall be installed in raceways with the following exceptions:

1. Where exposed for the adjustment of snap action limit switches with the length no greater than what is needed for the full range of adjustment (for example: 18 in. maximum for the "Fully Open" and "Fully Closed" snap action limit switches typically found on swing span bridges).
2. For flex loops from the center pier to the span on swing span bridges, exposed cable shall not be subject to being stepped on.

8.9.1—General Requirements

The following shall replace the 2nd paragraph in *A8.9.1*.

Conductors shall be sized to limit the maximum voltage drop to 5 percent from the incoming service to the end device on any circuit with the following exception:

Conductors shall be sized to limit the maximum voltage drop to 3 percent with motor circuits.

All wire markers shall have a post heat shrunk text height as follows:

- No less than 8/100 in. (0.08”) on #12 and smaller.
- No less than 1/10 in. (0.1”) on #10 and greater.

8.9.2—Splicing and Tapping Conductors

The following shall supplement *A8.9.2*.

Splices will not be permitted in conduit bodies or raceways.

Service and feeder conductors shall be installed in their entire length without splices. Where taps are required from feeder or service conductors, the taps shall be made without cutting the main conductors. Taps shall be made with parallel type gutter tap connectors having insulated covers. Terminal blocks shall be one-piece barrier-type rated 600 volts. The terminal blocks shall also have high pressure box lug terminals suitable for copper conductors.

The following shall replace the 5th paragraph in *A8.9.2*.

Screw-on type wire nuts shall not be used on movable bridge electrical systems.

8.9.3—Labeling and Identifying Conductors

The following shall supplement *A8.9.3*.

Conductor sizes AWG #8 and smaller shall be identified by color coding their entire length. All other conductors shall have individual permanent identification at each termination, splice, tap, junction box, and equipment enclosure.

All disconnects and junction boxes shall have a permanently engraved plate attached to the cover or housing with stainless-steel hardware. The plate shall clearly identify each component's function and the specific equipment served.

Nameplate Specification:

Satin-black outer layers with white inner layers, phenol plate engraving stock, 1/16 in. thick with 45° beveled edges, 3/16 in. high letters, stainless-steel mounting screws.

8.9.7—Submarine Cables

The following shall supplement *A8.9.7*.

Submarine cables shall be constructed in the following ways: cross-linked polyolefin-insulated conductors; polyethylene-jacketed; polyethylene-coated, helically served steel armor; power, communication and control cable with an overall jacket of polyethylene for underwater installations.

8.9.7.1—Conductors

C8.9.7.1

The following shall supplement *A8.9.7.1*.

Conductor insulation must meet the following physical and thermal requirements:

Unaged:

- 1,800 lb./in.^{2} (tensile strength).
- 250 percent elongation minimum.

Aged (air oven at 168 hours at 136° Celsius):

- 80 percent in tensile strength minimum of the unaged conductor insulation.
- 80 percent elongation minimum.

The insulation thickness and wire overall diameter are nominal dimensions. The

ICEA numbers from the old specification, S-66-524/NEMA WC7, have been withdrawn and

dimensional tolerances for the conductors shall meet the requirements of ICEA publication #S-95-658/NEMA WC70. The insulation thickness shall meet the requirements of ICEA publication #S-92-658/NEMA WC70.

Conductor coding shall be accomplished by the use of printed coding consisting of the appropriate color number followed by the corresponding spelled word or words; per appendix L, method 3. The coding shall be legible after handling, subsequent to installation and maintenance.

The insulation shall be easily removable from the conductor. A separator is required between the conductor and the insulation to enhance the strippability.

replaced with S-95-658/WC70.

8.9.7.2—Cable Construction

C8.9.7.2

The following shall replace the last sentence in *A8.9.7.2*.

The direction of lay for adjacent layers shall be reversed. Maximum length of lay shall be in accordance with ICEA publication #S-95-658/NEMA WC70.

ICEA numbers from the old specification, S-66-524/NEMA WC7, have been withdrawn and replaced with S-95-658/WC70.

8.9.7.3—Inner and Outer Jacket Material

C8.9.7.3

The following shall replace *A8.9.7.3*.

The cable shall be provided with a high-density polyethylene jacket according to ICEA publication #S-95-658/NEMA WC70.

The jacket thickness shall be in accordance with ICEA publication #S-95-658/NEMA WC70.

Optional jacketing materials (PVC, TPR, PU) are available to specific functional requirements.

ICEA numbers from the old specification, S-66-524/NEMA WC7, have been withdrawn and replaced with S-95-658/WC70.

8.9.7.4—Cable Armor Wire

C8.9.7.4

The following shall replace *A8.9.7.4*.

HDPE jacketed steel armor:

Cable armor shall consist of strands of galvanized steel wire.

The size and number of strands shall provide coverage of between 91 percent and 97 percent.

Cable armor shall be applied to a nominal lay angle of between 18° and 25°.

The armored cable shall have a polyester separator between armor and armor jacket according to ICEA publication #S-95-658/NEMA WC70.

Armor Jacket:

The armored cable shall be provided with a high-density polyethylene jacket in accordance with ICEA publication #S-95-658/NEMA WC70.

The jacket thickness shall be in accordance with ICEA publication #S-95-658/NEMA WC70.

Optional jacket materials (PVC, TPR, PU) are available to meet specific functional requirements.

ICEA numbers from the old specification, S-66-524/NEMA WC7, have been withdrawn and replaced with S-95-658/WC70.

8.9.7.5—Testing

C8.9.7.5

The following shall replace *A8.9.7.5*.

The following tests shall be conducted on the completed cable:

Voltage test—In accordance to ICEA publication #S-95-658/NEMA WC70.

Insulation resistance—In accordance to ICEA publication #S-95-658/NEMA WC70.

ICEA numbers from the old specification, S-66-524/NEMA WC7, have been withdrawn and replaced with S-95-658/WC70.

8.10—CONDUITS, WIREWAYS, BOXES AND CABINETS

8.10.1—Conduit, General Requirements

The following shall supplement *A8.10.1*.

All conduits shall be installed concealed unless specifically stated on the contract drawings. All conduit runs shall be supported every 5 ft.

Conduits shall not be installed above the wire mesh reinforcing of concrete slabs and shall be placed sufficiently below the slab to permit entrance conduits to emerge perpendicular to the slab surface. Conduits entering the slab shall be continuous to the first device or junction box. Where conduits are installed through fire-rated walls or floors, the holes shall be sealed with fire seals to preserve the fire rating of the barriers.

Where conduits are installed through vapor barriers, the holes shall be suitably sealed.

Where empty conduits are required, the

conduits shall be capped on each end.

Underground conduits shall be installed 3 ft. below grade unless otherwise stated on the contract documents.

Where conduits are subject to movement or cross expansion joints, the conduits shall be supplied with expansion and/or deflection fittings, or other methods having been determined by the Bridge Design Engineer Administrator. Expansion fittings shall be installed at all transitions from one fixed structure to a separate structure, including conduits crossing expansion gaps between approach slabs, and/or as deemed necessary by the Bridge Design Engineer Administrator. All expansion fittings shall have an integral bonding jumper (braid).

8.10.1.1—Rigid Steel Conduit

The following shall supplement *A8.10.1.1*.

Rigid steel conduit shall conform to ANSI C80.1 and shall be installed where conduits enter the ground or slab, or where shown on the plans. Fittings shall be threaded type with cast or malleable iron bodies and covers having a zinc finish, solid neoprene gaskets, and stainless-steel setscrews.

8.10.1.2—Rigid Aluminum Conduit

The following shall supplement *A8.10.1.2*.

Rigid aluminum conduit shall conform to ANSI C80.5 and shall be installed where conduits are required outdoors, in hazardous locations, where subject to physical damage, or where deemed necessary by the Bridge Design Engineer Administrator.

Threads shall be painted with a conducting oxide-inhibiting compound before installation.

Fittings shall be threaded type with cast or die-cast copper-free bodies and covers, solid neoprene gaskets, and stainless-steel screws. Expansion fittings shall be installed with external aluminum bonding straps, stainless-steel u-bolt clamps and hardware.

Rigid Steel PVC Coated Conduit

The Designer shall have to make a request to the Bridge Design Electrical Section and include justifications to see if PVC-coated conduit will be allowed. The product specifications in the contract shall include installation regulations similar to the following: Manufacturers of PVC-coated conduit stipulate specific tools and procedures for proper clamping, cutting, threading, bending, and assembly of conduit. All manufacturers' installation guidelines must be strictly adhered to by the Contractor. To assure proper installation, all those installing PVC-coated conduit shall be certified by the manufacturer of the coated conduit being used and shall provide certificate of training to the Contractor, the Project Engineer, and the designer prior to installation.

8.10.1.3—Electrical Metallic Tubing (EMT)

The following shall supplement *A8.10.1.3*.

Electrical metallic tubing (EMT) shall conform to ANSI C80.3 and shall be installed only where specified by the electrical engineer. EMT shall not be installed where subject to physical damage or corrosion, in concrete, or underground. EMT shall not be connected to rigid conduits without a device or junction box. Set screw type fittings will not be acceptable. All fittings shall be the compression gland type having an insulated throat. All EMT require equipment grounding conductors.

8.10.1.4—Rigid Nonmetallic Conduit

The following shall supplement *A8.10.1.4*.

Rigid nonmetallic conduit shall be schedule 40 PVC or schedule 40 High-Density Polyethylene (HDPE) and shall be buried 3 ft. underground unless installed under concrete slabs. Nonmetallic conduit will not be permitted above ground or slabs. All nonmetallic conduits shall contain an equipment grounding conductor.

Submarine Conduit

The following shall supplement *A8.10.1.4*.

Prior to installation, the Contractor shall provide the proposed method for installing and weighting the submarine ducts to the Bridge Design Engineer Administrator for approval along with the buoyancy force calculations.

Submarine cables/ducts that run up the sides of piles from the underwater floor shall be secured with ¼ in. x 3 in. marine-duty stainless-steel straps located every 3 ft. (maximum), starting from the underwater floor. Secure by pressure; do not anchor the straps to the pile. Secure submarine cables/ducts with pipe clamps on top of surfaces (piers, house floors) where they run up through and surfaces.

Submarine Duct Specifications:

Schedule 80, Electrical-Listed, Smooth-Wall, High-Density Polyethylene Conduit.

8.10.1.5—Flexible Metal Conduit

The following shall supplement *A8.10.1.5*.

Flexible nonmetallic conduit shall not be used.

Flexible metal conduit shall conform to ANSI C33.92 and shall be installed where a connection is made to recessed lighting fixtures, motors, transformers, and other equipment requiring a flexible connection. When flexible conduits are installed outdoors or in areas subject to moisture, oil, or other liquids, the conduit shall be of liquid tight construction.

Flexible metal conduits shall be installed in 36 in. maximum lengths or a maximum according to the minimum bending radius of the conduit, except for sections serving recessed lighting fixtures in buildings, in which case they may be 4 ft. in length. Flexible conduit connectors shall be compression type with ground lugs. Thread on type connectors shall not be acceptable. All flexible conduits shall have external bonding jumpers.

External bonding jumpers shall be sized based on the following: Largest grounding conductor in the conduit, #6 AWG, or minimum size of the connector ground lug wire range, whichever is

greater.

BX and armored cable shall not be used.

8.10.2—Wire ways

The following shall supplement *A8.10.2.*

Wire ways shall not exceed 25 percent fill.

8.10.3—Junction Boxes and Terminal Cabinets

The following shall supplement *A8.10.3*.

All conduits entering junction boxes shall have bolt on hubs. For conduits of 1 ½ in. diameter or less, if the electrical design engineer determines that a lack of space disallows the use of bolt on hubs, the electrical design engineer has the option to use NEMA 4X Myers type hubs with a bonding wedge (grounding) locknut or a locknut with a grounding screw with bare conductor to ground.

Where metal boxes are mounted to concrete there shall be a ¼ in. space between the box and the concrete.

All junction boxes shall have a 1/8 in. drain hole in the bottom and a breather in the top.

8.11—SERVICE LIGHTS AND RECEPTACLES

The following shall supplement *A8.11*.

All receptacles and switches shall be mounted flush and wires shall be connected by means of screw terminals. Switches and receptacles shall not be located on wall spaces that are obstructed by open doors, or on permanently installed counters, cabinets, or equipment.

Receptacles shall be grounding type and shall have standard configurations, except where installed to serve specific equipment that is provided with other configuration plugs.

1. General-purpose wall receptacles shall be mounted 18 in. from the finished floor to the receptacle center except to avoid conflicts with other equipment.
2. Bridge receptacles shall be ground-fault circuit interrupting.

Switches shall be quiet type. The number of

C8.11

The following shall supplement *C8.11*.

For fluorescent lighting, all fluorescent ballasts shall be provided with a ballast disconnect. Alternatively, the ballast disconnect may be provided in the cabinet to be served.

poles and type shall be as required for intended use. Where switches are required for general lighting control and connected to 20 amp branch circuits, the switches shall be rated 20 amps.

1. Light switches shall be mounted on the walls adjacent to the latch side door jamb, approximately 50 in. from the floor, except to avoid conflicts with other equipment.

8.12—GROUNDING

8.12.1—General

The following shall replace *A8.12.1*.

A grounding system shall be provided to meet or exceed the requirements of the NEC (see NEC Article 250 requirements for other items that may be required to be bonded to the grounding system, for example, metal framing of building or structure, metal underground water pipe). The grounding system shall be bonded to the utility neutral only in the main (service) disconnect and to the generator neutral only at the engine generator set.

Where step-down transformers are provided, grounding shall be according to applicable codes.

The power system supplying the bridge shall be a solidly grounded system.

All grounding conductors shall be copper and shall have green insulation, unless otherwise determined by the electrical design engineer.

8.12.2—Equipment Grounding

The following shall supplement *A8.12.2*.

UL-listed means of terminating grounding conductors shall be provided for all enclosures requiring splices to ground.

8.12.3—Structure Grounding

The following shall supplement *A8.12.3*.

Ground rods shall be ¾ in. diameter x 10 ft. (minimum), constructed from nickel-sealed high-quality carbon steel having a consistent covering of electrolytically applied copper (i.e. copper bonded or copper clad). Multiple ground rods shall

be separated, 10 ft. minimum. All ground rods shall be UL listed.

UL-listed exothermic welds ("CADWELD," "THERMOWELD," or approved equal, shall be used when connecting grounding electrode conductors to ground rods. When multiple ground rods are required, grounding electrode conductors may be cut, provided a suitable exothermic weld is utilized. All grounding electrodes shall be installed unbroken from the first ground rod to the respective service equipment. All exposed grounding electrode drops to ground rods outside shall be installed in UV-rated schedule 80 PVC conduit (minimum).

8.13—LIGHTNING PROTECTION

The following shall supplement *A8.13*.

The contract documents shall state that the lightning protection system shall be installed by a firm presently engaged in the installations of master-labeled or LPI-certified lightning protection systems. Once the lightning protection system is completed, it shall be inspected by a UL field representative and modified to obtain a UL MASTER LABELED certification.

Alternately, if the Master Label Certificate is not obtainable due to bridge construction conflicts only, a UL Letter of Findings shall be obtained. UL 96A installation requirements for lightning protection systems, NFPA 780 "Standard for the installation of Lightning Protection Systems," or other applicable approved published lightning protection standards may be used to obtain the Master Label Certificate or Letter of Findings. If a standard other than UL 96A or NFPA 780 is utilized for the inspection, it is the installers' responsibility to provide a copy of the standard to UL prior to the inspection. The Designer is to make certain that the Contractor coordinates all requirements with the certifying inspector prior to installation.

SUBMITTALS

This section was added to the *BDEM* to provide the Consultant the LADOTD Bridge Design submittal process which the Contractor will be required to follow. It is the Consultant's responsibility to obtain the most current edition of the *Louisiana Standard Specifications for Roads and Bridges (Standard Specifications)* to obtain the submittal process and procedure. Additionally, the Consultant shall contact the Bridge Design Engineer Administrator to verify that there has not been any amendment to the submittal procedure after the latest publication of the *Standard Specifications.*

The following is the most current submittal process which the Consultant shall include in the contract documents:

After the start of the assembly period and prior to commencing work, the Contractor shall provide electronic submittals, as PDF documents, to the Bridge Design Engineer Administrator. Submittals 10MB or less can be transmitted through email. All larger submittals shall be sent through the large file transfer system selected/approved by the Bridge Design Engineer Administrator. Other methods can be considered upon request.

Submittals shall include, but are not limited to, catalog cut sheets, shop drawings, descriptive data, installation and operating instructions, brochures, etc., for all material to be installed on the project. The state project number, project name, fabricator or manufacturer's name, and Contractor's company name shall be on every sheet of the submittal and be in a typed or stamp format. Handwritten submittals are not acceptable. All cut sheets within the submittal shall have all pertinent data on each item clearly marked to indicate material description, brand name, model number, size, rating, and manufacturing specification. Do not use highlighting to mark information. Submittals that do not contain all data necessary to verify conformance will be returned for correction. Additional submittals or random samples may be requested at the discretion of the Bridge Design Engineer Administrator or Project Engineer.

Shop drawings shall easily print to full size (22 in. x 34 in.). Equipment submittals shall easily print to 8 ½ in. x 11 in. or 11 in. x 17 in.

Equipment brochures shall be clear and legible. Provide accurate representation of colors and patterns where such is called for in the item's description or as needed for clarity.

After review, items that are stamped "No Exceptions Taken" will be distributed electronically. Items stamped "Returned For Correction" shall be corrected and resubmitted. Any comments on submittals are not intended to relieve the Contractor from compliance with the contract documents. Approval of submittals and drawings does not imply that the equipment and materials described is complete, can be constructed or installed, will operate successfully, or will coordinate with existing or other equipment specified. The Contractor shall remain responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordination of the work, performing the work in a safe and satisfactory manner, and for satisfactory installation and operation of equipment.

The furnishing of all submittals, shop drawings, samples, etc. as required herein is paid for under Item 730-09-00100. No material shall be ordered and no fabrication or installation of equipment shall begin until the related submittal has been distributed without exception by the Bridge Design Engineer Administrator and a copy has been received by the Project Engineer.

Note: See *A8.1.1* for the submittal process with regards to “Installation, Operation, and Maintenance Manuals.”

REFERENCES

AASHTO LRFD Bridge Construction Specifications, Latest Edition, American Association of State Highway and Transportation Officials, Washington D.C.

AASHTO LRFD Movable Highway Bridge Design Specifications, Including the Latest Interim Revisions to the 2nd Edition, American Association of State Highway and Transportation Officials, Washington D.C., 2007

AASHTO Standard Specifications for Movable Highway Bridges, 5th Latest Edition, MHB-5. American Association of State Highway and Transportation Officials, Washington D.C.

Louisiana Standard Specifications for Roads and Bridges, Latest Edition, State of Louisiana Department of Transportation and Development, Baton Rouge, LA

Applicable Standards and Codes:

ANSI—American National Standards Institute

ICEA—Insulated Cable Engineers Association

IEEE—applicable Institute of Electrical and Electronics Engineers standards for electrical components and equipment

NEC—National Electrical Code (NFPA 70)

NEMA—applicable National Electrical Manufacturers Association standards for electrical components and equipment

NESC—National Electrical Safety Code (ANSI C2)

NFPA—National Fire Protection Association

NFPA 70E—Standard for Electrical Safety in the Workplace

NFPA 110—Standard for Emergency and Standy Power Systems

NFPA 780—Standard for the Installation of Lightning Protection Systems

OSHA 29 CFR part 1910—Occupational Safety and Health Standards

UL96A—Standard of Installation Requirements for Lightning Protection Systems

UL 1008—Transfer Switch Equipment

UL 2200—Standard Engine Generator Assemblies

VW-1 (UL 1581)—Standard for Vertical Flame Test

APPENDIX—REQUIRED ELECTRICAL PLAN SHEETS

REQUIRED ELECTRICAL PLAN SHEETS GENERAL (ALL BRIDGE TYPES)

- The electrical design engineer shall contact the Bridge Design Engineer Administrator and obtain example plan sheets.
- Call 225-379-1315 or 225-379-1086.
- See the particular bridge types in the following Appendices for additional required sheets.
- If a plan sheet does not have enough space for the required material, additional sheets must be added.

E0 Sheets: Electrical Requirements & Specifications

Electrical General Requirements Sheet

Shall contain all of *A1.3.1* with any modifications for specific conditions.

Electrical Specifications Sheet

Shall contain all of *A1.3.2* with any modifications for specific conditions.

E1 Sheets: General Plan Layouts & Operator's House Layout

General Plan Layouts

This is the Plan and Profile sheet for the project. This sheet is built upon the corresponding civil/structural sheets and is used to indicate the placement and flow of electrical and mechanical items with the inclusion of minimum civil/structural details needed for clarity. This includes all mechanical and electrical items with exception of those inside of the operator's house. Refer to the particular bridge types located in the following appendices for further exceptions or additions.

Operator's House Layout

The Operator's House Layout Sheet shall show the electrical floor plan of each floor. This sheet shall show all electrical equipment and mechanical items that will require electrical power. Typical electrical equipment includes: lights, switches, receptacles, disconnects, air compressor, switchboard, control desk, photocells, navigation horn equipment, engine generator set, transfer switch, and surge protection device. Typical mechanical equipment includes: air handling unit, condensing unit, exhaust fans, sewage treatment equipment, and hot water heater.

E2 Sheets: Riser Diagram, Conduit and Wire Schedule

Riser Diagram

The riser diagram and shall show all raceway, junction boxes, electric equipment, and mechanical equipment requiring electrical power. The layout shall reflect the actual physical layout as much as possible. Every conduit and cable shall be assigned a conduit number. Equipment numbers and labels/descriptions shall be shown to differentiate and identify different equipment.

Conduit and Wire Schedule

This sheet shall be compiled using the riser diagram. It shall contain the following information about every conduit, cable, or raceway in table form from left to right:

1. Conduit number from the riser diagram.
2. Nominal conduit size.
3. Approximate length of conduit (also cable type if used).
4. Number and size of conductors and cable type if used.

Wire numbers/labels for conductors located in conduit, cable, or raceway. Provide a ground wire in all conduits and cables. Provide 10 percent to 15 percent spares in all conduits, with the exception of the power wires from the electrical service, engine generator set, and transfer switch. Indicate the number of spares in the same section where the wire labels are located.

E3 Sheets: 3 Phase Power, 1 Phase Power

Three (3) Phase Power Schematic

Wiring diagram showing all phases, wires, and wire numbers starting from the service conductors feeding the service disconnect to the 3 phase loads. Wire numbers change across circuit breakers, disconnects, contactors, motor starters, and the transfer switch. Symbols representing these items, loads, and others items are drawn on this sheet. Amp meter current transformers and amp meter selector switch table is show on this sheet. Equipment numbers and labels/descriptions shall be shown to differentiate and identify different equipment. Where there is a 208 volt high leg, tag this phase with a warning and give instructions to mark the high leg orange at the service disconnect, engine generator set, switchboard, and where the NEC code requires.

Single (1) Phase Power Schematic

Wiring diagram showing all phases, wires, and wire numbers starting from the load conductors from the main circuit breaker in the switchboard to all non 3 phase loads. Wire numbers change across circuit breakers, disconnects, contactors, switching devices. Symbols representing these items, loads, and others items are drawn on this sheet. Equipment numbers and labels/descriptions shall be shown to differentiate and identify different equipment. Where there is 120/240 volt power with a 208 volt high leg, the 120 volt loads shall not be connected to the 208 volt high leg.

E4 Sheets: Control Schematic, Indication Light Schematic

Control Schematic

One sheet shall contain the entire control system schematic (wiring diagram), starting from the line side of the control system circuit breaker. Place the Span Control Switch (SW-SC) table on this sheet. Control wire number shall beginning with the letter "C." Control schematic additions: If there is available space:

a) Place all snap action, rotary, and traffic gate limit switch contact activation tables on this sheet.
b) Place the Gate Control Switch (SW-G1, SW-G2, SW-G3, SW-G4), Control Circuit Switch (SW-CC), and Voltmeter Selector Switch (SW-VM) tables on this sheet.

Indication Light Schematic

Indication light wire numbers shall begin with "I." If the indication light circuit used a neutral wire, this wire number will start with "N." If there is available space and the control schematic additions do not fit on the control schematic sheet and do not need a complete sheet of their own, they may use space on this sheet.

E5 Sheets: Details Sheets

General details which shall be located on these sheets are:

1. Custom-built junction box details and information. Notes to include the position of all electrical enclosures such that NEC clear work space is not violated.
2. Bolts on hub detail.
3. Junction boxes: drawings showing width, height, and terminal block placement with the actual wire numbers on the terminal blocks.
4. Service pole: profile and equipment description and instructions.
5. Traffic warning signals: profile, mounting base and its positioning, breakaway base with pull apart connector, and conduit in the mounting base.
6. Navigation light: profiles, junction boxes, and means of mounting.
7. Conduit clamping methods.
8. Traffic gates: profiles, mounting base and its positioning, orientation of gate box with lowered arm and mounting base to the approaches with side barriers, and conduit in mounting base. The center line of gate arms shall be 33 in. above the approach, where the arm of the gate is 4 ft. from the approach center line. The ends of two separate gate arms on the same side of the waterway, not including the end lights, shall be between 18 in. to 24 in. apart.
9. Junction box mountings: Profiles, maintain NEC workspace clearance, places that junction boxes are mounted, dimensions for mounting, materials and methods for mounting.
10. Limit switch and disconnect mounting methods, placement, material, and dimensions.

E6 Sheets: Bridge Equipment List

This sheet is the equipment list for all electrical items not located on the switchboard or control desk. The items shall be numbered consecutively beginning with number 300. The following information shall be included for each item:

1. Item number.
2. Quantity of item.
3. Item name including abbreviated label where applicable. Ex. For traffic gates: TRAFFIC GATES (G1, G2, G3, G4).
4. Name and catalog number of primary manufacturer.
5. Name of alternate manufacturer for projects receiving federal aid.
6. Description of item to include all pertinent information about the equipment. This description shall be sufficiently detailed to govern all requirements for the Contractor to submit an approved equal to the primary and alternate manufacturer's equipment.

A note section on the equipment list sheet shall explain the following contract notes, in addition to equipment notes that are specific to the project:

1. Equipment shall be as specified or approved equal.
2. Description shall govern over catalog numbers.
3. All conduits shall have bolt-on hubs. For conduits of 1 ½ in. diameter or less, Myers hubs with grounding locknuts might be allowed if the electrical inspector determines that the lack of space disallows the use of bolt-on hubs.
4. Be aware of the NEC cubic inch capacity requirement concerning device, pull, and junction boxes.
5. UL-listed means of terminating grounding conductors shall be provided for all enclosures requiring splices to ground. Examples are junction boxes on E5 sheets.

E7 Sheets: Switchboard Detail

The switchboard detail shall show general layouts of electrical equipment located on the exterior and in the interior of the switchboard. The switchboard equipment layout shall ensure that sufficient space is provided for each electrical component and its respective wires.

The exterior layout shall depict the locations of the circuit breaker access points, circuit breaker nameplates, and door latches. Equipment is to be arranged to reflect the physical orientation of the switchboard. The circuit breaker nameplates shall be inscribed with the breaker's function and abbreviation where applicable. Ex. For emergency stop; EMERGENCY STOP (CB-ES).

The interior layout shall depict the terminal block layout, to include all wire numbers terminating inside the switchboard. Each terminal block shall allow the wire bending radius required by the NEC for the largest wire size used.

The interior layout shall also depict all electrical components that require wiring, to include: meters, heaters, circuit breakers, relays, starters, door switches, dimmers, luminaries, etc. Electrical equipment shall be labeled to reflect the wire numbers connected to each piece of equipment. The switchboard shall be wired from the back. All wiring shall be laced into well supported bundles with nylon cable ties. All corners shall be rounded and all welds shall be grounded smooth.

E8 Sheets: Switchboard Equipment List

This sheet is the equipment list for the switchboard and all its electrical components. The items shall be numbered consecutively beginning with number 200. The following information shall be included for each item:

1. Item number.
2. Quantity of Item.
3. Item name including abbreviated label where applicable.
4. Name and catalog number of primary manufacturer.
5. Name of alternate manufacturer for projects receiving federal aid.
6. Description of item shall include all pertinent information about the equipment. This description shall be sufficiently detailed to govern all requirements for the Contractor to submit an approved equal to the primary and alternate manufacturer's equipment.

A note section on equipment list sheet shall explain the following contract notes, in addition to equipment notes that are specific to the project:

1. Equipment shall be as specified or approved equal.
2. Description shall govern over catalog numbers.
3. Control and indication wires in the switchboard that do not leave the switchboard and are connected between control devises devices or connected between control devices and the terminal blocks in the control switchboard will be allowed to be a minimum size of #12 AWG.

E9 Sheets: Control Desk Details

The control desk detail sheets shall show general layouts of electrical equipment located on the exterior and in the interior of the control desk. The control desk equipment layout shall ensure that sufficient space is provided for each electrical component and its respective wires.

The exterior or top layout shall depict the locations of the switches, push buttons, indication lights, meters, generator enunciator panel, and nameplates. The profiles shall indicate desk dimensions, door, and door handle locations. Equipment is to be arranged to reflect the physical orientation of the control desk. All corners shall be rounded and all welds shall be grounded smooth.

The interior layout shall depict the terminal block layout, to include all wire numbers terminating inside the switchboard. Each terminal block shall allow the wire bending radius required by the NEC for the largest wire size used. Other interior components requiring details are: bypass switch mounting, bypass switch nameplates, 3 point latching on double doors, means of mounting piano hinges, door rubber bumpers, and means of manual navigation horn operation.

Wiring of the control desk: The electrical equipment shall be labeled to reflect the wire numbers connected to each piece of equipment. The control desk wiring shall be show as viewed from underneath. All wiring shall be laced into well-supported bundles with nylon cable ties.

E10 Sheets: Control Desk Equipment List

This sheet is the equipment list for the control desk and all its electrical components. The items shall be numbered consecutively beginning with number 100. The following information shall be included for each item:

1. Item number.
2. Quantity of item.
3. Item name, including abbreviated label where applicable.
4. Name and catalog number of primary manufacturer.
5. Name of alternate manufacturer for projects receiving federal aid.
6. Description of item to include all pertinent information about the equipment. This description shall be sufficiently detailed to govern all requirements for the Contractor to submit an approved equal to the primary and alternate manufacturer's equipment.

A note section on the equipment list sheet shall explain the following contract notes, in addition to equipment notes that are specific to the project:

1. Equipment shall be as specified or approved equal.
2. Description shall govern over catalog numbers.
3. Control and indication wires in the control desk that do not leave the control desk and are connected between control devices or connected between control devices and the terminal blocks in the control desk will be allowed to be a minimum size of #12 AWG.

REQUIRED ELECTRICAL PLAN SHEETS FOR SWING SPAN BRIDGES

All required electrical plan sheets in the appendix titled "Required Electrical Plan Sheets General (all bridge types)" shall apply.

E1 Sheets: Center Pier Layout

This is a plan view of the center pier which shows the placement of electrical and mechanical items mounted to the center pier and to the pivot bearing girder. Typical items shown are mounting brackets, limit switch strike plates, snap and rotor limit switches, hydraulic cylinders, pump motor assembly, hydraulic tubing, disconnects, conduit and flexible cable, and junction boxes. If space is available on this sheet, limit switch mounting bracket and strike plate details may be shown. Otherwise, these details should be located on the E5 sheets.

E5 Sheets: Detail Sheets

Provide a detail showing the profile of the center pier platform and the bearing girder. Detail shall face the side of the bearing girder which the span junction box is mounted on. This detail shall also include the following: Conduits, lights, receptacles, center pier junction boxes, center wedge or lift junction boxes, center wedge or lift limit switches, and flex loop from the center pier junction boxes to the span junction boxes. Note: This detail is not required to show conduits, disconnects, span motors, or hydraulic equipment on the center pier itself other than the duct/cable from the operator's house and the conduits to the flex loop feeding the span.

Provide details for the center pier auxiliary control station. Details shall include a) layout of push buttons, switches, and indication lights, b) layout for back wiring of "a," and c) legend for the nameplates for the push buttons, switches, and indication lights.

REQUIRED ELECTRICAL PLAN SHEETS FOR VERTICAL LIFT BRIDGES

All required electrical plan sheets in the appendix titled "Required Electrical Plan Sheets General (all bridge types)" shall apply.

E1 Sheets: Machine Deck Layout

This is a plan view of both machine decks (and crosswalk if provided for in the design) which shows the placement of electrical, mechanical, and civil equipment. Typical items shown are conduits, junction boxes, lighting, height and skew indication equipment and their enclosures, lightning protection system equipment location and routing, span motors, span brakes, differential motor (mechanical), and the differential limit switch. Other mechanical and civil items shown are handrails, stairs, sheaves with their mounting stands, trunnion shafts and their bearings, and the main parallel shaft reducers. Show which columns the conduits use to provide access to the machine decks.

E4 Sheets: Selsyn Schematics

Provide wiring diagrams for the connections to the height and screw selsyn systems.

E5 Sheets: Tower Stair Light Mounting

Provide details for the tower stair light mounting.

E6 Sheets: Lightning Protection System Additional Material Specifications

All conductors and lightning rods shall be made of copper with the exception of when the lightning protection system is mounted to aluminum material (Examples: 1) Operator's house having an aluminum roof, 2) Running along light poles that are aluminum).

All connectors that are not underground, under water, or cast in concrete shall be bolt tension type and not a compression type and shall have material compatible with the conductors. All connections that are underground, underwater, or cast into concrete shall be exothermic welded.

Ground loops shall be installed a minimum of 5 ft. from the underwater floor and have 10 ft. x ¾ in. copper ground rods. Exothermic weld the ground loop to all down conductors and the ground rods.

Tower machine decks having concrete columns shall have insulated-copper down conductors running concealed inside the columns and continue through the concrete piers. Down conductors, in route to the grounding loop, shall exit underneath the piers near the piles to which they will be secured. See specifications to follow for bonding the down conductors to rebar.

Down conductors will be running along some of the pier and house piles. Bond the rebar in the pier to the pre-stressed cable in the effected piles in accordance with NFPA 780. The top 2 in. (maximum) of concrete surrounding one pre-stressed cable of each effected piles shall be removed for exothermic welding.

Sheave lightning rods are to be mounted on top of 2 in. diameter galvanized heavy-duty steel poles. Poles shall be mounted to the sheaves bases using stainless hardware. Prime and paint poles to match sheaves. Note: Do not paint lightning protection system conductors.

Lightning protection system conductors shall be secured every 3 ft. (maximum). See NFPA 780 for bending regulations.

Bonding conductors and associated connectors may not be shown in the plans but shall be provided and installed. A list of items requiring bonding to the main conductors (loops and down conductors) using bonding conductors are listed below. The list below may not be complete. Provide any additional bonding that is required by governing codes.

1. Tower columns and tower machine decks: sheave bases, light poles, machinery bases, junction & pull boxes, handrails, conduit, stairs (at the top and bottom), guide rails for counterweight and span (at the top and bottom), rebar in concrete columns (near the top and bottom), horizontal rebar in the tower machinery decks (at the top and bottom layers of both far ends).
2. Bottom of bridge towers and tower piers: handrails, stairs, junction & pull boxes, conduit, vertical rebar in the columns (at the bottom) and horizontal rebar in the tower piers (at the top and bottom layers at both far ends), pre-stressed cable in effected piles, barrier machinery base and barrier towers.
3. Operator's house equipment, which includes: handrails, condensing unit, stairs (at the top and bottom), equipment inside and outside the operator's house, engine generator set, generator fuel tank, door frames, vent grills, roof metal, rebar/metal in the concrete floors, pre-stressed cables in effected piles, and conduit.

REQUIRED ELECTRICAL PLAN SHEETS FOR BASCULE BRIDGES

All required electrical plan sheets in the appendix titled "Required Electrical Plan Sheets General (all bridge types)" shall apply.

E1 Sheets: Bascule leaf Pivoting Pier Layout & Bascule leaf Pivoting Pier Profiles

Bascule leaf Pivoting Pier Layout

This is a plan view of the bascule leaf pivoting pier which shows the placement of electrical and mechanical items mounted to the pier and to other structural items associated with the pier. Typical items shown are mounting brackets, rotary limit switches, hydraulic cylinders, pump motor assembly, hydraulic tubing, disconnects, conduit and flexible cable, service lights and receptacles, junction boxes, conduit, and submarine cabling means to the service, operator's house, and far side pier.

Bascule leaf Pivoting Pier Profiles

As many profiles as needed to clarify equipment elevation and installation.

REQUIRED ELECTRICAL PLAN SHEETS FOR PONTOON BRIDGES

All required electrical plan sheets in the appendix titled "Required Electrical Plan Sheets General (all bridge types)" shall apply.