SP-150095
(New)

SPECIAL PROVISIONS
FOR
RAILROAD SIGNALS

Pottawattamie County
NHSN-192-1(25)--2R-78

Effective Date
April 19, 2016

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

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28-01.1 GENERAL – SCOPE OF WORK

28-01.1.1 DESCRIPTION

A. Scope. The work under this specification consists of furnishing, delivering, installing, and testing all new systems required for the installation of a highway grade crossing system at 23rd Avenue, Council Bluffs, IA. All work shall be coordinated with Iowa Interstate Railroad or their designated representative (the Railroad). The Contractor shall conform to the instructions provided by the Railroad concerning work performed in the proximity of the railway, required on-track safety training of personnel, permission for fouling of the railway, flagging, personal protective equipment, and access to railway facilities. Additionally, the Contractor shall conform to the requirements of the Federal Railway Administration for work performed in the proximity of the railway and specifically for work that affects the operation and safety of the signal system(s) that govern the movement of trains on the Railroad.

The new crossing shelter, signals, foundations, cable, termination shunts and track connections shall be installed as described by the contract documents.

B. The work shall consist of the provision of a new highway grade crossing warning system consisting of a new controls shelter, Constant Warning Time Device (CWTD), DC track circuits, vital B1 plug-in relays, required back-up battery systems and chargers, power-off lights, strobe light, wire and tags. The shelter shall be equipped with lockable exterior pushbutton enclosure and lockable exterior junction box for traffic signal interconnection. All new signals equipped with LED flashing lights, electronic bells, crossbucks, and automatic gate arms. All new underground cable and conduit shall be installed as well as all new track wire and track connections. Crossing approaches shall be double-bonded using a head-bond and a web-bond. Insulated joints, switch rods and gauge rods shall be installed at the extents of the crossing approaches as shown in the plans.

The highway grade crossing warning system controls shelter shall be wired and tested, and test documents provided to, and accepted by, the Engineer before the shelter is delivered to the work-site. Full testing of the highway grade crossing, as described in CFR 49 Rule 234 shall be performed and recorded on approved forms before the work is accepted by the Engineer.

C. Further Requirements for the Work.

1. The Contractor shall be responsible for all transportation and storage of materials, all required tools, labor and supervision, and all required safety equipment; and shall maintain good housekeeping about the workplace, observing all laws, rules and regulations concerning storage of equipment onsite, protection of open trenches, work about roadways, work about railways and safety of personnel. The Contractor shall maintain a safe system of work and shall promptly report any accidents, either to staff or to the public, to the Engineer and the Railroad.

2. Salvaged materials shall be the property of the Railroad and shall be delivered to the Iowa Interstate Council Bluffs Yard. Contact Greg Mitchell with Iowa Interstate Railroad for specific location within the yard. Since this is a new signal installation it is assumed that salvaged materials will be minor.

3. The Contractor shall be responsible for obtaining all necessary licenses and permits.

4. The Contractor shall provide complete detailed as-built wiring diagrams, track plan drawings and instrument housing layout drawings. As-built drawings will be provided to the Railroad following the approval of the installed systems.

Circuit nomenclature and symbols shall conform to the recommendation of the AREMA

Communications and Signals Manual. All design shall be to the best current practice and shall use failsafe principles.

During the field installation of the project a working set of the plans shall be maintained with changes and additions to the plans captured, and initialed, as they occur. In addition, a set of testing plans shall be maintained. All changes made to the working set shall be transferred to the testing set. All testing shall be captured, and initialed, on the testing set. At the completion of testing of the installed systems, both the working set and the testing set of plans shall be used to up-date the drawings to as-built condition. As-built plans will be provided to the Railroad in both soft and hard formats. Soft format shall be in the form of a labeled CD-ROM with all drawing files in the AutoCad 2010 format, Adobe PDF copies of all drawings with the reviewing engineer's seal locked on the drawings, and Adobe PDF copies of all testing documents. Hard format will include four sets of 11 inch by 17 inch drawings with the reviewing engineer's seal.

A system of configuration management shall be used to maintain the plans during the course of the project. Revised plans shall be issued as complete sets including all drawings, whether revisions are made to all sheets or not. Drawings that are revised will bear a new revision number and note, and changes to the plan will be highlighted as X=OUT and O=IN.

All revised drawings shall be reviewed and sealed by an engineer qualified in the particular area of practice and licensed as a professional engineer in the state of Iowa.

5. Before progressing with the project, the Contractor shall submit drawings and catalog cut sheets for equipment to the Engineer for approval. Work performed without the approval of the Engineer shall, at the request of the Engineer, be completely removed, and then performed in an approved manner by the Contractor at no additional cost to the project. All equipment shall be designed for use on the railroad in an environment similar to that of the site and shall have a five year history of use in similar projects.

6. Before progressing with the project, the Contractor shall submit a phasing narrative describing how the work will be performed and detailing coordination with the Railroad. The narrative shall address all construction and demolition required for the project and shall identify a critical path for all the work. Care will be taken to assure that the operations of the Railroad are addressed in the narrative and that measures are taken to assure that the work of the Railroad suffers a minimum of disruption. The work will take place about an operating freight rail line. Disruption to service shall only occur with the permission of the Railroad.

7. The systems shall be fully tested following installation. Testing shall be 'end-to-end', rather than incremental, and shall follow the requirements of FRA CFR49, parts 234 and 236, the recommendations of AREMA. All testing shall be documented using the proper test forms. No more than thirty days following the completion of installation testing, all documentation, including the as-built drawings, shall be submitted to the Engineer for approval. The project shall not be considered as completed until approval of the installation, as-built drawings, and of the final installation testing is received from the Engineer.

D. Safety and Roadway Worker Protection Training

1. The Contractor shall conform to all safety regulations set forth by the Railroad, CPUC, FRA and all jurisdictions.

2. The Contractor is advised that freight operations will be allowed during the construction window and shall be prepared to work safely under such conditions.

3. All personnel working in the Right-Of-Way (ROW) shall have current Roadway Worker Protection (RWP) cards and shall have undergone RWP training in the last year.

E. Submittal Requirements.

1. The Contractor shall submit all current safety training certificates for all personnel expected to be accessing the ROW.

28-01.1.2 COMPATIBILITY WITH EXISTING SYSTEMS

A. Compatibility. New construction and modifications to the existing systems shall be compatible with any existing system(s) in all respects, and shall be designed to provide the highest levels of reliability, maintainability, and safety performance within the operational parameters of the existing system.

B. Interface to the Existing System. Should interfaces to any existing systems be required, such interfaces shall be made so that the existing and new systems form a complete, functional and seamless signaling system.

C. The Contractor shall submit a Compatibility Report identifying specific design measures and tests intended to assure compatibility with the existing wayside signaling system.

28-01.1.3 ELECTROMAGNETIC COMPATIBILITY

A. Compatibility. New construction and revisions to existing systems shall be compatible with any existing system(s) in all respects, and shall be designed to provide the highest levels of reliability, maintainability, and safety performance within the operational parameters of the existing system.

B. Interface to the Existing System. Should interface to any existing systems be required, such interfaces shall be made so that the existing and new systems form a complete, functional and seamless signaling system.

C. Compatibility Report. The Contractor shall submit a compatibility Report identifying specific design measures and tests intended to assure compatibility with the existing signaling system.

28-01.1.4 SUITABILITY OF EXISTING INFRASTRUCTURE

A. Where required by the contract documents, the Contractor shall determine the suitability of existing infrastructure for reuse in the revised system. This shall include, but not necessarily be limited to, signals, lights, light arms, gate mechanisms, bases, foundations, wire, tags, conduit and conduit accessories.

B. The Contractor, before beginning the work, shall provide the Engineer a statement confirming that infrastructure that is indicated by the plans to be reused is suitable for purpose. Subsequent discovery that existing infrastructure is not suitable for reuse shall not necessarily be grounds for a change to the Contract. Such a change shall only be allowed if in the judgment of the Engineer it was not reasonable for the Contractor to anticipate the situation. The extent to which such a discovery shall be grounds for a change is the sole judgment of the Engineer.

28-01.2.1 WIRE AND CABLE

A. Requirements. The Contractor shall furnish and install the wire and cable required for the Automatic Highway Grade Crossing Warning Systems.

B. Cables shall be suitable for installation in direct contact with earth, in trenches, cable ducts, troughs, on messengers, or in any combination of these methods.

C. Control Cable for the automatic highway grade crossing warning system shall conform to or exceed the following requirements:

1. All cable shall be suitable for direct burial, hanging on messenger and installing in conduit. The cable furnished shall be compact and shall be of the highest standards of the industry. There will be no relaxation on the quality of the materials or thickness specified.

2. The conductor shall be soft annealed solid copper.

3. Each shipped length of cable shall bear a marking (full length) showing the name of the manufacturer. Multiconductor cable shall also be marked with the year of manufacture. Single conductor cable shall also be marked with the wire gauge number.

4. The Contractor shall furnish to the Engineer copies of the test results of the tests called for in the respective ASTM and ICEA-NEMA Specifications.

5. The Contractor shall procure the cable from a manufacturer who has had adequate successful commercial experience in the manufacture of the basic type of cable the Contractor proposes to furnish.

D. Control cable shall conform to, or exceed, the following minimum requirements:

CABLE DESIGN	AWG	CONSTRUCTION
Highway Flasher, Gate Mechanism Power	7C No. 6	Solid
Gate Mechanism Control	7C No. 14	Solid
Track Circuit	2C No. 6 TW	Solid
Track Circuit Connection	1C 3/16”	Stranded
Battery Buss and Supply	No. 6	Stranded
Type B1 & B2 Relay Wiring	No. 16, No. 10	Stranded

1. These Specifications provide for single and multi-conductor insulated and jacketed cable for installation in direct contact with the earth, in conduit or pipe, or any combination of these types of installations, on circuits rated at up to 600 volts.

2. The signaling cable required for this project shall consist of the following types:
   a. Sizes of wire stated above shall be considered minimum. The Contractor shall be responsible for sizing the cable to accommodate the calculated load.
   b. For 120/240V volt power service circuits, three No. 1/0 AWG stranded copper conductors and one No. 6 AWG stranded copper conductor. Cable shall be sized to provide no more than a 10% voltage drop based on the anticipated peak load.
   c. In addition to the number of active conductors that are required in these types of cable in order to provide a complete working Train Control System, the following spare conductors shall also be provided:
      1) 15% spare conductors with a minimum of one spare conductor in each main line cable. If multiple cables run to the same destination, the spares for all cables may be consolidated in one construction, provided that the requirement for total spares is still met.
      2) Spare conductors are not required in track circuit feeds.

E. Qualifications.

1. The manufacture of cables in accordance with the requirements of these Specifications shall be accomplished in compliance with a Quality Assurance Program that meets the intent of ASQC Standard C1, General Requirements for a Quality Program. Such compliance shall assure the production of properly designed, well made, and thoroughly tested cable, which will render long service life to the user. Efficient methods of production test and production

evaluation shall be used, but prime concern shall be focused on the necessary formal quality requirements to ensure that cable failure cannot be attributed to actions or lack of actions by the manufacturer.

2. To assure accountability and traceability in applicability of the quality assurance plan, the manufacturer shall prepare, and apply conductor insulating materials and cable outer coverings and shall perform conductor insulating and cable assembly and testing in its own plant.

3. If the vendor does not normally prepare insulating materials in its own plant, it is acceptable for the vendor to have its proprietary formulations prepared at another non-owned facility. This facility shall be subject to the same Quality Assurance procedures and systems the vendor uses in its own facilities.

4. Cable design and insulation materials offered for this service shall have a minimum of 15 years reliable experience on vital circuit signaling cables with a minimum of at least 2,000,000 cable feet installed.

F. Conductor. The conductor shall be solid and shall conform to ASTM B33-94 or ASTM B3-95.

G. Insulation (Signal Cable).

1. The insulation shall be a synthetic rubber compound consisting substantially of ethylene propylene rubber and shall meet the experience requirements, and pass the qualification requirements of these contract documents.

2. The insulation shall be applied by the continuous tube method without joints; it shall be properly vulcanized homogeneous in character, tough, elastic, concentrically applied about the conductor, and shall fit tightly thereto. Where an insulating jacket is applied over the insulation, it also shall be homogeneous in character, tough, elastic, concentrically applied about the conductor, and shall fit tightly thereto.

3. The insulating compound shall be clean and free stripped, leaving the coated conductor unimpaired and ready for soldering.

H. Identification.

1. Multi-conductor Cable. Each length of cable shall be permanently identified as to the manufacturer and year of manufacture, at intervals not more than one foot, with a moisture resistant marker tape under the jacket and parallel to the longitudinal axis of the cable.

2. Single Conductor Cable. It shall be identified by a printing, contrasting painted, printed or manufacturer's color threads. The printing shall be on the outer jacket and parallel to the longitudinal axis of the cable. The color threads shall be placed under the outer jacket and parallel to the longitudinal axis of the cable.

I. Inspections and Tests.

1. Types of Tests. The manufacturer shall, at the point of production, carry out all of the following tests:
   a. Conductor size and physical characteristics
   b. Insulation high-voltage and insulation resistance tests
   c. Physical dimension tests
   d. Final, high-voltage, insulation resistance and conductor resistance tests on shipping reels.

2. Certified Test Reports. The Contractor shall furnish certified electrical and physical test reports for the finished single conductor and multiple conductor cables.

3. Rejected Cable. Cable, which does not meet the minimum requirements of these Specifications, will be rejected. Wire or cable, which shows defects or non-compliance with these Specifications, after arrival at the Project destination, will be rejected and returned to the manufacturer at no additional cost to the Contracting Authority.

J. Submittal Requirements.

1. Cable and wire proposed for use shall be submitted to the Engineer for approval.

28-01.2.2 SIGNAL SHELTERS AND SIGNAL CASES

A. General.

1. All equipment shall operate correctly and without damage over a temperature range of -40°F to 160°F. Where AREMA requirements for specific equipment exceed the limits of this temperature range, such equipment shall conform to requirements set forth by the AREMA.

2. The Equipment House shall be identified by a name/address sign. The name/address signs shall be installed adjacent to the main access door. Make the sign of A-2 aluminum, 0.080 inch thick minimum, secured by stainless steel vandal proof screws, white reflective enamel background with silk-screened, black enamel lettering. The Railroad shall provide a name and address for the sign. The Contractor shall submit the name/address sign to the Engineer for review. Signs shall include lettering as follows:

First line - [Street Name]

Second line - [Street address]

3. The Equipment House shall be furnished complete with an electrical panel including main breaker and required branch breakers as described in the plans.

4. The Equipment House shall be constructed to comply with IBC (International Building Code) Section 1604.1 – Buildings, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional design methods, as permitted by the applicable material chapters.

B. Description.

1. Size and Equipment Mounting.
   a. Equipment House shall be sized as described by the plans.
   b. Clearances as described in the plans shall be observed for the installation of equipment, racks, terminal boards and shelves.
   c. Relays and electronic components which require periodic test and adjustment shall be mounted a minimum of 18 inches above floor level and not higher than 6 feet 6 inches above floor level, as described by the contract documents.

2. Equipment House:
   a. Minimum interior headroom is 7 feet. Width and length shall be as described in the plans.
   b. The Equipment House shall be located as described in the plans, but in no case shall the Equipment House or Case be allowed to intrude into the dynamic envelope of operating trains.

C. Construction.

1. The Equipment House shall be of a walk-in modular construction fabricated of 0.100 inch 3003 aluminum with PVC peel coat to the protect exterior surfaces of walls, doors and the roof during manufacturing. The peel coat shall be removed before shipping. House walls shall be insulated with 1 inch fiberglass faced polyisocyanurate panels and the doors shall be insulated with 2 inch panels of a similar material. The walls shall then be covered with 31/32 inch plywood laminated with 0.045 inch plastic. The House ceiling shall be insulated with 2 inch panels covered by 0.045 inch plastic panels.

   All exterior seams shall be caulked with gray RTV silicone. A manufacturer's nameplate with the Equipment House serial number shall be riveted above the door on the (A) side of the house.

   A threaded grounding stud shall be provided 6 inches above the floor on wall (B) of the Equipment House. The stud shall extend through the wall and shall provide for continuous electrical contact with the exterior shell of the Equipment House. Two securing nuts, two flat washers, a star washer and a locking washer shall be provided on the outside threads of the stud. A rubber hose shall be placed over the stud and taped in place to protect the threads during shipment. Two securing nuts, two flat washers, a star washer and a locking washer shall be provided on the inside threads of the stud. The stud shall provide a central ground point for all systems within the Equipment House.

2. The Equipment House floor shall be constructed of 0.125 inch 3003 aluminum, and shall be finished with 1/2 inch insulating material. The insulation shall be covered by a 1/4 inch non-skid, non-grooved rubber mat.

3. A lockable door shall be provided on the walls designated (A) and (B) as shown in the plans. The (A) door shall provide access to the house. The main terminal board shall be in-stalled at the (B) end and the (B) door shall provide access to the rear of the terminal board. Both (A) and (B) doors shall be equipped with gutters and/or rain shields.

4. All doors shall be equipped with three-point latching devices, which ensure that the door cannot be locked until it is completely closed. Hasps and handles shall be reinforced and partly shielded to prevent breakage. The door locking mechanism shall be configured so the door can be opened from the inside even if a padlock has been inserted in the exterior locking hasp. Each door shall contain ventilating openings in accordance with manufacturer's standards. Louvers shall be closable, covered with fine stainless steel mesh screens and protected by weather caps, which shall prevent the entrance of moisture.

5. All doors shall be equipped with lubricated hinge fittings and with hooks to hold the doors open at either 90 or 180 degree positions.

6. All doors shall have gaskets to prevent dust and water incursions.

7. Lifting hooks shall be provided at all four corners of the Equipment House which shall allow completely wired and equipped houses to be lifted into place. The lifting hooks shall be integral to the house and shall be designed to prevent damage during handling and lifting into place. The Equipment House shall have sufficient structural strength that no additional bracing is required to permit lifting by an overhead crane for loading, unloading and placement on the house foundations.

8. Houses shall be constructed and installed without contact between dissimilar metals, to prevent electrolysis.

9. The interior of the Equipment House shall be insulated with a minimum of 1 inch inch thick

fiberglass insulation on the walls and 2 inch thick fiberglass insulation in the ceiling and doors. The Equipment House shall be equipped with a 120 volt AC thermostatically controlled exhaust fan.

10. The Equipment House shall be equipped with one ceiling mounted exhaust fan with closable weatherproof aluminum louvers. The Equipment House doors shall also be provided with a closable weatherproof louver covered by a fine screen mesh and provided with filters to allow cross-ventilation of the house when the exhaust fan operates. The exhaust fan thermostat shall allow the fan to turn on automatically when the temperature inside the house reaches 90°F. The exhaust fan shall be protected by its own circuit breaker on the power panel.

11. The Equipment House shall be equipped with shelves as described in the plans. Shelves shall be constructed of 1 inch shelving material and shall be mounted to 3/8 inch by 1 1/2 inch steel bar brackets bolted to the vertical keyways on the wall. Shelves shall be painted white and then covered on their upper surface by 1/4 inch non-grooved rubber mat. Shelf brackets and miscellaneous hardware shall be finished with white polyester powdercoat or with zinc plated clear chromate.

12. Field cables shall enter the house by means of 4 3/4 inch sealed ducts in the floor adjacent to the (B) door. Six 3 foot lengths of 4 inch schedule 40 PVC conduit with one end finished with a collar shall be provided to serve as the cable entries. All cable entrance conduits shall be sealed with a pliable duct sealant following the installation of cable.

13. Overhead ladder type cable trays shall be provided to route the cables to the racks, terminal boards and shelves. Cable trays shall provide a continuous means of routing cables along walls (A), (B), (C) and (D) of the Equipment House and shall extend from wall to wall over the centerline of the equipment rack. Cable trays shall be 6 inches wide and 3 inches deep with 9 inch rung spacing. Cable trays and miscellaneous hardware shall be finished with white polyester powdercoat or with zinc plated clear chromate. The finish shall be smooth to the touch with no sharp burrs that might snag the insulation on wire or cable laid in the trays. Where wire and cables make transitions in the trays, rub strips shall be placed over corners of the tray or over the rungs to provide further protection for cable and wire insulation.

14. Power for the Equipment House shall be fed via buried cable or overhead service from the public utility feed located in the southwest quadrant of the crossing. All wiring shall be per the best practices of the NEC.

15. Utility power shall be brought into the Equipment House via a 100A, 120/240V volt, three wire, UL approved Load Center panel. The panel shall be as furnished by Square D, or approved equivalent. A secondary surge arrester shall be provided as described in the plans.
16. The circuit breakers shall be thermal-magnetic type, UL rated. Main and branch breakers shall be provided as described in the plans. All circuits shall be identified by name on the inside of the panel door.

17. Fluorescent ceiling lights and convenience outlets. Two rows of fluorescent ceiling lights shall be provided. Light housings shall be securely attached to the house structure using appropriate brackets. All wires to the lights shall be run in flexible metal conduit. Light housings shall not be used as junction boxes. The lights shall be switched by a switch located on wall (A) near the entrance door of the Equipment House. Two convenience outlets shall be provided on wall (A) near the entrance door. The outlets shall be fed by a GFCI (Ground Fault Circuit Interrupter) breaker as described in the plans. The fluorescent ceiling lights and the convenience outlets shall be fed from separate branch circuit breakers as described in the plans.

18. Provisions shall be made for a portable generator to be installed to supply power in the event of a loss of utility electrical power. A 30A, 240V, two pole, two wire branch circuit breaker,

interlocked with the main breaker, such that only one power source can be fed to the panel at a time, shall be installed. The generator receptacle shall be installed through the wall of the Equipment House with the outside socket covered by a weatherproof, gasketed cover. The receptacle shall be of a locking type. The receptacle shall be a NEMA L5-30P.

19. A separate branch breaker shall be provided for each battery charger and for the thermostatically controlled exhaust fan as described in the plans. All wiring to the battery chargers and to the exhaust fan shall be run in flexible metal conduit.

20. The Equipment House shall be factory wired and tested in accordance with the contract documents of the circuit and wiring diagrams. Wire, cable, wire and cable termination, cable entrances, and tagging shall be provided in accordance with the contract documents. All bundled wire shall be tied approximately every 3 inches with Nylon straps in accordance with AREMA recommendations. No more than two wires shall be terminated on any one terminal post.

21. All wires terminated on AREMA type binding posts strips shall be fitted with an approved insulated crimp type terminal. Wire eyes shall not be permitted in stranded wires. Solid conductors may be eyed, but insulation shall not be removed by 'ringing' the conductor. Insulation shall be carefully removed from the conductors without marring the finish. Eyes will be large enough to slide easily over the binding post, but shall not be so loose as to extend outside the washers placed over and under the conductor. The terminals used on stranded wire shall conform to Section 14.1.1 of the AREMA recommendations.

22. All vital wiring shall be minimum No. 16 AWG, stranded and terminated in accordance with AREMA recommendations.

23. All wiring shall be provided with sufficient slack to prevent stress or pulling on any termination point. All relay-connected wires shall be of sufficient length to permit them to be moved to any contact on the same relay or around bends. All bends in cable/wires shall be greater than the minimum bending radius of the cable/wire recommended by the manufacturer.

24. Terminals shall be placed on the wire by means of a standard forming tool of the proper size, which is equipped with a lock to guarantee that the proper pressure is applied before the tool is released. Care shall be taken to assure that the correct size of wire terminal is used, and that the wire is thoroughly cleaned and centered properly in the wire terminal when using the forming tool.

25. Wire terminals shall not be bent, nicked or otherwise damaged. An approved wire-stripping tool shall be carefully used to remove the insulation from No. 9 AWG and smaller wires. Scraping of these conductors with any sharp instruments shall not be permitted. For wires larger than No. 9 AWG, a knife may be used to remove the insulation, with extreme care being taken to prevent nicking the conductors. The Contractor shall submit catalog data and samples of the terminals proposed for use in connecting all wires to binding posts.

26. Connections to bases for plug-in relays and similar connections crimped using an approved connector. Not more than two wires shall be attached to a terminal of the relay bases.

27. Insulated nuts shall be provided on all AREMA terminals energized with 110 volts or more.

28. Cables entering from the outside of the Equipment House shall be run and terminated such that any wire in a cable can be relocated to any place on the entrance panels.

29. The Equipment House shall be securely mounted on precast concrete, or galvanized steel foundations.

30. Provide power-off indicator lights, visible from the track and the roadway that are permanently on while utility power is available. Power-off indicator lights shall be white LED type as produced by GEMS.

D. Submittal Requirements. Supplier cut sheets shall be submitted for all Equipment Houses and Cases proposed for use as described elsewhere in this specification.

28-01.2.3 POWER SUPPLIES, BATTERY CHARGERS AND BATTERIES

A. General. All DC power supplies furnished under this Contract shall meet the following minimum basic requirements:

1. Batteries and chargers shall be provided.

2. Cooling.
   a. The power supplies shall be natural convection cooled. No supplementary fans or other cooling devices will be allowed.

3. Duty Cycle. The power supplies shall be rated for a continuous duty cycle.

4. Input Voltage. The power supplies shall not be damaged by a sustained input voltage varying from 0 to 150% of the rated input voltage.

5. Current Rating. The power supplies shall be sized in such a manner that no individual power supply operates at less than 20% of its rated current output during normal operation.

6. Output Current. The power supplies shall self-limit their output current to no more than 200% of their rated load unless otherwise specified herein. Reverse output current protection shall be provided to prevent shorting or sagging of tandem supplies in the event of a filter capacitor failure.

7. Identification. Each power supply shall be clearly and permanently labeled with the following:
   a. Manufacturer's name.
   b. Part or model number.
   c. Serial number.
   d. Input rating.
   e. Continuous output rating.

B. Batteries and Chargers. Maintenance-free storage batteries and chargers shall be supplied. Each battery bank shall consist of maintenance free storage cells, sized per the plans.

1. The charger for this battery shall be regulated and filtered. Output shall be adjustable up to 19 volts. Ripple shall not exceed 1 volt peak-to-peak at 30 Amperes output.

2. The charger/battery shall be able to maintain/charge the batteries in both float and equalizing charge modes.

3. The chargers shall be Cragg Railchargers.

4. Batteries shall be maintenance-free storage batteries sized as described in this section. The electronic equipment battery banks shall have a nominal voltage of 12VDC. The lighting and gate control battery banks shall have a nominal voltage of 14VDC. Batteries shall be GNB Absolyte GP.

5. Battery trays shall be provided for all battery sets. Trays shall be sized as required to accommodate the battery sets and shall be as provided by FIBERCO.

C. Submittal Requirements.

1. All battery chargers, batteries and battery trays proposed shall be submitted.

28-01.2.4 LIGHTNING ARRESTERS AND EQUALIZERS

A. Lightning arresters shall be provided to protect signaling equipment.

B. Arrester Types.

1. Signaling arresters shall be specifically designed for railway signaling use.

2. The primary function of the signaling arresters shall be to provide line-to-ground protection. This requirement shall not exclude the arrester from performing other functions.

3. Arresters, line-to-ground type
   a. The arrester shall pass negligible current at rated circuit voltage.
   b. The arrester failure mode shall be to open rather than short circuit or partially short circuit.
   c. The arrester shall be suitable for use on circuits of 0 to 35 volts DC without circuit impedance restrictions.
   d. The arresters shall have an average DC breakdown voltage of 1000 volts or less.
   e. Arresters shall have a maximum impulse spark over voltage not exceeding 2000 volts peak for an impulse with a 10 kV/microsecond rise time. The arrester shall be AGA-1 heavy-duty clearview manufactured by GE Transportation Systems.

C. Submittal Requirements.

1. Lightning arresters proposed for use shall be submitted to the Engineer for approval.

28-01.2.5 SIGNAL TERMINAL BINDING POSTS

A. Signal circuits shall be terminated on terminal binding posts. Terminal binding posts shall be in accordance with AREMA Communications and Signals, Part 14.1.0.

B. Submittal Requirements.

1. Binding posts, and required accessories proposed for use, shall be submitted to the Engineer for approval.

28-01.2.6 RAIL CONNECTIONS AND BONDS

A. Signal Rail Bonds.

1. Signal rail bonds shall be rail head type manufactured bonds prepared for welding. The bonds shall be as described in AREMA Communications and Signals Manual Part 8.1.30. Signal rail bonds shall be as manufactured by Erico Products, Inc., or approved equal.

2. These bonds shall be manufacturer's bonds prepared for welding by the exothermic process.

B. Signal Rail Connections.

1. Signal rail connections shall be manufactured connections prepared for welding. The bonds shall be as described in AREMA Communications and Signals Manual, Part 8.1.32. Signal rail connections shall be as manufactured by Erico Products, Inc., or approved equal.

C. Submittal Requirements.

1. Rail bonds and connections proposed for use shall be submitted to the Engineer for approval. Submittals shall include the means of preparing the rail for welding and the welding materials to be used.

28-01.2.7 SEALING COMPOUND

A. Sealing compound shall meet the requirements of the AREMA Communications and Signals Manual, Part 15.2.15.

B. Submittal Requirements.

1. Sealing compounds proposed for use shall be submitted to the Engineer for approval.

28-01.2.8 CONSTANT WARNING TIME DEVICES

A. Description. The constant warning time device track circuit shall be self-contained, and microprocessor controlled, with a lower frequency AF track circuit providing detection of approaching trains over the extents of the grade crossing approach and a second higher frequency AF track circuit providing detection of trains over the grade crossing. Directional stick logic shall be provided by the constant warning time device such that, following the expiration of any loss-of-shunt time, the train detection output of the device will energize allowing the grade crossing to open immediately upon being cleared by a receding train. The constant warning time device shall have normal and standby sections with a transfer logic function that allows the device to automatically switch from normal to standby in the case of a fault. The constant warning time device shall be an XP-4 manufactured by GE Transportation Systems.

B. General performance requirements.

1. The constant warning time device shall conform to AREMA part 3.1.15.

2. Electronic devices and components for the constant warning time device shall conform to AREMA part 8.6.1.

3. The system shall withstand voltage surges, when protected to the secondary level as described in AREMA part 11.2.1, and as required by the manufacturer.

4. The system shall conform to AREMA part 11.5.1 and shall be suitable for installation in wayside equipment houses and instrument cases.

5. The system shall be self-contained in a metal enclosure suitable for rack, shelf or wall mounting.

6. Individual sub-systems within the constant warning time device system shall be field replaceable plug-in modules to facilitate testing maintenance. Field replaceable modules shall be keyed to prevent incorrect substitution. It shall be possible to interchange field replaceable modules without affecting the location-specific programming of the system.

7. The constant warning time device track circuits shall operate at specified frequencies and shall be capable of operating in conditions of a minimum ballast resistance of 2 Ohms per 1000 feet, distributed, and 2 Ohms lumped ballast resistance at the crossing.

8. The constant warning time device shall operate from a nominal supply voltage of 13.5 VDC with a tolerance of from 10.0 VDC to 14.0 VDC with a maximum ripple voltage of 0.2 VRMS.

9. Vital relay drive outputs shall be isolated and capable of driving 7.5 VDC into a load of 250 ohms and 10 VDC into a load of 500 to 1000 ohms.

10. Indicators shall be provided for diagnostic requirements, system actuation, and island occupancy.

11. No single component failure shall result in unsafe operation of the system. Any component failure which could result in unsafe operation because of successive component failures, shall result in interruption of its respective relay drive output.

12. The track circuit signal applied to the rail shall be sinusoidal AC with a less than 5% harmonic content. The frequency of the track circuit shall be in the audio range between 60 Hertz and 20KHertz. The frequency of the approach track circuit shall be adjustable via user programming, dip switches or strapping and shall not require frequency specific transmitter and receiver field replaceable modules.

13. The approach track circuit shall be defined by the track connections either side of the roadway and the termination shunts located at the extent of the approach. Termination shunts shall be appropriate for the application. Multi-Frequency Narrow bandpass terminations, configured and applied per the manufacturer, shall be provided for the termination of Constant Warning Time Track Circuits. Existing terminations shunts that are required to be moved as part of the project, shall not be re-installed and shall be replaced with new units.

14. The system shall be capable of predicting train time to crossing and shall provide a uniform warning time in a range centered about a pre-programmed requested warning time. No train, within the parameters described earlier, shall be allowed to arrive at the crossing with less than 20 seconds warning time.

15. The system shall be capable of operation in either bi-directional or uni-directional configurations.

16. The constant warning time device shall be capable of operation when configured and applied per the recommendations of the manufacturer in the vicinity of both DC track circuits and other AF track circuits.

17. The constant warning time device shall provide a timeout period of five to twenty seconds after the train detection output has been deenergized and the approaching train shunt either stops, recedes, or is lost.

18. Directional stick logic shall be a function of the system such that train detection outputs are energized within 2 seconds of a receding train clearing the island track circuit, or, in the case of a uni-directional application with no island, within two seconds of a receding train clearing the insulated joints at the track connections. This time shall be adjustable to up to six seconds based upon the requirements of the application.

19. The system shall be capable of operation, when configured and applied per the recommendations of the manufacturer, with 60 Hertz AC noise of up to 5 VRMS imposed upon the rail.

20. The system shall provide for the synchronization of multiple units of common approach frequency.

21. The system shall provide for internal redundant operation. Transfer logic and a programmable transfer time shall be part of the system.

22. The constant warning time device may provide multiple track operation from a single operating chassis.

C. Train Detection.

1. Track circuits shall detect a shunt anywhere within the track circuit boundaries. Shunting sensitivity shall be 0.06 Ohm with a rail-to-rail leakage impedance of 2 Ohms minimum per 1000 feet of track at the operating frequency, and 2 Ohms lumped impedance resistance at the crossing under the following conditions:
   a. Train moving or stopped.

2. The constant warning time device shall, when applied per manufacturer recommendations, provide 20 second minimum warning times for constant train speeds of 2 MPH or greater.

3. The system shall be capable of detecting any track circuit discontinuity which could result in reduced warning time within 70% of the approach track. In the case of such discontinuity, the train detection output associated with that track circuit shall be deenergized.

4. Low ballast conditions that could interfere with the acquisition of approaching trains shall cause the train detection output associated with the track circuit to be deenergized.

D. Track Leads. The Contractor shall provide and install connections to the rails, and all other material and apparatus including track and jumper bonds, as required for a complete track circuit installation.

E. Termination Shunts. The Contractor shall provide and install all necessary termination shunts for the constant warning time device as described in the contract documents. Hardwire terminations shall consist of two 1C 3/16 inch bond strand leads connected to the rails as described elsewhere in this specification and shall be neatly dressed along the rails and ties. Narrow bandpass termination shunts shall be GETS FSS-1F/2F multiple frequency termination shunts, or an approved equivalent. Narrow bandpass termination shunts shall be installed in a PVC tube sealed on one end with a glued cap and on the other end with a gasketed cap and shall be buried outside the rails in such a manner as to create a neat installation and to reduce tripping hazards. Attachment wires shall be connected to the rails as described elsewhere in this specification and shall be neatly dressed along the rails and ties. Where required, dummy track loads shall be sized per the contract documents and shall be of a type that are suitable for installation in the termination shunt tube.

F. Design Requirements

1. The equipment shall meet FRA requirements. The equipment shall meet or exceed the standards and requirements of the AREMA Communications and Signals Manual of Recommended Practice. The equipment shall be applied per the recommendation of the manufacturer. Track circuits shall be configured as described in the contract documents.

2. All terminations, cable materials, and methods shall be of commercially available types. Any terminals for the direct connection of underground cables shall be AREMA approved binding posts.

3. Parts shall be available for a minimum of 10 years after Final Acceptance.

4. Environment. Equipment shall meet the basic temperature requirements, without heating or cooling enhancements such as heating strips and fans.

5. Inputs for the equipment shall be electrically and physically isolated from one another.

6. Outputs for the equipment shall be electrically and physically isolated from one another.

7. Lightning Protection. Lightning protection devices shall be provided according to the manufacturer's standard. Protection against lightning, surges, spikes, and over-voltage shall be provided. The Contractor shall protect all input and output lines and any auxiliary equipment as necessary.

G. Submittal Requirements.

1. All Constant Warning Time Devices, including all Modules required for their operation, shall be submitted as described elsewhere in this specification.

28-01.2.9 CROSSING CONTROLLERS AND SURGE PANELS **(DOES NOT APPLY)**

A. Crossing Controllers, General. Crossing controllers shall consist of a solid-state unit that is actuated from the control output of a signal relay or solid state train detection device and which directly operates flashing lights, gates and pedestrian bells at a highway grade crossing. Additionally, the crossing controller shall be capable of the control of both entrance and exit gates at a four-quadrant crossing and shall provide accommodation for interconnection with highway traffic controllers for the purpose of effecting a pre-emption notification. Crossing Controllers shall be integrated units installed in the CWTD chassis and controlled from the CWTD backplane.

1. The system shall be capable of operation without the necessity of connection to external vital control relays.

2. The system shall be capable of providing programmable gate delays for both the entrance and exit gates.

3. Those functions of crossing control and indication that are normally recognized as being vital functions shall be performed in a fail-safe manner by the crossing controller. Non-vital I/O may be provided as part of the crossing controller’s function; however, such I/O shall not be used to perform vital functions.

4. All crossing controller modules shall be field replaceable without affecting location specific programming. Wiring to the crossing controller shall be via a plug, or plugboard, such that wiring can be quickly disconnected and reconnected when performing service to the unit.

5. The crossing controller flasher control shall provide three-wire alternately flashing lamp drives capable of operating 10 volt signal lamps. Flasher controls shall be capable of providing a minimum of 20 amps of current.

6. Gate controls shall provide a minimum 11 volts at 4 amps.

7. Bell drives shall provide a minimum 11 volts at 2 amps.

8. The crossing controller shall be designed such that no single component failure can result in an activation failure. Any component failure that could result in an activation failure following a further successive component failure shall result in a system activation.

9. The crossing controller shall provide a means for the adjustment of individual lamp and bell voltages.

10. The crossing controller shall have a service record of a minimum of 5 years on a similar rail property and in similar service to that proposed by this project.

B. Surge Panels, General. Surge panels shall be provided for the termination and protection of all

wires leading to/from the crossing controller to/from the highway crossing signals.

1. The surge panels shall protect the crossing controller, and other connected electronics, against lightning and other voltage surges in input, output and power supply leads when installed as described in the AREMA Communications and Signal Manual, Part 11.2.1, Recommended General Practices for Electrical Surge Protection for Signal Systems, and per the manufacturer's recommendations.

C. Submittal Requirements.

1. Crossing Controllers and Surge Panels proposed for use shall be submitted to the Engineer for approval.

28-01.2.10 SHUNT ENHANCER PANEL **(DOES NOT APPLY)**

A. A shunt enhancer panel shall be provided as described in the plans.

1. The shunt enhancer panel shall have power inputs for both 120VAC and 12VDC. The primary power source shall be the 120VAC line voltage with failover to 12VDC in the event that 120VAC line voltage is not available.

2. The shunt enhancer panel shall not interfere with the operation of the CWTD and shall provide an output that can be used to trigger the CWTD in the event of a total failure of the panel.

3. The shunt enhancer panel shall be a t-Rx7100 as manufactured by Genesis.

B. Submittal Requirements.

1. Shunt enhancer panels proposed for use shall be submitted to the Engineer for approval.

28-01.2.11 DC TRACK CIRCUITS

A. DC track circuits shall be provided as described in the contract documents. DC track circuits shall be driven by a track battery replacer. The track battery replacer shall be a DC/DC converter that operates on a 10-VDC nominal input voltage and provides an output voltage ranging from 2.2-VDC to 0.7-VDC, depending upon load. The output drive shall be isolated from the input drive. The track battery replacer must be capable of driving at least one DC track circuit; however, more than one track circuit may be driven from a single unit. The track battery replacer shall be a 2TC as manufactured by GE Transportation Systems. Track relays shall be vital plug-in relays as described elsewhere in this specification.

1. Track circuit drivers shall consist of a DC to DC converter.

2. Track circuits shall be separated by an insulated joint installed in each rail.

3. Track circuit drivers shall be capable of driving a standard 4 ohm track relay.

4. Track circuits shall provide broken rail detection for both rails.

5. Track circuit equipment shall detect the failure of an insulated joint and protect against it causing any unsafe condition.

6. Track circuits shall be normally energized such that occupation of the track circuit by a train, a false shunt, a broken rail, a broken track connection, or other fault to the track circuit shall cause the track relay to be deenergized.

7. Track circuit drivers shall be powered from a backed DC source such that a failure of the public utility power shall not cause a failure of the track circuits.

8. Track circuit resistors shall comply with the requirements of AREMA Communications and Signal Manual Part 14.2.15.

9. Equip vital relays with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plug board.

10. Identify each relay with nametag(s) as indicated on the plans.

11. The Contractor shall furnish one e-post wrench for opening and closing the relay test terminals with each shelter where relays are installed. E-post wrench must be in each shelter for final acceptance.

12. The Contractor shall furnish two insertion/extraction tools for each type of contact at each shelter where relays are installed. Insertion/extraction tools must be in each shelter for final acceptance.

B. Detection Requirements.

1. Track circuits shall detect a shunt anywhere within the track circuit boundaries. Shunting sensitivity shall be 0.06 Ohm with a rail-to-rail leakage impedance of 3 Ohms minimum per 1000 feet of track at the operating frequency, under the following conditions:
   a. Train moving or stopped.
   b. Rail condition for prevalent operation; that is, a secondary, lightly used line where the rail is subject to accumulations of rust and scale.

2. Failure of track circuit components shall not permit the shunting sensitivity to fall below that specified after the track circuit has been properly adjusted. Failures of track circuit components shall result in failsafe operation.

C. Design Requirements

1. The equipment shall meet FRA requirements. The equipment shall meet or exceed the standards and requirements of the AREMA Communications and Signals Manual of Recommended Practice. The equipment shall be applied per the recommendation of the manufacturer. Track circuits shall be configured as described in the plans.

2. All terminations, cable materials, and methods shall be of commercially available types. Any terminals for the direct connection of underground cables shall be AREMA approved binding posts.

3. Parts shall be available for a minimum of 10 years after Final Acceptance.

4. Environment. Equipment shall meet the basic temperature requirements, without heating or cooling enhancements such as heating strips and fans.

5. Inputs for the equipment shall be electrically and physically isolated from one another.

6. Outputs for the equipment shall be electrically and physically isolated from one another.

7. Lightning Protection. Lightning protection devices shall be provided according to the manufacturer's standard. Protection against lightning, surges, spikes, and over-voltage shall be provided. The Contractor shall protect all input and output lines and any auxiliary

equipment as necessary.

8. Track Devices. Insulated rail joints, insulated switch rods, and insulated gauge plates shall be furnished and installed by the Contractor; however, this specification does not intend to describe the insulation to be provided, nor the method of installation. The Contractor shall be responsible for inspection of the track and provision and installation of the required devices. Failure of the Contractor to anticipate the required devices shall not result in additional cost to the project.

9. Track Leads. Contractor shall provide and install connections to the rails, and all other material and apparatus including track, fouling and jumper bonds, as required for a complete track circuit installation.

D. Submittal Requirements.

1. Shunt enhancer panels proposed for use shall be submitted to the Engineer for approval.

28-01.2.12 RELAYS

A. Vital relays shall be provided as described in the plans. Vital relays shall meet the requirements of AREMA C&S Manual Part 6.2.1, where they do not conflict with any requirements specified herein.

1. Vital Relays shall be Alstom Type B, Safetran Type "ST", or an approved equal. Contractor shall use the specific relays shown on the plans.

2. Vital dc relays, unless otherwise indicated on the plans, shall be of the plug-in type and rack-mounted. Relays shall have a transparent dust cover made of a nonflammable composition that will not support combustion.

3. Vital Relays, with a nominal operating voltage of 10 to 16 volts, shall be capable of operating continuously without resultant damage, with a minimum voltage range of 7 to 21 volts inclusive, applied to their operating circuits.

4. Vital relays shall have a test terminal to allow convenient measurement of the coil voltage.

5. Design biased neutral vital relays so that gravity alone will prevent the armature from picking up if the permanent magnet is de-energized or if no current is applied to the coil, due to interruption of the normal magnetic circuit.

6. All front contacts shall be silver-to-metal carbon, meeting the requirements of the AREMA C&S Manual Part 6.2.1.

7. Arc suppression for vital relays shall be built into the relay or into its plugboard.

8. Equip vital plug-in relays, except vital time-element relays and special application relays, with front current testing facilities. Where shown on the 9lans, provide facilities to enable the testing of voltage from the front of the relay, without having to remove the relay or remove adjacent relays.

9. Equip vital relays with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plug board.

10. Identify each relay with nametag(s) as indicated on the plans.

11. The Contractor shall furnish one e-post wrench for opening and closing the relay test

terminals with each shelter where relays are installed. E-post wrench must be in each shelter for final acceptance.

12. The Contractor shall furnish two insertion/extraction tools for each type of contact at each shelter where relays are installed. Insertion/extraction tools must be in each shelter for final acceptance.

B. Submittal Requirements.

1. Vital relays, plugboards w/ test posts, and terminal flags proposed for use shall be submitted to the Engineer for approval.

28-01.2.13 FLASHING LIGHTS AND CROSSARMS

A. Flashing Lights mounted on cantilever masts, cantilever arms and gate masts shall comply with AREMA Communications and Signals, Part 3.2.35.

1. Flashing Lights shall be 12 inch LED units.

2. Flashing Light bodies, horns and crossarms shall be constructed of cast aluminum.

3. Flashing Light units shall be equipped with 24 inch backgrounds and with 8 inch hoods constructed from aluminum and painted flat black.

4. Flashing Light units shall produce a uniform light output in a highway crossing red color.

5. Flashing Light units shall be capable of operation at both 10VDC and 10VAC.

6. Flashing Light unit body shall be marked with the manufacturer's name, model number and date of manufacture.

7. Crossarms for flashing lights shall have models capable of 5 inch mounting. Crossarms shall conform to AREMA Communications and Signals Manual, Parts 3.2.50 and 3.2.51.

8. All bolts, nuts and washers for the crossarms shall be stainless steel. All threaded parts exposed to weather shall be coated with anti-seize compound.

B. Submittal Requirements.

1. Flashing light units, crossarms and hardware proposed for use shall be submitted to the Engineer for approval.

28-01.2.14 ELECTRONIC BELLS

A. Requirements. Electronic Bells shall conform to the requirements of AREMA Communications and Signals Manual, Part 3.2.61. Bells shall be provided as described in the plans.

1. Bell shall be designed to be mounted on either a 4 inch or 5 inch pipe post.

2. Bell shall mimic the sound of an electro-mechanical bell as described in AREMA Communications and Signals Manual, Part 3.2.60.

3. The outside dimensions of the bell, complete with the pipe post attachment shall not exceed the following:
   - Height – 18 inches.
   - Width – 15 inches.

- Depth – 10 inches.

4. The bell shall conform to AREMA Communications and Signals Manual, Part 11.5.1, Recommended Environmental Requirements of Electrical and Electronic Railroad Signal System Equipment, Class B. The bell's circuit board shall be coated to prevent undue deterioration.

5. The bell housing shall be of aluminum or cast iron and shall have an opening of not less than 1 inch in diameter to allow wire entrance in the pipe post base. Binding posts conforming to AREMA Communications and Signals Manual, Part 1.4.1.C, shall be provided. Binding posts shall be clearly marked with indications of polarity and shall be readily accessible.

6. The bell shall have a nominal operating voltage of 12VDC and shall provide satisfactory operation when the operating voltage is from 75% to 125% of the normal operating voltage.

7. The bell shall provide between 100 and 325 impulses per minute. Impulses shall be so timed that no one sound wave interferes with subsequent waves.

8. The bell shall not be louder than 105dba nor softer than 75dba when tested as described in AREMA Communications and Signals Manual, Part 3.2.61. It shall not produce radio interference and shall conform to AREMA Communications and Signals Manual, Part 11.5.1. Program memory for the bell shall be nonvolatile and shall not depend on any power source for memory integrity.

9. The bell shall be identified with a tag attached inside the housing and marked with the following data:
   - Manufacturer's name.
   - Type.
   - Serial Number.
   - Operating Voltage.
   - Date of Manufacture.

B. Submittal Requirements.

1. Electronic bells proposed for use shall be submitted to the Engineer for approval.

28-01.2.15 CROSSBUCK SIGNS

A. Crossbucks signs shall be provided for each new signal. Replacement crossbuck signs shall be provided for existing signals if their condition so requires.

1. Crossbuck signs shall conform to AREMA Communications and Signals Manual, Part 3.2.70.

2. Crossbuck signs shall be constructed of aluminum with high intensity reflective sheeting. Lettering shall be round type 5 1/2 inches. A strip of retroreflective white material not less than 2 inches wide shall be used on the back of each blade as described in MUTCD, Section 8B.02.

3. Hardware for the mounting of the crossbuck signs shall conform to AREMA Communications and Signals Manual, Part 3.2.90.

B. Submittal Requirements.

1. Crossbuck signs and mounting hardware proposed for use shall be submitted to the Engineer for approval.

28-01.2.16 FLASHING LIGHT JUNCTION BOX BASES AND MASTS

A. Flashing light junction box bases and masts shall be provided for each new signal. Replacement bases and masts shall be provided for existing signals if their condition so merits.

1. Flashing light junction box bases shall conform to AREMA Communications and Signals Manual, Parts 7.2.41A or 7.2.41B.

2. Flashing light junction box bases shall be of the split base variety and shall have an adequate number of terminals to land all control, indication power and lighting conductors for the signal. Where necessary, double junction box bases must be used.

3. Flashing light junction box bases shall be of cast aluminum and shall accommodate a 5 inch O.D. pipe post mast.

4. Masts shall be constructed of high-strength to weight ratio aluminum. Masts shall be 5 inch O.D. and shall be a minimum of 17 feet in height. Handholes shall be factory drilled. Field cutting of handholes with a torch shall not be permitted.

5. Masts shall be provided with appropriate pinnacles.

6. Where masts are supporting a gate mechanism and gate arm and the gate arm exceeds 32 feet in length an extra tall mast shall be provided (19 feet tall). Two high wind guards shall be attached to the mast as described elsewhere in this specification.

B. Submittal Requirements.

1. Flashing light junction box bases and masts proposed for use shall be submitted to the Engineer for approval.

28-01.2.17 PRECAST CONCRETE FOUNDATIONS

A. The Contractor shall provide and install precast concrete foundations for crossing signals.

1. Precast concrete foundations for crossing signals shall conform to the requirements of AREMA Communications and Signals Manual, Parts 14.4.1A, 14.4.3A, and 14.4.7C.

2. Precast concrete foundations for the signal house shall conform to the requirements of AREMA Communications and Signals Manual, Parts 14.4.1A and 14.4.11.

3. Reinforcing steel shall be not less than 1 inch from the outside surface of the precast concrete foundation. Reinforcing bars and ties shall conform to AREMA Communications and Signals Manual 15.1.4.

4. Bolts, nuts and threads shall conform to AREMA Communications and Signals Manual, Part 14.6.20. Washers shall conform to AREMA Communications and Signals Manual, Part 14.6.21. All such parts shall be galvanized or plated in conformance to AREMA Communications and Signals Manual, Part 15.3.1.

5. Concrete used shall conform to AREMA Manual for Railway Engineering, Chapter 8. Coarse aggregate shall consist of 1/2 inch maximum. Air entrainment shall not exceed 6%. Compressive strength shall not be less than 5,000 pounds per square inch after 28 days. Calcium chloride shall not be used in the concrete.

6. Cavities for nuts and bolts should be plugged for shipment to prevent intrusion of ice and other materials. Threads on bolts should be similarly protected against crushing and

deformation.

B. Submittal Requirements

1. Precast foundations proposed for use shall be submitted to the Engineer for approval.

28-01.2.18 GALVANIZED STEEL FOUNDATIONS

A. Galvanized Steel Foundations shall conform to the requirements of AREMA Communications and Signals Manual Parts 4.4.17 through 4.4.23, as appropriate.

1. Steel used in the foundations shall conform to the requirements of ASTM Standard A35/A36M-96. Steel shall be hot dipped galvanized and shall conform to the requirements of ASTM standard A123/A123M-97A and shall have a minimum galvanized thickness of 0.0034 inches.

2. Bolts, nuts and washers shall be galvanized or zinc plated and shall conform to AREMA Communications ands Signals Manual Part 15.3.1.

3. All joints shall be welded by certified welders using certified welding procedures.

B. Galvanized Steel Foundations.

1. Galvanized Steel Foundations proposed for use shall be submitted to the Engineer for approval.

28-01.2.19 GATE ARM MECHANISMS

A. Gate arm mechanisms shall be provided as described in the plans.

1. Gate arm mechanisms shall conform to the requirements of AREMA Communications and Signals Manual, Part 3.2.15.

2. Gate arm mechanisms shall be capable of mounting on a 5 inch O.D. mast. An appropriate cable entry shall be provided in the mechanism that allows that control and indication wires to be fed to/from the junction box base. The hose between the two connections shall be of either flexible metal construction, or metal mesh reinforced hose. The appropriate fittings shall be provided for both ends of the hose.

3. Gate arm mechanisms shall be provided complete with counterweight assemblies appropriate for the length of gate arm to be mounted. Assemblies shall be complete including mounting arms, support arms, castings, counterweights, mounts, studs, nuts and washers.

4. All miscellaneous hardware shall be stainless.

5. Gate arm mechanisms be as described in the plans and shall be Model 3597 as manufactured by Western Cullen Hayes.

6. Entrance gate mechanism shall be provided as described in the plans. Entrance gate mechanisms shall be designed and installed such that in the event of a loss of power to the gate mechanism it will fail in the horizontal position.

B. Submittal Requirements.

1. Gate arm mechanisms proposed for use shall be submitted to the Engineer for approval.

28-01.2.20 GATE ARMS

A. Gate arms shall be provided in the quantities and lengths as described in the contract documents. Gate arms shall be Alumi Lite as manufactured by NEG.

1. Gate arms shall conform to AREMA Communications and Signals Manual, Parts 3.2.20 and 3.2.24.

2. Gate arms shall be striped in a retro-reflexive material per the recommendations of AREMA Communications and Signals Manual, Part 3.2.25.

3. Gate arms shall be provided with a breakaway gate arm adapter and conversion bracket as described in AREMA Communications and Signals Manual, Part 3.2.21.

4. Gate arms in excess of 32 feet in length shall be provided with a flex gate arm tip as manufactured by NEG, or approved equivalent.

5. Wind Guards shall be provided. Wind guards shall conform to the requirements of AREMA Communications and Signals Manual, Part 3.2.22 and shall be capable of mounting on a 5 inch O.D. pipe post mast. For gate arms in excess of 32 feet in length two wind guards shall be provided.

B. Submittal Requirements.

1. Gate arms proposed for use shall be submitted to the Engineer for approval.

2. Wind guards proposed for use shall be submitted to the Engineer for approval.

28-01.2.21 GATE ARM LIGHTS

A. Gate arm lights shall be provided as described in the plans. Gate arm lights shall be EZ Gate LED kits, 9298-1120G, as manufactured by Railway Equipment Company.

1. Gate arm lights shall conform to AREMA Communications and Signals Manual, Part 3.2.40.

2. Gate arm lights shall be 4 inch units capable of operation at 10VDC and 10VAC.

3. Tip lights shall be equipped with a tip light diode as manufactured by Railway Equipment Company, 9298-0900D.

4. Gate arm lights shall be complete with a junction box with two cable entries, one on each side, capable of admitting a multiconductor lighting cable. The junction box shall be capable of being opened, and reclosed, without the use of special tools and shall have sufficient space for the interconnection of the lighting cable with light wires. The lid to the junction box shall be gasketed to prevent the entry of moisture. Cable entries shall be complete with cable adapters providing a tight fit to prevent the entry of moisture.

5. Gate arm lights shall be positioned on the gate arm in conformance with the recommendations of the AREMA Communications and Signals Manual, and the MUTCD.

B. Submittal Requirements.

1. Gate arm lights proposed for use shall be submitted to the Engineer for approval.

28-01.2.22 GROUND RODS

A. Ground Rods. The Contractor shall furnish and install 3/4 inch by 10 feet copper covered ground rods driven to a minimum depth of 10 feet 2 inches for all new and relocated signals. A No. 6 AWG bare solid, soft-drawn copper conductor shall then be run from the rod to the signal, or cantilever, mast. The conductor shall be exothermically welded to the ground rod and to the signal mast using a product such as produced by Erico Products, Inc., or an approved equivalent.

B. Submittal Requirements.

1. Ground rods, exothermic welds, and ground wire proposed for use shall be submitted to the Engineer for approval.

28-01.2.23 CONDUITS

A. Conduits. Directly buried conduits for the routing of signaling cables shall be furnished and installed by the Contractor. Conduits shall be installed where it is necessary to route cables beneath the roadway, pavement, or the track. Pull boxes shall be provided at the equipment house, either side of the roadway, and at points in conduit runs where pulling pressures would exceed recommendations.

1. Conduit shall be Galvanized Rigid Steel (GRS) Conduit. Conduit and fittings shall be made of the best grade standard weight steel pipe protected inside and outside by a coat of hot-dip galvanizing. Minimum size of conduits shall be 4 inches; however, it is the Contractor's responsibility to assure that the size of the conduit is suitable to assure no more than 40% fill and to reduce necessary pulling pressures and the possibility of cable jams.

2. A pull line shall be provided in each conduit. The pull line shall be a minimum of 3/16 inches in diameter with a tensile strength of 720 pounds. The pull line shall be a polypro material, highly visible bright yellow and weather resistant.

3. Conduit openings shall be sealed using an appropriate sealing compound. The sealing compound shall be suitable for burial and shall be impervious to contaminants in the soil and wet conditions. Stuffing the ends of conduits with rags or paper shall not be permitted.

4. A marker tape fabricated from color-coded polyethylene shall be buried approximately 12 inches above the conduit continuously along the cable run. The marker tape shall be bright yellow, 6 inches wide and continuously coded in black lettering with the following legend: CAUTION! BURIED CABLE!

5. A mandrel shall be run through the conduit before the installation of cable. The mandrel shall be appropriately sized for the conduit and shall be tapered on both ends to allow it to be pulled in either direction. The mandrel shall be fabricated from a soft material that will not cut the conduit walls.

B. Submittal Requirements.

1. Conduit, conduit fittings, cleaner solution and solvent cement, pull line, and marker tape proposed for use shall be submitted to the Engineer for approval.

28-01.2.24 WIRE AND CABLE TAGS

A. Requirements. Tags shall be provided on cables, wires, terminal boards, relays and wayside devices as described in this section. The lettering on the tags shall be easily readable. The minimum acceptable font size shall be 10 points. A point is defined as 1/72 of an inch. The nomenclature used on the tags shall correspond to that shown in the contract documents.

B. Cables. Each conductor in each cable shall be tagged on both ends with its nomenclature. Spare conductors shall be tagged with their nomenclature.

C. Wires. All wires shall be tagged at each termination point with a waterproof sleeve-type tag. Each terminal board terminal shall also be tagged with a waterproof flat-type tag securely fastened to the front of the board. The lettering on all tags shall be typed or computer generated and waterproofed; tag lettering shall also be permatized. Hand lettering of tags will not be allowed. The wire tags shall bear the following information in the sequence listed:

1. Wire nomenclature.

2. Near end termination point (rack number, row and contact number, if applicable).

3. Far end termination point (rack number, row, and contact number, if applicable).

D. Terminal Boards. All external wires, cables, and wires from terminal boards to terminal boards shall be tagged at both ends. The individual wires shall be tagged with a white, waterproof, plastic, flat tag suitable for slipping over the wire insulation prior to termination. Tags shall bear the following information in the sequence listed:

1. The nomenclature of the wire.

2. Local terminal designation.

3. Terminal designation for the far end of the wire.

This nomenclature shall be in waterproof black printing. Hand lettering of tags will not be allowed. Tags for main terminal boards shall attach to the board with escutcheon pins.

E. Relays. Tags for wires terminating at relays and relay bases shall be of the sleeve type and shall be white with black printing. Hand lettering of tags will not be allowed. Tags shall show the following information in the sequence listed:

1. Nomenclature of the wire.

2. Relay contact number.

3. The terminal or contact designation for the far end of the wire.

F. Wayside Devices. Tags at wayside devices shall be of the sleeve type and shall bear the wire nomenclature, terminal number, and cable number.

G. Submittal Requirements.

1. Wire and cable tags proposed for use shall be submitted to the Engineer for approval.

28-01.2.25 LOCKS

A. Scope. The Contractor shall provide screw locks for all equipment enclosures that have hinged or removable doors, and for other specific devices defined herein that must be secured. These locks shall be equipped with a bronze chain, which the Contractor shall attach to the housing adjacent to the lock location. The Contractor shall also provide all necessary screws, washers, nuts and other fastenings necessary for this attachment.

B. Locks shall be provided for, at a minimum, all Equipment House doors, the key control box door,

all junction box doors and all gate mechanisms, as well as all other devices provided with a hasp. Devices that have built-in screw locks, such as flashing light bodies, shall not require additional security.

C. Submittal Requirements.

1. Locks proposed for use shall be submitted to the Engineer for approval.

28-01.2.26 TAPE

A. Rubber Tape. The Contractor shall furnish and apply field-applied rubber tape. Rubber tape shall be “Scotch Super 33+”, or approved equivalent. Rubber tape shall conform to the requirements of ASTM D1000.

B. Submittal Requirements.

1. Tape proposed for use shall be submitted to the Engineer for approval.

28-01.3.1 ENGINEERING REQUIREMENTS

A. Plans. The plans represent a solution to the requirement for a complete working signal system and are developed around specific products and procedures. The Contractor may submit substitutions for the products and procedures shown in the contract documents; however, revisions to the plans to show the substitutions shall be the responsibility of the Contractor. Additionally, while the plans are intended to be as correct as possible, it is the responsibility of the Contractor to assure that the signal systems provided work correctly and safely. Revisions required to the plans to achieve this are the responsibility of the Contractor.

The Contractor will be provided with the AutoCad files of the plans upon Notice to Proceed. It will be the Contractor’s responsibility to provide the revisions required to the drawings at the As-Wired and As-Built stage of the project.

B. The Contractor shall nominate a Project Engineer to be responsible for the installation and testing of all systems. The Project Engineer shall have the authority to make decisions relating to progressing the project, and shall be the Railroad’s point of contact for the project. The Project Engineer shall have a minimum of 10 years experience in the installation and testing of signal systems of a similar size and scope. The Contractor shall submit the resume of the proposed Project Engineer to the Railroad for approval. No work shall be performed until the Project Engineer has been approved. The Project Engineer may function as the day-to-day lead for the work being performed. In the event that an individual other than the Project Engineer is responsible for oversight of the day-to-day work, their resume shall also be submitted to the Railroad and they shall have a level of experience similar to that required for the Project Engineer.

C. The Contractor shall provide to the Railroad the resumes of individuals who will perform responsible signal work during the project. Responsible work shall be defined as work that affects the safety of the signal system and highway crossing systems and includes testing of disarranged circuits, installation of software, validation of circuits and software, and oversight of laborers. Laborers are defined as individuals performing such work as digging trenches, pulling cable, landing cable, setting signals and other such work. The Contractor shall be careful to assure that they has adequate personnel on the project to perform the responsible work. If, in the opinion of the Railroad, the Contractor does not provide evidence that they have adequately staffed the project, the Railroad reserves the right to stop the work until such time as it is adequately staffed.

D. Applications Logic. The Contractor shall program and test all applications logic required for

programmable devices proposed for the project.

E. Submittal Requirements.

1. Project Engineer. The resume of the nominated Project Engineer shall be submitted immediately following Notice to Proceed.

2. As-Wired Plans. As-wired plans shall be submitted to capture changes to the plans that result from the wiring and factory testing processes.

3. As-Built Plans. As-built plans shall be submitted to capture the changes to the plans that result from the installation and field testing processes.

4. Serialization. The Contractor shall submit the serial numbers of all electronic modules and systems installed new or provided as replacement or improvement of existing systems.

28-01.3.2 INSTALLATION REQUIREMENTS

A. Crossing Signals.

1. No part, either fixed or movable, of any signal layout shall project into the clearance envelope for the railway.

2. Minimum clearance of crossing signals, including all parts, either fixed or movable, shall be maintained per the recommendations of the MUTCD.

3. All crossing signals shall be equipped with a 24 inch background and hood.

4. Signals shall be aligned and focused, both horizontally and vertically, in conformance with the recommendations of AREMA Communications and Signals, Part 3.3.5.

5. The top of all crossing signal and cantilever foundations shall be a maximum of 4 inches above the final grade. The top of the foundations shall be no higher than the crown of road, or sidewalk, that the signal governs.

6. Foundations shall be installed level and plumb. Signals shall be installed level and plumb on foundations. Normal shimming is allowed; however, excessive shimming shall not be permitted and shall be grounds for the rejection of a signal or a foundation. The judgment of the Railroad is final in this matter, and the Contractor shall replace rejected signals or foundations at no additional cost to the project.

7. A 3 inch layer of AREMA No. 5 walking stone shall be placed around all signals following the completion of excavations to provide a level walking space, a minimum of 2 feet wide, around the signal for maintenance.

B. Track Connections.

1. Rail connections for track circuits shall be made by means of a 3/16 inch insulated bond, strand length as required, Erico Products, or approved equivalent, with one end pressed into a copper sleeve for welding to the rail by the exothermic welding process at the neutral axis on the outside (fieldside) of the rail. Before applying the weld, rail shall be ground to a bright and clean condition by means of a grinding wheel. A file or handstone shall not be used for this purpose. Welds shall be clean and shall not have drips or voids. Any weld which shows any defect shall be replace at no cost by the Contractor. The Railroad shall have final judgment of the condition of welds. The other end of the bond shall be finished in a 3/16-to-3/16 sleeve. A length of 3/16 bondstrand shall be attached to the bond and run to a trackside

bootleg where a 3/16-to-6 sleeve shall be used to attach the bondstrand to the twisted No. 6 UG trackwire. An appropriate crimping tool shall be used for crimping the sleeves. The sleeve shall be covered with 3 layers of rubber tape. Track connections shall conform to the requirements of AREMA Communications & Signal Manual, Part 8.1.25.

The bootleg shall be a 3 feet length of brake hose. The connection between the bondstrand and the trackwire shall be made within the bootleg. Before placing the connection into the bootleg, it shall be taped and painted. The bootleg shall be stapled to the end of the tie. Bondstrand shall be stapled to the tie at least 4 inches below its top surface. Rail clips shall be used to secure the bondstrand along the rail. Track connections shall be neatly dressed to reduce the likelihood of damage from dragging equipment or vandals.

Termination shunts shall be buried at trackside just beyond the ends of the ties. Where possible, the termination shunt shall be buried such that personnel are not between tracks when working. The bondstrand from the termination shunt shall be clipped to the tie between the rails. Rail clips shall be used to secure the bondstrand along the rail. Connections shall be made to the rail by means of a 3/16 inch insulated bond strand length as required, Erico Products, or approved equivalent, with one end pressed into a copper sleeve for welding to the rail by the exothermic welding process at the neutral axis on the outside (fieldside) of the rail. Bond strand shall conform to the requirements of AREMA Communications & Signal Manual, Part 10.3.19. Before applying the weld, rail shall be ground to a bright and clean condition by means of a grinding wheel. A file or handstone shall not be used for this purpose. Welds shall be clean and shall not have drips or voids. Any weld which shows any defect shall be replaced at no cost by the Contractor. The Railroad shall have final judgment of the condition of welds.

C. Excavating.

1. Prior to beginning any excavation the Contractor shall locate all existing underground facilities. It shall be the Contractor's responsibility to locate and mark all underground facilities. The Contractor shall be responsible for any damages to underground facilities.

2. Turf and sod shall be removed and stored for later reinstallation.

3. Wire, cable and conduit shall be buried to a depth of 36 inches below the surface of the finished grade.

4. Ballast shall be protected from contamination during excavating.

5. Horizontal boring shall be used for the installation of conduit beneath existing roadways and sidewalks, and beneath the tracks.

6. Excavations, and cuts in roadways and sidewalks shall be made in a workmanlike manner and so as to cause the least amount of damage. Cuts in roadways and sidewalks shall be saw cut. Should damage to a sidewalk, gutter, curb or section of roadway be caused by excavations, the Contractor shall replace it in kind. Damage caused by longitudinal cuts requires only the replacement of the damaged area. Damage caused by transverse cuts requires that the entire damaged concrete section is replaced.

7. Excavations in asphalt shall be replaced with appropriate hot mix asphalt.

8. Open trenches and foundation holes shall be protected. Excavations undertrack, or in the vicinity of the track shall be closed the day that they are opened. Excavations for foundations or trenches shall be made immediately prior to the installation of the foundation or conduit.

9. On-site materials obtained from the trench, and other excavations, to be used as backfill shall

be approved by the Railroad.

10. Excavated materials shall be stored in a location approved by the Railroad. Locations shall be selected to cause the least inconvenience to vehicular and pedestrian traffic, and to cause the minimum interference with local conditions.

11. Surplus excavated material shall be removed and disposed by the Contractor at no additional cost to the project. Surplus material shall be disposed of in an approved manner. The Contractor is responsible for all required permits and licenses for the disposal of such material.

12. Trenches may be excavated manually or with mechanical trenching equipment. Trench walls shall be vertical to minimize the disturbed area. The bottom of trenches shall be smooth and free of coarse aggregate. Blades of road patrols or graders shall not be used to excavate the trench.

13. Trenches shall be at least 6 inches wide. Where multiple conduits are installed in a trench, the width shall be increased accordingly.

14. If rock excavation is encountered, the rock shall be removed to a depth of at least 3 inches below the required excavation depth. It shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained using a 1/4 inch sieve. The Contractor shall ascertain the local conditions for excavation before bidding. Unexpected conditions shall not be cause for changes to the project price.

15. A minimum of 4 inches of sand shall be placed on the bottom of the trench prior to laying the conduit. Backfill material shall be deposited in trenches in 6 inch layers. The first layer of material shall be sand and shall not be compacted. The second layer of material shall be 5 inches and shall contain no particles that would be retained using a 1 inch sieve. The remainder of the trench may be backfilled using excavated or imported materials and shall not contain stone or aggregate larger than 4 inches in diameter.

16. Backfill material shall be deposited in 6 inch layers around foundations. Material shall be compacted between layers.

17. Backfill shall be finished level with the finished grade. It shall be compacted and watered and then finished as required.

18. A marker tape fabricated from color-coded polyethylene shall be buried approximately 12 inches above the conduit continuously along the cable run. The marker tape shall be bright yellow, 6 inches wide and continuously coded in black lettering with the following legend: CAUTION! BURIED CABLE!

D. Installation of Cable.

1. Power cable mounted on poles shall run down the pole and underground for entrance to the Equipment House. The cable shall be properly secured as it runs down the pole and a suitable guard shall be installed from just below ground level to a height of 6 feet.

2. Wire must not be nicked or twisted when forming eyes or applying terminals. Formed wire eyes shall be placed on terminals to ensure closing of the eye when terminal nuts are tightened.

3. Wiring of all appliances shall conform to the applicable parts of the AREMA Communications and Signals Manual.

4. Precautions shall be taken to prevent the kinks or twisting of wire and cable during installation. Kinks or twists that unavoidably occur shall be removed by hand. Insulation shall not be injured or marred by dropping, stepping, or throwing materials or tools on wire or cable. Wire and cable shall not be pulled over rough surfaces.

E. Rail Bonds.

1. Non-insulated joints shall be bonded with a rail-head bond. Before applying the weld, rail shall be ground to a bright and clean condition by means of a grinding wheel. A file or handstone shall not be used for this purpose. Welds shall be clean and shall not have drips or voids. Any weld which shows any defect shall be replaced at no cost by the Contractor. The Railroad shall have final judgment of the condition of welds.

28-01.3.3 SYSTEM SAFETY

A. System Safety. The Contractor shall perform comprehensive safety analyses to identify all potentially hazardous conditions. The Contractor shall perform, document and submit quantitative analyses as required to ensure that adequate safety consideration has been given. Apply system safety analyses to:

1. Evaluate alternatives.

2. Evaluate and verify safety requirements of the signaling system.

3. Evaluate the operation/emergency procedures and training requirements.

28-01.3.4 CONSTRUCTION STANDARDS AND CODES

A. Requirements. Unless modified elsewhere in the contract documents, the installation of signals and train control equipment shall be governed by the latest provisions of the NEC Standard of the National Board of Fire Underwriters for Electrical Wiring and Apparatus, the AREMA Communications and Signal manuals, FRA rule 234 and all other applicable codes. All provisions of these Codes shall be considered applicable whether or not specifically mentioned in these contract documents.

28-01.3.5 COORDINATION OF THE WORK

A. Requirements. The Contractor shall submit an installation and cut-over sequence plan. The plan shall be submitted prior to commencing any field installation work, and shall include, at a minimum, the following:

1. Narrative descriptions and schematics to maintain existing train operations and headways.

2. Narrative descriptions and schematics for temporary or interim circuits and materials.

3. Narrative descriptions and schematics for final circuits and materials.

4. Descriptions for the implementation and sequencing of all required tests.

B. Interface Requirements. The Contractor shall be responsible for all design and development of the interface between Contractor-furnished equipment and existing equipment and installations.

C. Submittal Requirements.

1. A sequence plan for installation and cut-over shall be submitted to the Railroad for approval. Submittals shall be made as described in the appropriate section of this specification.

28-01.3.6 CLEARANCE

A. Requirements. For the installation of wayside equipment, the Contractor shall be responsible to provide adequate clearance in relation to the dynamic outline of trains, utility equipment clearance, signal sighting distances, and obstructions and access by maintenance personnel.

28-01.3.7 ELECTRICAL CONNECTIONS

A. Terminals. These requirements for electrical connections shall apply to factory and field wiring. All wires which are terminated on AREMA binding posts shall be fitted with an acceptable insulated crimped type terminal as described in AREMA Communications and Signal Section, Part 14.1.1. These terminals shall be placed on the wire by means of standard forming tools of the proper size, equipped with locks to assure that the proper pressure is applied before the tool is released. Care shall be taken to assure that the correct size of wire terminal is used and that the wire is thoroughly cleaned and centered properly in the wire terminal when using the forming tool.

B. Stripping of Wires. Wire terminals shall not be bent, nicked or otherwise damaged. An acceptable wirestripping tool shall be carefully used to remove the insulation from No. 9 AWG and smaller wires. Scraping of these conductors with any sharp instruments shall not be permitted. For wires larger than No. 9 AWG, a knife may be used to remove the insulation, extreme care being taken to prevent nicking the conductors.

C. Wire Connections. Connections to bases for plug-in relays and similar connections to lever and lamp contacts shall be soldered or crimped using a connector.

D. Submittal Requirements.

1. Terminals, crimping and strip tools, and wire connectors proposed for use shall be submitted to the Railroad for approval. Submittals shall be made as described in the appropriate section of this specification.

28-01.3.8 PAINTING

A. Requirement. All painting and other coating shall be furnished and applied as specified in this Article unless otherwise specified.

B. The painting and coating of materials and equipment furnished under these contract documents shall comply with the requirements of the AREMA Communications and Signal Manual, Part 2.4.30, insofar as they apply and except as hereinafter modified. With the exception of galvanized and plated surfaces, machined surfaces, wires and cable, bolts and nuts for field assembly and other similar surfaces and materials, all materials and equipment to be furnished under this Contract shall be cleaned and painted in the factory with one prime coat and one finish coat. All equipment shall be touched up after installation.

C. Brand. Paints for primer and finishing coats shall be a recognized acceptable proprietary brand.

D. Application. No paint shall be applied on wet, damp, frosted or dirty surfaces, or when the temperature of the air is below 40°F.

E. Inaccessible Surfaces. Surfaces required to be painted and which shall be inaccessible after installation or erection shall be given two additional coats of paint before installation or erection.

F. Damage. If any surface, which has been painted, is damaged prior to the completion of the work, such damaged surface shall be cleaned, touched-up, or completely repainted by the Contractor at

no additional cost to the Contracting Authority.

G. Submittal Requirements.

1. Paints, including spray paints used for touch-up, shall be submitted to the Railroad for approval. Submittals shall be made as described in the appropriate section of this specification.

28-01.3.9 STENCILING AND MARKING OF EQUIPMENT

A. Identification. Instrument cases, equipment and junction boxes shall have the name of each individual piece shown directly on the respective door, cover, or frame by means of permanently stenciled lettering.

B. Milepost and DOT Crossing Number. The Contractor shall be responsible for assuring that the Milepost and the DOT Crossing Number are stenciled on the roadway side of the signal house. Stenciled identifications shall be in black paint in letters five inches tall.

C. Emergency Notification Signs per MUTCD Section 8B.18. Signs shall be installed on the signal house and on each signal (one per entrance quadrant).

28-01.3.10 SYSTEM DELIVERY REQUIREMENTS

A. Scope. The Contractor shall provide fully tested, functional, signal system. Equipment and materials used shall have individual certificates of conformance proving that they have been fully tested and proven acceptable. Field testing shall provide validation of system function.

B. Field Testing. Field Testing shall include, but not be limited to, the testing described. All tests shall be documented on an approved testing form.

1. Interior and exterior condition of the equipment shall be verified with discrepancies, and corrections, noted on a discrepancy form. Minor discrepancies in fit and finish may be repaired; however, major discrepancies shall be grounds for rejection of material. The Railroad has final judgment of the suitability of equipment. The Contractor shall replace rejected equipment at no additional cost to the project.

2. Signal House Electrical. The Contractor shall test all signal house electrical systems in the Equipment Case noting discrepancies, and corrections, on a discrepancy form. All discrepancies shall be corrected.

3. Ground Testing. A test for grounds shall be performed on each energy bus furnishing power to circuits that affect the safety of warning system operation. All circuits shall be free of grounds.

4. Flashing Light Units and Lamp Voltage. Flashing light units shall be inspected for proper alignment and frequency of flash. Lamp voltage shall be tested.

5. Insulation Resistance Tests. Insulation resistance tests shall be made between all conductors and ground, and between conductors in each multiconductor cable. Insulation resistance of conductors to ground, or conductor to conductor shall not be less than 40 megohms. Insulation resistance testing shall be made using a James Biddle Major Megger Insulation Tester Type 21159, or an approved equivalent.

6. Insulated Joints, Bonds and Track Connections. Insulated joints, bond wires and track connections shall be inspected. Discrepancies shall be corrected. Approach distances shall be wheeled off and noted against the plans.

7. Constant Warning Time Device Setup. The constant warning time device shall be setup per the recommendations of the manufacturer. Testing shall confirm that a 0.06Ω track shunt is detected by the device. Lumped impedance adjustment, narrowband termination compensation, and 50% and 100% approach distance shunt values shall all be tested.

8. System Operation.
   a. Observe two trains in each direction over the constant warning device track. Confirm that the crossing system operates as expected and that no tail ringing occurs as the trains recede from the crossing. Observe the operation of the constant warning time device as the trains approach and recede and verify that the track levels rise and fall in a linear manner. Note discontinuities in the approaches and investigate to determine if rail connections and rail bonds are in good condition in those areas of the track. The results of all testing shall be captured on testing forms. Discrepancies shall be corrected before the crossing is signed into service.

9. Track circuit operation. All track circuits shall be tested to assure that they are correctly setup and that the track relay, or equivalent of the track relay, deenergizes when a 0.06Ω shunt is placed across the track circuit.

10. The results of all testing shall be captured on testing forms. Discrepancies shall be corrected before the crossing is signed into service.

C. Test Instruments. All test instruments shall bear calibration stickers that indicate the calibration dates. All instruments shall have been calibrated within the last 365 days.

D. Submittal Requirements.

1. The test plan and test forms proposed for use shall be submitted to the Railroad for approval. Submittals shall be made as described in the appropriate section of this specification.

28-01.3.11 SYSTEM REQUIRED TESTING

A. Testing shall be performed as directed by MUTCD Part 8, and FRA Rules 234 and 236 (as applicable). All testing shall be recorded on testing forms. Discrepancies shall be corrected before the crossing is signed into service. Testing shall include, but not necessarily be limited to, the following tests:

1. FRA 234.211. Security of warning system apparatus. The Contractor shall assure that all apparatus and housings are secured against unauthorized entry. Testing forms shall record that locks have been installed as required.

2. FRA 234.249. Grounds. The Contractor shall assure that each circuit that affects the proper functioning of a highway grade crossing warning system is free of any ground, or combination of grounds, that would permit a current flow of 75% of more of the release value of any relay or electromagnetic device in the circuit. Relief from this requirement shall only be provided as described in the text of this rule. Testing forms shall record the results of all ground testing.

3. FRA 234.251. Standby Power System. The Contractor shall assure that the standby power system is capable of operating the highway grade crossing warning system in the event of an interruption to the primary power system. The Contractor shall further assure that the capacity of the standby power system is correctly recorded on the plans. Testing forms shall record the results of the standby power system testing.

4. FRA 234.253. Flashing light and lamp voltage. Warning Aspect. The Contractor shall

assure that the flashing light units are properly positioned and aligned, and are visible at least 300 feet from the crossing on a bright day with the sun near its zenith. Light units shall flash alternately at a rate of 35 to 55 flashes per minute. Hoods and backgrounds shall be provided for all lights. Roundels and reflectors shall be clean and in good condition. Lamp voltage as measured at the farthest light from the crossing shall not be less than 85% of the prescribed rating for the lamp. Testing forms shall record the results of the flashing light and lamp voltage testing.

5. FRA 234.257. Warning system operation. The Contractor shall assure that the crossing warning system, including warning bells, function properly. Testing forms shall confirm the proper operation of the warning system and the warning bells.

6. FRA 234.259. Warning time. Length of Circuit. The Contractor shall assure that normal trains provide approximately 25 seconds of warning time. Testing forms shall record the length of the approach tracks as measured from the track connections at the crossing, and the warning time for trains approaching the crossing from both directions.

7. FRA 234.263. Relays. The Contractor shall test all new relays installed as a part of this project to assure that they function per their manufacturer's specifications. Certificates of Conformance, as provided by the manufacturer, shall be included as part of the testing documentation. Testing forms shall record the results of all relay testing.

8. FRA 234.265. Timing relays and timing devices. No testing is required for the timing functions of the constant warning time devices and the solid-state crossing controllers beyond that previously described in this section.

9. FRA 234.267. Insulation resistance tests, wires in trunking and cables. Before beginning the work, the Contractor shall perform insulation resistance testing on all existing cables. Where insulation resistance of a conductor, either conductor to conductor, or conductor to ground, is less than 500,000 ohms, the Contractor shall inform the Railroad. Defects found as a result of this testing shall be the responsibility of the Railroad to correct. This testing shall be documented and provided to the Railroad.

   Before the work is considered to be complete, insulation resistance testing shall be performed on all cables, both existing and newly installed. Existing cables shall be subject to the requirements of FRA 234.267. Where insulation resistance of a conductor in an existing cable is less than 500,000 ohms, either conductor to conductor, or conductor to ground, the Contractor shall be responsible for repair or replacement of the cable. Newly installed cables shall have an insulation resistance of 40 Megohms, either conductor to conductor, or conductor to ground. Insulation resistance testing shall be made using a James Biddle Major Megger Insulation Tester Type 21159, or an approved equivalent. Testing forms shall record the results of all insulation resistance testing.

10. FRA 234.269. Cut-out circuits. The Contractor shall test the circuits switch position override circuits for the crossings. Testing forms shall record the results of all override circuits.

11. FRA 234.271. Insulated rail joints, bond wires, and track connections. The Contractor shall inspect all insulated rail joints, bond wires and track connections. Testing forms shall record the results of such inspection.

28-01.4 SUBMITTAL REQUIREMENTS

A. Scope. Submittals will be made as directed by this specification.

B. Format. Submittals will provide sufficient information to allow the reviewer to determine that they are suitable for the purpose for which they are proposed. Cut sheets or shop drawings will be

provided for all equipment or materials submitted. Where more than one item is shown on a cut sheet or drawing, some means such as cross-out or highlighting will be used to indicate the item being submitted.

1. Submittals will be made on 8 1/2 inch by 11 inch paper. Where cut sheets or drawings are larger than this, they will be folded to an 8 1/2 inch by 11 inch size.

2. Three copies of each submittal shall be provided to the Engineer. Submittals will be accompanied by a transmittal that clearly identifies the submittal by specification section and description. Transmittals will also provide the date that the submittal is made, and the contact information of the individual responsible for making the submittal.

3. The Engineer will forward the submittal to the Railroad.

4. The Railroad will review the submittal packages and shall return one copy of the package to the Engineer within 15 working days of its receipt. This package will be forwarded to the Contractor. The package will be accompanied by a transmittal identifying the package and providing the following information:
   - ACCEPTED. Submittal accepted without comment. Submitted item may be used in the work.
   - REJECTED. Submittal rejected. Comments provided with the rejection notice, including comments written on the submittal sheets, will identify the deficiencies in the submission. Submitted item may not be used in the work. Item shall be resubmitted with deficiencies corrected.

5. Items that require resubmission will be subject to the same requirements as the original submission. The Railroad will return one copy of the resubmitted package to the Engineer within 10 working days of its receipt. The package will be accompanied by a transmittal identifying the package and providing information as to its status.

28-01.5 MEASUREMENT AND PAYMENT

A. Railroad Signal shall be a Lump Sum payment for completion of the work included in this specification as indicated in the bid documents.

B. Prior to the preconstruction meeting the Contractor shall forward to the engineer a list of unit costs for the individual crossing signal items from the Bill of Materials. The sum of costs for each item shall equal the total Lump Sum price for the crossing signal installation. The total cost shall not be unreasonably distributed among the individual unit items.