



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

JOHN ELIAS BALDACCI
GOVERNOR

DAVID A. COLE
COMMISSIONER

June 25, 2009
Subject: **Bowdoinham**
State Aid Project No: BH-1509(100)X
State Pin No: 015091.00
Amendment No. 1

Dear Sir/Ms:

Make the following change to the Bid Document:

In the Bid Book, after page 83, **INSERT** the attached "SPECIAL PROVISION, SECTION 648, RAILROAD, Highway Grade Crossing Signal System", 24 pages dated May 2009.

Consider this change prior to submitting your bid on July 8, 2009.

Sincerely,

Scott Bickford
Contracts & Specifications Engineer



PRINTED ON RECYCLED PAPER

SPECIAL PROVISION
SECTION 648
RAILROAD
Highway Grade Crossing Signal System

The work under this item shall conform to the applicable sections of the State of Maine Department of Transportation Standard Specifications and Standard Details (Revision of 2002), American Railway Engineering Maintenance-of-Way Association (AREMA) Communications & Signals (C&S) Manuals Vol. 1-4, Federal Railroad Administration (FRA) Title 49, Chapter II, Part 234 & Part 236, Manual on Uniform Traffic Control Devices (MUTCD), Part 8, the Plans, General Notes and the following:

648.01 Description

This work shall consist of designing, furnishing, installing and testing of an Automatic Highway Crossing Warning (AHCW) system for the at-grade crossing of Rt. 24 (Harwards Crossing). Detection for the AHCW system shall be the AC/DC (type C) track circuit, including installation of (2) flashing light units, (2) cross-bucks, (2) electronic bells, (2) motorized gates/arms and (1) crossing control case with all new cable to the gates/flashing lights/track circuits. The case shall be pre-wired and include all crossing circuits, control equipment, batteries, battery charging units and other ancillary equipment as shown on the Project Plans and as listed within this section.

Related work is specified in other Sections as follows:

- Rail-Highway Crossings are specified in Special Provision Section 648 - Railroad

648.02 Basic Technical Requirements

AHCW system equipment proposed for this Contract must be proven by a minimum in-service operation of two years.

The Contractor shall verify that the AHCW systems start circuits are correct for the reaction time of the type of equipment he proposes to install. Any relocation of the start circuits due to the reaction time of proposed/approved equipment shall be at no additional cost to the Maine DOT.

All apparatus shall be furnished completely factory wired and tested. The Contractor shall furnish all plans required to install the systems.

648.03 General Requirements

A new Safetran System factory-wired case shall be provided for all new AHCW system equipment.

- The case shall be provided in accordance with Section 650.16 of these Specifications.

- The foundation shall be in accordance with Section 650.13 of these Specifications.

Internal circuit logic shall be so designed that a momentary shunt applied to the island circuit while the approach is occupied shall not allow the crossing warning system to cease operation (clear).

Additionally, since the crossings are located in unsignalled territory, stick cancellation timers shall be utilized.

The AHCW system shall be designed and furnished in accordance the applicable paragraphs of the American Railway Engineering & Maintenance of Way Association (AREMA) C&S Manual, Vol. 1, Section 3.

648.05 Delivery Storage and Handling Locations and Ability to Inspect at Leisure

- AHCW system equipment shall be shipped properly packaged and identified with equipment type, module type, drawing number, and installation location printed on the outside of the carton.
- Special shipping requirements for individual items are specified in each items subsection.
- Materials shall be protected from damage throughout delivery, storage and handling.
- Notify the Resident Engineer upon receipt of materials.

648.06 Gate Mechanism/Arms

Gate mechanism shall be new S 40 type as manufactured by Safetran or approved equal. Gate arms shall be an aluminum/fiber-glass combination with 4" LED lights, wind guards and gate savers as manufactured by Safetran, General Signals Inc., or approved equal.

648.061 Flashing Lights

Flashing lights shall be new 12 inch LED, front/back mounted for a 5 inch mast pole as manufactured by Safetran or approved equal.

648.062 Bells

The bells shall be new electronic mounted for a 5 inch mast pole as manufactured by Safetran or approved equal.

648.063 Mast Poles

Mast poles shall be new 5 inch aluminum and bases shall be cast aluminum junction box type as manufactured by Safetran or approved equal.

648.07 Event Analyzer/Recorder

Event recorder shall be a microprocessor controlled unit capable of monitoring digital inputs, analog voltage/current inputs, and dedicated internal functions as manufactured by Safetran or approved equal.

648.08 Railroad Cable

Material and workmanship shall be of the highest quality assuring durability for minimum life expectancy of forty years. These cables shall be suitable for use in the environment to be encountered on a railroad signal system and shall be certified for continuous operation at 75 degrees C in wet or dry locations with no conductor failing in continuity or with loss of insulation to cross or ground less than one meg-ohm.

Local distribution cable shall contain a minimum of ten percent spare conductors or one spare conductor; whichever is greater, except that two conductor cables will not require spare conductors. Local distribution cables are those cables that run the crossing control case and an individual unit of equipment.

The wire and cable to be furnished under this Contract shall meet the requirements of wire and cable specifications as state herein.

DELIVERY, STORAGE AND HANDLING

Shipping, storage and handling shall be in accordance with AREMA C&S Manual, Part 10.4.1 and Part 10.3.16. During storage and handling, prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.

The cable shall not be abraded or damaged during shipping and handling. The condition of the cable shall be inspected upon delivery and as the cable is being installed to ensure no damage has occurred. Any damaged noted shall be reported to the MDOT Engineer, and the damaged cable shall be replaced at no additional charge to MDOT.

CABLE INSTALLATION

The installation of wire and cable shall conform to AREMA C&S Manual Vol. 3, Part 10.4.1 and 10.4.30, except as modified herein.

Cable shall be direct buried except when crossing under tracks where 4" schedule 80 conduit shall be used.

The Contractor shall provide sufficient slack in cable conductors at all terminations to enable three termination of the conductor without re-servicing or re-potheading the cable.

Cables shall not be bent to a radius less than 12 times the diameter of the cable during installation or as finally installed.

Tags to identify cables shall be of plastic material. Tags shall be lettered to correspond with the cable destination and number of conductors in the cable.

All cables shall be terminated in conductor order. Individual cable conductors shall be identified at each cable termination with plastic tags. All spare conductors in each cable shall be terminated and identified.

All cable entrance openings shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area

around cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed or plugged in an approved manner.

A suitable lubricating medium, non-injurious to the cable insulation, shall be used when pulling cables into conduit, pipe, or duct bank.

Underground Buried Installation

- Cables installed under the tracks shall be installed in conduit as indicated in Special Provision 648 and on the Plans.
- A five-foot slack coil shall be left in each cable buried 42 inches below the crossing case and each gate or flasher foundation.

Conduit under Roadway

- Cables installed through the roadway shall be installed in conduit as indicated in Special Provision 648 and on the Plans.
- Glycerized non-injurious liquid lubricant or other lubricant approved by the cable manufacturer shall be applied to the cable when installing cables in conduits.
- The ends of the cable shall be immediately sealed until such time as the terminating and protecting of the cable in the cases and gates or flashers is affected.
- Cables shall not cross one another when they are pulled into a conduit and care shall be taken not to have the conductors pulled tight or kinked. All cables to be installed in a conduit shall be pulled and installed simultaneously.

CABLE TESTS

Testing of cables shall be accomplished in accordance with Section 650.22 of these Specifications.

648.09 Relays

Relays shall be applicable plug-in type Safetran component or approved equal. Relays of each type shall be uniform in design and contact assembly.

Each relay shall have at least two spare dependent front-back contracts, or one spare independent front and one spare independent back contract.

Calculations for time release shall be performed in accordance with AREMA C&S Manual Vol.3, Part 2.4.20, where applicable.

Relays shall meet the requirements of AREMA C&S Manual Vol. 3, Part 6.2.1, except as specified herein.

All plug-in relays shall be equipped with front current testing facilities to enable the testing of voltage from the front of the relay.

DC track relays shall be biased neutral type, with a minimum contact arrangement of one front-back, one front, and one back contacts. Track relays shall be Safetran ST1 with 4-ohm coil resistance.

DELIVERY, STORAGE AND HANDLING

Relays shall be shipped separately from the wired cases in which they are to be used. They shall be packaged individually, each in a sturdy corrugated cardboard carton with the drawing number of the relay printed on the outside of the carton. Relays shall be stored in a protected area until tested and installed.

The Contractor shall ensure that the relay operating characteristics have not been altered due to damage during shipping procedures.

Relay plugboards shall be as specified in Section 650.16 of these specifications.

An approved typed or printed relay nametag for each relay shall be mounted on relay cover. The nametag shall be easily replaceable, but shall not come off during normal service.

The Contractor shall test all relays in accordance with Section 650.22 of this specification.

648.10 Rectifiers, Batteries, and Battery Charging Equipment

The Contractor shall provide separate battery banks and chargers for each bus. Use of split battery banks to provide different voltages will not be accepted. Separate battery banks shall also be provided for the dc-dc converters for track circuits.

All battery charging equipment as specified herein shall meet the requirement of AREMA C&S Manual, Vol. 3, Part 9.2.1, where the requirements of the AREMA C&S Manual do not conflict with any requirements specified in this Section.

All batteries as specified herein shall meet the requirements of AREMA C&S Manual, Vol.3, Part 9.1.15, where the requirements of AREMA C&S Manual do not conflict with any requirements specified in this Section.

DELIVERY, STORAGE AND HANDLING

Batteries shall be shipped separate from the housing. All terminals shall be protected and insulated to prevent damage or discharge.

DESIGN REQUIREMENTS

Equipment shall be designed for continuous operation.

Equipment shall be designed to deliver rated outputs with an input voltage fluctuation of 20% above and below rated nominal voltage.

Equipment shall have a reserve capacity at least 25% above the calculated requirements.

Terminal markings for ac and dc terminals shall be permanent. Input and output terminals shall contain a non-conducting device or insulated safety cover to protect personnel from electrical hazards. Insulating device shall be rated for a minimum of four times the normal voltage of terminal.

Equipment shall be a wall mounted device with perforated protective covers. Power equipment shall be designed to provide natural convection cooling.

Surge protection requirements shall be in accordance with the system manufacturer standards.

BATTERY CHARGERS

Battery Chargers shall meet all applicable requirements of the AREMA C&S Manual, Vol.3, Part 9.2.1.

Battery Bank Chargers shall be fully adjustable rectifiers as manufactured by Safetran SJ20/SJ40, or approved equal.

The Contractor shall furnish new dc battery bank chargers for operating all equipment required to operate the connected equipment.

The charger shall provide a stabilized output voltage, with output current limiting. The capacity of the batter charger shall be determined by the manufacturer. The charger shall adjust its output current automatically according to the load and to the demand on the battery.

Chargers shall be equipped with dc ammeters and voltmeters with 2% accuracy.

Chargers shall be equipped with plug-in temperature sensors.

STORAGE BATTERIES

The Contractor shall furnish new nickel cadmium (Ni-Cd) storage batteries, as manufactured by SAFT America Type SPL or approved equal. Gel type cells will not be approved.

The batteries shall have a projected life of 25 years at 25 degrees C.

The battery cells shall be mounted in wood trays and sized. Unless otherwise approved, batteries shall be mounted in a single tier.

Batteries and battery chargers shall be handled and installed per the Manufacturer recommendations. The Contractor will perform initial adjustment and monitoring of the battery chargers.

All batteries shall be sized for a minimum 24 hour standby capacity, and shall not be less than the following 240 AMP-Hour B12 and B14 busses AHCW system locations. The loads shall be based upon the equipment that he proposes to furnish.

RECTIFIERS

The Contractor shall furnish new AC/DC track circuit rectifiers avalanche type silicon diode and a protective equalizer model TCR6 as manufactured by Safetran or approved equal.

648.11 Solid State Crossing Control Unit

The Solid State Crossing Control Unit shall meet all applicable requirements of the AREMA C&S Manual, Vol.3, Parts 1.5.1, 3.2.55 and other parts applicable to solid-state devices.

- The crossing control unit shall be the Safetran SSCC-III Plus unit.
- This unit shall replace the vital XR, XRP, EOR, POR and light transformer and gate delay functions without use of external relays.

- The unit selected (20-amp or 40-amp) shall drive no more than 80% of the actual lighting load it is required to support.

SOFTWARE DESIGN

- The system shall be fail-safe system design.
- All executive and vital system software, including all self-checks, shall be installed in the system in a manner that will prevent unintentional changes by the user.
- Location specific vital software shall be programmable by the user and shall be stored in non- volatile memory.
- The system shall automatically reset and should attempt a restart after a condition causing system shutdown is eliminated.
- The system shall remain in fallback mode until self-initialization software and hardware tests have been completed to determine that the system is operating properly.
- The system shall contain internal diagnostics to permit trouble shooting.

648.12 Record Documents

The work to be done under this Section consists of the production and furnishing of design and final record drawings and tracings. The general format of drawings, types of drawings, and the manner in which information shall be displayed for working drawings and record drawings is described herein.

WORKING DRAWINGS

These are drawings that have been submitted and approved for use in the installation of the Contract. Working drawings and installation drawings shall show circuit details, wiring diagrams layouts, schematic cable plans, and mounting details and such other information as is necessary for installation by the Contractor.

RECORD DRAWINGS

Drawings that show the actual installation of the Contract as approved and accepted. Hard copy drawings prepared by the Contractor shall be 11”X17”, with form and title as required.

The Contractor shall design the wiring diagrams and final circuit drawings for the equipment being furnished.

The Contractor shall be solely responsible for the correctness of the wiring diagrams and final circuit drawings.

The Contractor shall prepare the relay contact, relay location and detail wiring assignments for the final design and provide arrangement drawings where the contact usage of each relay is recorded. Circuit drawings shall contain circuit nomenclature, terminal identification, fuse and resistor sizes and relays with their contacts identified by number and by coordinates to identify the location of the relay on the instrument rack.

AREMA standard symbols and nomenclature shall be used, except as shown otherwise on the Contract Drawings.

When the final circuit is not wired as shown on the Contractor’s drawings, the Contractor shall revise his tracing to indicate the actual wiring before final Record prints are made.

648.13 Signal Equipment Foundations

The work to be done under this Section Consists of furnishing and installing either pre-cast concrete foundations and or galvanized steel foundations. Foundations to be furnished and installed shall be provided complete with rebar, galvanized anchor bolts, washers, nuts and associated hardware and installed at locations shown on the Project Plans.

The Contractor shall furnish and install all foundations for the signal houses, signals, and cases.

QUALITY ASSURANCE

- A permanent record shall be kept by the pre-cast fabricator of the date conditions of casting of each unit.
- The Contractor shall verify that the bolt sizes and spacing shown on the equipment shop drawings match those shown on the foundation drawings.

BOLTS, NUTS AND HARDWARE

- Bolts, nuts and washers shall be galvanized. Nuts and threads shall be in accordance with AREMA C&S Manual, Vol.4, Part 14.6.20.
- Plain and Spring washers shall be in accordance with AREMA C&S Manual, Vol. 4, Part 14.6.21.
- Bolt diameters for anchor bolts shall be per manufacturer's requirements.

FOUNDATIONS

- Signal foundations shall be pre-cast concrete and extend below the frost line.
- Concrete shall be in accordance with State of Maine Standard Specifications Section 626.02, Precast Concrete Units and Section 626.021 Miscellaneous Material.
- Steel shall be in accordance with AREMA C&S Manual, Vol. 4, Part 15.1.4, Section 1.

648.14 Insulated Rail Joint

The work to be done under this section consists of designing, furnishing and installing all insulated rail joints at all necessary locations to complete approach and island circuits, including all required associated materials such as plates, spikes, etc.

Non-bonded insulated joints shall be new, and meet all the requirements of AREMA C&S Manual, Vol. 1, Part 2, Section 2.12, and shall be as manufactured by PORTEC, 3M, or equal.

Insulated joints locations shall meet all the requirements of AREMA C&S Manual, Vol.1, Part 2.1.20E and shall be a minimum of 50 feet from the edge of pavement. If there should be any conflicts, the Resident Engineer shall determine the exact location(s).

648.15 Rail Bonding

The work to be done under this Section consists of designing, furnishing, and installing all rail bonds, track circuit connections and all other material required for bonding rail track joints and track circuit connections as specified herein and necessary for a complete and functioning grade crossing system.

All rail connections shall be exothermic weld type.

The Contractor shall furnish all welded bonds and connections complete with weld materials, molds, clamps, igniters, and all other materials required to install the connection. Rail grinding and rail drilling equipment will be provided by the Contractor.

Railhead bonds shall be in accordance with the requirements of AREMA C&S Manual, Vol.3, Part 8.1.30, where the requirements of that Part do not conflict with these Specifications.

Bonding materials and track circuit connectors shall be as manufactured by Erico Products, Inc., approved equal.

Railhead bonds shall be 5/16 inches in diameter with steel terminals welded to the conductors and shall have a nominal length of 7 inches. Railhead bonds shall be composed of 7 strands; each strand shall consist of 19 wires. Wires shall be .0125 inches of cadmium bronze, 99% copper, 1% cadmium, hard drawn.

The welding material shall consist of copper exothermic mixture employing tin-metal in an amount to effectively constitute 4.5 percent to 5.5 percent of the resulting weld metal. The resulting weld metal shall be of high electrical conductivity and shall have a minimum tensile strength of 39,000 pounds per square inch. The tensile strength shall be determined by tensile test performed on ½ inch nominal diameter tensile specimens (without flaws) cast in graphite molds.

Conductors for stranded type bonds shall be composed of 133 cadmium bronze wires, 80 percent conductivity, each wire 0.0125 inc. diameter.

Track circuit rail connectors shall be 3/16 inch stranded bronze conductors with a one inch tab style terminal on one end and compression sleeve on the other end, for a direct crimp type connection to the track wire. Conductors shall be PVC insulated. The length of the conductors shall permit termination within a track circuit junction box located between the rails, with sufficient slack within the junction box for three reterminations.

The Contractor shall furnish one hole clamps and fasteners for securing the wires along and across ties. Use of staples for securing the wires will not be allowed.

The Contractor shall demonstrate that the bonding is in accordance with the requirements of this Section and as specified in AREMA C&S Manual, Vol.3, Part 8.1.30.

648.16 Crossing Control Case

MATERIALS

The crossing control case shall be a Safetran 6' x 6' aluminum house. All material contained within shall be either Safetran manufactured parts or approved for use by Safetran.

Where required, wooden trays of a suitable design and size, located eight inches above the floor case, shall be provided for the batteries. Unless otherwise approved, the design shall provide for batteries to be mounted on battery trays of a single tier.

Provisions shall be made for locking with Railroad approved padlock. In each door there shall be a minimum of two ventilating openings covered with fine mesh stainless steel, copper, or bronze screening. The exterior of the ventilated openings shall be headed to minimize the entrance of rain. Doors shall be provided with a two-position retaining device to secure the door when open.

Cable Entrances

Cable entrance pipes shall be as specified in Section 650.21 and sized to fit the entrance knockout.

Equipment Racks

Racks shall be provided with spare space for four plug-in relays of the type and size used. Crowding of the equipment shall be avoided.

Relay Plugboards

Plugboards shall be designed for the insertion of removable type contacts. The method of attaching the wires to the removable contacts shall be solderless connection. Unless otherwise approved, the plugboard shall be designed so that the removable contact will have a direct connection with the relay coil and the contact prongs. The plugboards shall be in accordance with the applicable sections of AREMA C&S Manual, Vol.2, Part 6.2.1.

Relay and Component Mounting

- Relays for track circuits shall be mounted in the upper half of the relay rack.
- Track and control relays shall be mounted in geographical succession in relation to the track arrangement.

Identification

- There shall be an identifying nameplate for each relay, relay rack, or terminal board.
- The back and front of the relay plugboards shall be equipped with a tag as specified in Section 650.21.
- The wiring to each removable contract shall be identified with a wrap-around tag as specified in Section 650.21.
- Wire and cable conductor identification tags for terminal board mounting shall be as specified in Section 650.21.

Terminal Boards

- Terminal boards and backboards, constructed of one inch, Type AB plywood shall be provided for mounting terminal blocks. Terminal boards shall be painted with a fire resistant paint.
- The Contractor shall determine the physical size of the terminal board to meet the requirements of this Project.

- Multiple unit terminal blocks for wire and cable conductors shall be in accordance with AREMA Drawing 14.1.6.
- Lightning arresters shall be as specified in Section 650.21.
- Additional 10% spare terminals and lightning arresters shall be provided. Spare terminals shall be provided complete with terminating washers and nuts.
- Provisions shall be made to locate spare wire conductors on a dedicated terminal post or lightning arrester in line with the working conductors of any one cable. Wires to each cable shall be terminated successively as one block, and shall not be broken up into separate blocks.
- Wire wound resistors shall be mounted on the terminal board spaced with on-half inch spacing between adjacent resistors.

Wiring

All case wiring shall be in accordance with AREMA C&S Manual, Vol.3, Part 10.3.15. No. 16 AWG flexible 19-strand shall be used for all circuits, except No. 10 AWG or larger flexible wire shall be used for 120 volt circuits, lighting circuits, and all wires to feed energy buses. No. 10 AWG wire will also be permitted for use in track circuit wiring within the case.

Wiring Raceway

Plastic raceways will not be permitted within the signal case.

Grounding

A stud bolt for externally grounding the case shall be provided per manufacturer's standard. Perforations of sheet steel cases will not be permitted.

Painting

- The interior of the wayside case shall be painted according to the manufacturer's standard. The terminal boards shall be painted gray ANSI 61 or approved equal.
- The wooden battery trays and spacers shall be painted with two coats of an acid-resistant black paint.
- If the case is not hot dip galvanized or aluminum, the manufacturer shall apply corrosion resistant undercoating using organic zinc-rich coating containing 95% metallic zinc, as an equivalent to hot-dip galvanizing such as ZRC cold galvanizing compound or approved equal.

INSTALLATION

The case shall be mounted level and plumb and fastened with the hardware provided. Trackside doors in the open position shall clear center line of the nearest running track by 8'-6".

Pipes for underground cable entrances shall be installed in the knockout holes provided in the rear of each case. These pipes shall be secured to each case by locknuts and bushings.

All cable entrance pipes shall be sealed with a sealing compound as specified in Section 650.21.

Relays shall be installed on the relay plugboards corresponding to the relay nomenclature and securely fastened in-place with the hardware provided.

Batteries shall be installed on battery trays. Battery posts shall be coated with approved anti-corrosive grease and battery connectors shall be securely fastened to the battery posts.

648.17 Metered Power Services

The work to be done under this Section consists of designing, furnishing, installing, and testing new Meter Services from Central Maine Power. The new supply systems shall provide power to the new Grade Crossing Warning System Control Cases as described within these Specifications.

The Signal Contractor shall design, furnish, install, and test all equipment and connections from the power utility demarcation point to the Grade Crossing Warning System Control Case.

This work shall also consist of providing all interface with, and conformance to, the standards and recommendations of Central Maine Power, and the National Electrical Code in order to obtain the commercial metered power services. The Contractor shall complete all permits required for obtainment of power.

The Contractor shall make all arrangements with the utility for the obtainment of power. The Contractor shall be responsible for all service construction costs incurred by the supplying utility associated with the installation of the new electrical services. Service fees and permits shall also be paid for by the Contractor.

The Contractor shall arrange and coordinate with the utility to schedule the utility access to the site to perform the new meter service installation. The Contractor shall conform to Central Maine Power standard requirements for electrical service and meter installations.

QUALITY ASSURANCE

All new meter service locations shall be in accordance with Central Maine Power standard requirements, and The National Electrical Code. The Contractor's Meter Service design shall be reviewed by the utility for approval, and shall permit access to the meter section by the utility.

The factory test or ac power supply equipment shall meet UL and the manufacturer's standard.

The Contractor shall furnish all the necessary equipment to perform the connection to the supplying utility termination. The equipment shall include all required metering devices, enclosures, conduit, and cable required to connect the power company supply.

Feeders and mains shall be of sufficient size to carry the rated load with a voltage drop of not more than three percent for feeders, and five percent for Grade Crossing Control Case power mains for the entire length of the cable run. The size of the feeders and mains shall be rated to carry a load equal to 125 percent of the total load that can be reasonably imposed by the portion of the Grade Crossing Warning system to be fed.

Conduit shall be in accordance with State of Maine Standard Specification Section 626.02 Non-Metallic Conduit.

Grounding material shall be in accordance with Section 650.19 of the Specifications. In case of conflict, the supplying utility's requirements shall govern.

The Contractor shall install all ac power service cables from the supplying utility demarcation point to the new Grade Crossing Control case provided at the designated location.

The Contractor shall furnish and install all mounting and fastening hardware, insulating cover, cable lugs, conduit, copper grounding strip, grounding, etc., required for the power distribution system and connection to the ac power supply equipment.

Power service grounding shall be installed in accordance with Section 650.19, the latest edition of the National Electrical Code, and the supplying utility's standard requirements. If there is a conflict the supplying utility's requirement shall govern.

648.19 Grounding

The work to be performed under this Section consists of furnishing, installing, and testing a grounding system for Grade Crossing Control Case, and any other equipment or apparatus herein specified for equipment that is to be furnished and installed by the Contractor.

All grounding shall be in accordance with UIC/CFR latest grounding standards.

The grounding system shall preclude any closed loop grounding arrangement.

Ground connection to the track rails or use of the neutral conductors of the Power Company or ac signal supply system shall not be permitted, unless prior approval is given by the Resident Engineer.

QUALITY ASSURANCE

The Contractor shall inspect and test the grounding system furnished and installed at the houses, cases, and junction boxes, and correct any deficiencies noted. The inspection shall be conducted in conformance with the requirements of Section 650.22.

GROUNDING MATERIALS

Ground rods shall be copper-clad steel, of the non-rusting type as manufactured by Copperweld Corporation, or approved equal. The rod shall be at least eight feet in length and at least ¾-inch diameter.

All connections to ground rods shall be by exothermic welds. All connections to house and case ground bars shall be by cable to bar copper terminal connectors, Burndy Type HYLUG copper compression type, or approved equal.

Internal ground wire; from the equipment to the ground bus shall be insulated No. 6 or 10 AWG stranded copper wire. Insulated ground wire shall be colored green.

Each signal instrument house shall be provided with a grounding bus extending the length of the house, mounted above the racks and trays, and connected to the external grounding studs for terminating ground wire.

Ground conductors shall not contain any splices between points. Where pre-manufactured pigtailed are used, such as in house stud to bus bar connections, the pigtail length shall be sufficient to connect between the two points without splices.

Ground conductors shall be installed in the most direct routing possible, without any sharp turns or kinks.

The Contractor shall be responsible for any special grounding required for his equipment over and above that specified herein, at no additional cost to Maine DOT.

Shields on shielded cables shall be single-point grounded, with the single ground connected to the house ground bus.

Convenience outlets and lighting utilities shall be grounded to the case ground bus.

CROSSING CONTROL CAST EXTERIOR GROUNDING

One ground rod shall be provided at each corner of each case for the grounding of all equipment. The ground rods shall be connected with No. 4/0 AWG copper bare wire buried around the entire perimeter of the housing, approximately two feet outside the house foundation, and approximately one foot below final grade. Connections to each ground rod shall be exothermic welds.

The house ground bus shall be connected to each of the four ground rods with No.3/0 AWG copper wire. Connections to the rods shall be exothermic. Connections to the house bar shall be copper compression lug type.

The Contractor shall make, verify, and record ground resistance tests after the ground rods are installed. If the specified ground resistance is exceeded, the Contractor shall install additional ground rods at each corner of the house to meet the grounding requirements.

All exposed metal parts within the case shall be grounded.

Resistance from the case to ground shall be five ohms or better.

The testing of all grounding systems shall be in accordance with the requirements of Section 650.19 and 650.22

648.20 Technical Support

OPERATION AND TECHNICAL MAINTENANCE TRAINING MATERIALS

The contractor shall submit two copies to the Operating Railroad of operational instruction (user) manuals and maintenance and troubleshooting manuals necessary to maintain the equipment supplied.

The manuals shall be so written that the average qualified technician is enabled, by the reading thereof, to maintain, repair, test and adjust the equipment. These manuals shall include, but not be limited to, the following:

- Complete description of operation and usage.
- Theory of operation.
- Complete block, schematic and wiring diagrams of system and subsystems.
- Diagrams showing interconnections to external equipment, including input and output connections, including cabinet equipment interconnections.
- Complete installation, alignment, and adjustment procedures.
- Diagnostic procedures to locate or isolate failed components.
- Routine preventive maintenance procedures.
- Complete replacement parts list.
- Recommended sources for procurement of failed components.

648.21 Miscellaneous Components and Products

The work to be done under this Section consists of furnishing of miscellaneous components and products to be used on this Project.

All miscellaneous components and products used on this Contract shall be:

- New and free of manufacturing defects;
- Clearly and permanently labeled with value or type identification.

All electrical components shall be rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those, which the components will be subject to in service, unless otherwise specified herein.

CIRCUIT BREAKERS, FUSES AND FUSE CLIPS

Fuses and circuit breakers shall be of suitable capacities to protect the various pieces of signal apparatus from the effects of short circuits or overloads. All circuit breakers and fuses required for the equipment and systems shall be in accordance with these Specifications. Where allowable by the manufacturer, thermal type circuit breakers shall be used in lieu of fuses.

Circuit fuses shall be non-renewable, and shall be of the fiber-case, time lag, fusion type. The circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.

Fuse clips shall be so constructed that they shall retain their resilience under all installation and service condition to assure a positive contact between the clips and the fuse.

DIODES

All diodes to be furnished under this Contract shall carry JEDEC number or shall be available from more than one manufacturer and shall be used within the published specifications for such number. All diodes shall be silicone type.

RESISTORS

All resistors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual, Vol.4, Part 14.2.15.

Resistors for electronic circuits shall be in accordance with the applicable requirements of AREMA C&S Manual, Vol.4, Part 14.2.40.

REACTORS

All reactors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual, Vol.4, Part 14.2.20.

Reactors for electronic equipment shall be in accordance with the applicable requirements of AREMA C&S Manual, Vol.4, Part 14.2.20.

CAPACITORS

Capacitors, for electronic circuits, shall be in accordance with the applicable requirements of AREMA C&S Manual, Vol.4, Part 14.2.40.

SIGNAL TERMINAL BLOCKS

AHCW system terminal blocks shall be in accordance with the applicable requirements of AREMA C&S Manual, Vol.4, Part 14.1.5.

TERMINAL POST INSULATORS

All terminal posts, located on terminal boards in the crossing control cases use used to terminate circuits of 120 volts and greater shall be provided with a protective insulator.

The type of insulator shall be individual for each terminal post, fire-resistant, similar to Safetran Type 023408 Insulated Nut, or approved equal. Use of fiber tube type insulators will not be permitted.

INSULATED TEST LINK

Insulated test links shall be AREMA C&S Manual, Vol.4, 14.1.15-9, complete with gold nuts, insulated washers, and copper bars in accordance with AREMA C&S Manual, Vol.4, 14.1.15-11, 14.1.15-12, and 14.1.15-13.

LIGHTNING ARRESTERS AND EQUALIZERS

Lightning arrestors and equalizers shall be mounted on three-post porcelain or approved type base and shall be in accordance with AREMA C&S Manual, Vol.3, Part 11.1.15.

TERMINALS FOR WIRE AND CABLES

Terminal shall be of the solderless crimp-on type. All solderless terminals shall be in accordance with AREMA C&S Manual, Vol.4, Part 14.1.1.

All stranded copper wire shall be fitted with an approved type of terminal at all points where the wires are to be terminated on terminal binding posts.

The terminating means shall be of five types: (1) a lug for terminating heavy wires or power wires above No. 6 AWG; (2) a solderless insulated terminal as manufactured by AMP, Inc. under the trade name of "RingTongue Plasti-Bond, similar to Catalog No. 35628, or approved equal, for terminating No. 16 and No. 14 AWG stranded wires; (3) a solderless insulated terminal similar to AMP Catalog No. 35627, or approved equal, for terminating insulated wires Nos. 12-10; (4) a solderless insulated terminal similar to AMP Catalog No. 324108 for terminating other stranded vital circuit insulated wires No. 20-16 AWG having a maximum diameter of 0.200 inches; (5) a solderless insulated terminal, AMP Catalog No. 320554, or approved equal, shall be furnished for No. 8 studs and AMP Catalog No. 320571 or approved equal, shall be furnished for one-quarter inch studs for non-vital circuit insulated stranded wires No. 22-16 AWG having a maximum diameter of 0.125 inches.

The terminals shall be for attaching to the ends of the conductor in such a manner that the flexibility of the conductor will not be destroyed and the possibility of breakage at the terminal will be reduced to a minimum.

Terminal shall be for attaching to the wire with a tool made by the manufacturer of the terminal and recommended by the manufacturer for the terminals being furnished. The tool shall be equipped with a ratchet device to insure proper identification of the terminal and which will not release until proper indentation is complete.

TAGGING FOR CABLES, WIRES AND EQUIPMENT

Except as otherwise specified in this Section, both ends of each cable and each cable wire and all single wires that terminate in a crossing control case or gate junction boxes shall be permanently identified with a tag. Tags shall not obscure connecting links used between terminal binding posts. Tags shall be installed so that they may be read with a minimum of disturbance of the tags and wiring. Each conductor of the cable shall be rung out and identified before applying the tag.

Tags for wire and cable identification and for identification of transformers, resistors, reactors and other components shall be the following requirements:

1. Sleeve Type Tags

- Tags for identification of individual cable conductors and all wires within the crossing control case and gate junction boxes shall be the sleeve type as manufactured by Raychem Corporation, Thermofit Marker System (TMS), W.H. Brady Co., Bradysleeve (XC with B-321, -322, -323), or approved equal. The sleeve tags shall be 1-1/2 inches long. The application of the conductor nomenclature shall be in accordance with the manufacturer's instructions and shall result in a permanently bonded and legible, typed identification.

2. Flat Plastic Tags

- Tags for identification of vital relay plug boards, individual transformers, resistors, reactors, terminals, and other miscellaneous components within the crossing

control cases and gate junction boxes shall be the flat, plastic laminated, high-temperature adhesive type.

- These tags shall be one and one-half inches long by three-quarter inch wide. The distance from the edge of tag to the hole shall be approximately nine thirty-secondths of an inch. The untreated tag shall be milk white "vinylite", or approved equal.
- Lettering shall be typed; with the tag manufacturers approved device and ribbon or ink. The height of the lettering shall be not less than one-eighth inch.

After lettering, both the face and back side of the tag shall be covered with a clear plastic coating, "vinylite", or approved equal, or at least one hundredth of an inch thick.

The identifying nomenclature space shall allow for three rows of lettering, and the tag material shall be capable of receiving typed-on characters by conventional means. Nomenclature for the sleeve type and flat plastic tags shall be as follows:

First Line: Terminal post or contact identification

Middle Line: Functional Nomenclature

Bottom Line: Destination of the wire

Terminal posts on racks shall be identified by geometry coordinates, rack, row, and post number; progressively from the top down, and from left to right.

HARDWARE

All mounting hardware exposed to the elements shall be hot-dip galvanized.

1. Galvanizing

- The hot dip process of galvanizing shall be used. All parts shall be pickled so that all scale and adhering impurities will be removed. The zinc coating shall be of commercially pure zinc, and shall be continuous and thorough. It shall not scale or blister or be removable by any of the processes of handling or installation. The finished surface shall be free from fine line cracks, holes, or other indications of faulty galvanizing. It shall be smooth and free from lumps and globules. Parts shall be coated with at least two ounces of zinc per square foot of galvanized surface, after all bending, cutting, welding, drilling, and final fabrication.

2. Cadmium Plating

- All nuts, bolts, and washers used for the mounting of equipment within finished enclosures shall be cadmium plated or stainless steel.
- Cadmium plating shall be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries and shall completely cover the surface of the part in a smooth, bright layer. Plating on raised or prominent portions shall show no evidence of blackness or looses

crystalline structure. It shall have a minimum thickness of six ten-thousandths of an inch and shall withstand the salt spray test for at least 1000 hours.

PADLOCKS AND KEYS

The Contractor shall provide signal padlocks for all equipment housings, doors, and covers of signal equipment furnished and installed under this Project, including crossing control cases and gate junction boxes. Padlocks shall be furnished complete with a 13-1/2 inch bronze chain connected to the apparatus approved by the operating Railroad.

SEALING COMPOUND

Sealing compound for use in sealing cable entrances shall be fire retardant, and in accordance with AREMA C&S Manual, Vol.4, Part 15.2.15 as manufactured by Duct Seal or approved equal.

PAINT AND FINISH

All paint and painting procedures shall be in accordance with applicable requirements given in AREMA C&S Manual, Vol.1, Part 2.4.30, where the AREMA requirements do not conflict with any requirement of these Specifications.

CABLE ENTRANCE PIPES

Cable entrance pipe for crossing control cases shall be Schedule 80 PVC, provided complete with cable entrance bushings and secured to the case. One spare entrance pipe assembly shall be furnished for each case provided.

ENVIRONMENTAL PROTECTION

Protection as hereinafter specified, for machined – finished surfaces, threaded rods and nuts and other parts that are susceptible to rusting, shall be a corroding preventive compound, NO-OXIDE No. 90918, or approved equal. The product shall have sufficient body to resist weather and rusting for at least six months. The Contractor shall furnish Two gallons or equivalent weight.

648.22 Tests

The work to be done under this section consists of the tests and inspections, which shall be performed to demonstrate, that systems, subsystems, assemblies, subassemblies, and components supplied under this Project are in compliance with the Specifications.

Tests and inspections shall be made both during the progress of this Project and after completing the installation of equipment and shall consist of, but not be limited to, factory tests, circuit breakdown tests, wiring verification tests, continuity tests, resistance tests, voltage and current tests, time tests, operating tests, simulation tests, and other electrical and mechanical tests and inspections.

STANDARDS AND REGULATIONS

All test procedures and inspection procedures shall comply with all FRA rules and regulations.

Test equipment of the proper type, capacity, range and accuracy shall be supplied by the Contractor to perform the required tests and inspections. This equipment shall be in good working order and properly calibrated at the time the tests or inspections are conducted.

Each component and unit of the traffic control system shall have an inspection performed at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.

All approved system and subsystem tests to demonstrate that the installation meets these Specifications and design requirements shall be completed prior to any operational testing of systems or subsystems. Safetran shall certify that all appropriate factory tests have been performed prior to receipt of the equipment by the Contractor.

The work shall include all tests required to ensure the proper and safe operation of all systems and subsystems and to prove the adequacy and acceptability of the total installation specified herein. The tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.

SUBMITTAL

The results of each test shall be recorded and the test result documentation shall be on file with the Contractor within 10 days of completion of the test. Certified test results shall also be furnished for tests performed by any subcontractors when such tests are required within this Specification. Upon completion of all tests specified herein, the Contractor shall submit a letter to the MDOT Engineer signed by an authorized representative, certifying that all tests have been performed.

SITE TEST EQUIPMENT AND MATERIALS

All test instruments and equipment necessary to conduct the tests specified herein shall be available, ready-for-use not less than one week in advance of test need. Ready-for-use shall mean properly matched for test parameters, properly calibrated, sufficiently supplied with leads, probes, adapters, stands etc. necessary to conduct the particular test in a completely professional manner.

All temporary or interim tests related materials, special tools, connections, jumpers etc. shall be furnished and available not less than one week in advance of the test need.

Confirmation shall be provided by the Contractor that all required factory tests of systems, subsystems, assemblies, subassemblies, and components supplied under this Project have been performed. These tests shall verify design and nameplate ratings and adequate and proper performance.

When test results are not recorded on a test data plate affixed to the equipment or unit, certified test reports shall be furnished for each item at the time of delivery in a form and format suitable for regular office file record keeping.

Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.

FACTORY TESTS AND INSPECTIONS

Vital Relay Tests

All dc vital relays shall be factory tested and inspected in accordance with AREMA C&S Manual, Vol.2, Part 6.4.1.

Crossing Control Case

1. General

1. The crossing control case shall be wired complete at the point of assembly, with all equipment installed. An operational and wiring verification test shall be made in accordance with the approved circuit plans. Functions external to the housing shall be simulated where required.

2. Energy Distribution Tests

The tests shall include but not be limited to the following:

- All fuses shall be removed and circuit breakers placed in the open position.
- Verify that all over current devices are of the correct size as shown on the approved circuit plans.
- All energy distribution shall be checked, using a megger with a 250 – 600 volt range, to verify agreement with the approved plans.
- Verify wire gauge with that called for on the approved circuit drawings. All discrepancies in wire sizes shall be replaced with the proper size wire.
- Each energy bus shall be tested to all other energy buses to ensure that no crosses exist.

During energy distribution breakdown, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the approved circuit plans is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected and additional wires, if found, shall be removed.

- Tags shall be verified for proper nomenclature and terminal location.
- All power supplies shall be checked for correct setting and quantities.
- All circuits and power supplies shall be tested under full load conditions, using resistors or other devices to simulate full load.

3. Wiring Verification Test

All circuitry shall be checked for accuracy against the approved circuit drawings. Tests may be done with energy on or off and shall verify the following:

- Point to Point wiring

- During wire verification test, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the approved circuit plans is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected.
- Verify tags and nomenclature.
- Verify that all components, relays, resistors, etc. are the same as called for on the approved circuit drawings and located in proper positions.

FIELD TEST PROCEDURES

The field tests performed shall cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.

The quality of the installation shall be demonstrated by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection and any other tests required by FRA Part 234.

The Contractor's test procedures shall consist of pre-printed data sheets or inspection sheets for each test. When completed by the field test personnel and checked for accuracy and completeness, the sheet shall be submitted as the test report.

All test reports shall be dated and signed by the responsible employee of the Contractor on the day the test is performed. Test reports shall be filed no later than 10 days after completion of the test.

Should an error be discovered during field-testing, due to field wiring and connections that do not agree with the approved circuit plans, the Contractor shall correct such errors. Any changes made after completion of test procedure shall be retested in accordance with the applicable test procedure.

FIELD TESTS AND INSPECTION

1. General Field Tests

General field tests shall include, but not be limited to, the following:

- The Contractor shall perform ground verification tests.
- The Contractor shall perform line circuit verification.
- The Contractor shall perform operating tests.
- The Contractor shall perform printed circuit board input/output tests.
- All applicable tests prescribed by the FRA Part 234 and AREMA C&S Manual, Vol.1, Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these Specifications.

2. Specific Field Tests

- Ground Resistance Testing

- The Contractor shall perform testing of all crossing control case locations using a ground resistance direct-reading single test meter utilizing alternating current fall-of-potential method and two reference electrodes.
 - Test Procedure
 - The ground electrode to be tested and the two reference electrodes shall be oriented in a straight line spaced a minimum of 50 feet apart.
 - The two reference electrodes shall be driven five feet deep.
 - The maximum resistance value goal of the main ground for the crossing control case shall be 5 ohms. If it is found that the resistance value of the main ground exceeds this specified range the Railroad shall install additional ground rods to meet the grounding requirements.
- Insulation Resistance Tests

The test procedure for testing of insulation resistance shall include tests to verify the following:

- All wire and cable on the delivered reels shall be tested prior to installation to ensure that damage has not occurred during shipping and handling. A direct reading instrument, having 0-megohm to 1000-megohm scale range and a self-contained dc power supply rated 250 volts minimum to 600 volts maximum, shall be used to measure the insulation resistance. Resistance between conductors and ground shall not be less than infinity.
- All wire and cable installed by the Contractor along the right-of-way and the wire and cable entering or leaving wayside instrument case shall be tested after installation to ensure that insulation of wires and cable and connected equipment meet the specified resistance value. A direct reading instrument, having a 0-megohm to 1000-megohm scale range and a self-contained dc power supply rated 250 volts minimum to 600 volts maximum, shall be used to measure the insulation resistance. Resistance between conductors and ground shall not be less than infinity.
- The insulation resistance of each conductor to ground and between each conductor and all other conductors in each multi-conductor cable shall be tested. Power sources, made grounds and connections to the rails shall be disconnected from the circuits during testing.
- The point used as ground shall be the most convenient ground available.
- Insulation resistance test values shall be recorded in accordance with the Railroad supplied and approved forms.

3. Circuit Continuity Tests

All wire and cable installed by the Contractor shall be tested to verify the continuity of each conductor and that each conductor is connected to the proper terminal as shown on the approved drawings. Where parallel circuits exist, each parallel path shall be tested independently to verify the continuity of each path.

4. Power Tests

The following power tests shall be made and recorded:

- The voltage of the main power feeders shall be measured and recorded.
- A check of all circuit breakers and fuses shall be made for correct size and type.
- All power supplies, battery chargers, and batteries shall be checked for correct setting and quantities.
- Bus-to-bus checks as described within these Specifications.

648.30 Acceptance

All systems shall be complete and in operation to the satisfaction of the Resident Engineer at the time of the acceptance of the work.

The Contractor shall be responsible for the proper performance in service, in whole or in part, of the various AHCW system and all other installations furnished or installed under this Project and shall correct, at their own expense, all deficiencies in the operation which may arise prior to the acceptance of the work.

648.311 Method of Measurement

Highway Grade Crossing Signal System will be paid for as lump sum.

No separate payment will be made for designing, furnishing, installing, testing of; flashing light units, cross-bucks, electronic bells, motorized gates, foundations, mast poles, crossing control case (including factory engineering), cable, control equipment, batteries, battery charging units, insulated joints and all other ancillary equipment, but all costs shall be included in the respective contract unit price bid.

648.312 Basis of Payment

Highway Grade Crossing Signal System will be paid for at the respective Contract Lump Sum unit price, which shall include all labor, materials, equipment and incidental costs to complete this work.

<u>Pay Item</u>	<u>Pay Unit</u>
648.5206 Highway Grade Crossing Signal System	Lump Sum