

SECTION 18000

GENERAL SIGNAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes general procedures and requirements for the planning, manufacturing, installation, removal, relocation, modification, testing, placing in service, and documentation of as-built conditions of the various signal systems.

1.02 GENERAL

- A. Provisions of this Section apply to all Sections of Division 18, Signals.
- B. Modify existing equipment and material as shown on the Contract Drawings to interface with the existing and proposed signal system.

1.03 REFERENCE STANDARDS

- A. Electrical equipment, unless specifically excluded herein, shall conform to the standards of the National Electrical Manufacturers Association (NEMA), The Underwriters' Laboratories Inc., (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association, Inc. (NETA), or the Electronic Industries Association (EIA), wherever applicable. Unless specifically excluded herein, materials and workmanship shall conform to the requirements of the National Electrical Code; California Administrative Code, Title 8, Chapter 4, Subchapter 5, Electrical Safety Orders; Caltrain Signal Standards, and any applicable local ordinances.
- B. The following General Orders (G.O.) of the State of California Public Utilities Commission (CPUC) shall apply:
 - 1. G.O. 26 Clearances on Railroads and Street Railroads as to Side and Overhead Structures, Parallel Tracks, and Crossings
 - 2. G.O. 52 Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference
 - 3. G.O. 75D Protection of Crossing at Grade of Roads, Highways, and Streets with Railroads
 - 4. G.O. 88 Alteration of Existing Grade Crossing of Public Roads, Highways, and Streets with Railroads
 - 5. G.O. 118 Construction, Reconstruction, and Maintenance of Walkways and Control of Vegetation
 - 6. G.O. 128 Construction of Underground Electric Supply and Communication Systems

- C. The following parts of the Code of Federal Regulations, Title 49, Transportation, shall apply:
1. Part 212 State Safety Participation Regulations
 2. Part 214 Railroad Workplace Safety
 3. Part 219 Control of Alcohol and Drug Use
 4. Part 218 Railroad Operating Practices
 5. Part 220 Railroad Communications
Part 228 Hours of Service of Railroad Employees
 6. Part 234 Grade Crossing Signal System Safety
 7. Part 235 Instructions Governing Application for Approval of a Discontinuance or Material Modification of a Signal System or Relief From the Requirements of Part 236
 8. Part 236 Rules, Standards, and Instructions for Railroad Signal System

In addition, the Contractor shall be responsible for adherence to all of the above rules and reporting requirements, including those regulations which require pre-employment drug testing and random drug testing of employees engaged in the installation and testing of signal facilities, and the reporting and tracking of employees injured in the performance of work on a railroad.

- D. Manual on Uniform Traffic Control Devices (MUTCD), Part 8, Traffic Control Systems for Railroad and Light Rail Transit Grade Crossings, shall apply.
- E. In addition to the regulations and code requirements specified in this Section, materials and equipment for the signaling systems shall conform to the standards and recommendations of the Communications and Signals Manual of Recommended Practices of the American Railway Engineering and Maintenance of Way Association (AREMA), hereinafter referred to as the AREMA C&S Manual, except that where the Manual uses the word "should" the Contractor shall substitute the word "shall".

1.04 SYSTEM DESCRIPTION

- A. Owner-furnished materials for signal systems, if provided, along with delivery points or location of this material for pickup, are listed in the attachments to Section 01600, Materials. Refer to Section 01600, Materials, for Contractor responsibilities for receiving, accepting, and transporting Owner-furnished materials. Assemble and install this material as shown on the Contract Drawings.

- B. Provide all additional materials and installation services required for complete working signal systems, as described herein, and as shown on the Contract Drawings, including any equipment not designated as being relocated or designated as Owner-furnished.
- C. All materials and equipment for installation and for interconnection of the various signaling systems shall be fabricated, furnished, and installed as indicated on the Contract Drawings and specified herein.
- D. The Contract Drawings represent a final design utilizing systems, components, and materials that meet the Contract Specifications. Contractor may provide equivalent systems, components, and materials subject to the approval of the Engineer. If equivalent systems, components and materials are provided, the Contractor shall provide an alternate detailed final design as specified herein under Design Submittals.
- E. Provide systems that are compliant with applicable rules and regulations of 49CFR, parts 234, 235, and 236, and CPUC GO 75D. Refer to Design Submittals herein for Contractor's responsibility to indicate any corrections or modifications to the Contract Drawings final design that the Contractor may determine are required to conform to these rules and regulations.
- F. The Contractor shall be represented at all design meetings held with the Engineer by a signal engineer qualified in the design and application of the signaling equipment the Contractor proposes for use on this project.
- G. No circuit is considered to have met the requirement of these Specifications for function and safety until it has been properly tested and verified in the field. Any circuit changes made to meet the functional and safety requirements of these Specifications shall be considered as included as part of the Work.
- H. Provide continuous train control and highway grade crossing warning during all phases of rail construction. At no time shall the work of the Contractor cause delay to train operations, cause an unsafe signaling condition to exist, or reduce the effectiveness or quality of the existing or new grade crossing warning systems.
 - 1. Refer to Design Submittals herein for requirements for submittal of plans for providing wayside signaling and highway crossing warning systems protection during the Work and plans for point protection and fouling when crossovers are installed or removed. Alternate methods shall conform to CFR 49, Part 234, Part 236 and all local ordinances.
- I. Provide rail bonding for all new, temporary, and relocated turnouts as shown on the Contract Drawings or as required by the Engineer. Provide rail bonding, as necessary, to maintain existing systems during construction.
- J. Protect existing signal cabling and, where necessary, relocate existing cabling in order to prevent damage during track installation and surfacing.

- K. Refer to Section 01720, Contract Record Documents, and additional requirements specified herein. Record the final as-built conditions of the signal systems for each system.
- L. Perform and document all tests and inspections in accordance with CFR 49 regulations, the AREMA C&S Manual, the PCJPB Maintenance and Test Manual, and these Specifications.
- M. Refer to Section 01005, Contractor's Personnel and Equipment, and additional requirements specified herein. Provide at least one qualified signal person to accompany any on track equipment, and remove, relocate, or disconnect and reconnect any signal equipment that could be damaged by on track equipment.
- N. Coordinate installation, inspection, and testing of new Owner-furnished material with the Engineer. Notify the Engineer in writing 30 days prior to any installation, inspection, and testing as part of this coordination.
- O. Perform acceptance testing and commissioning of the signal system as a normal part of the Work.
- P. Contractor furnished software and components shall be new and manufacturer certified.
- Q. Remove, salvage, retire, relocate, furnish, and install project related devices as indicated in the Contract Documents and as required to complete the Work.
 - 1. To retire a grade crossing or a control point, first bulletin it as retired and then take temporary measures with the existing equipment, as required, before removing and salvaging it.
- R. Refer to Section 02300, Earthwork, for provisions for excavation and requirements for shoring of excavation as specified in Section 02200, Support of Excavation.
- S. Refer to Section 01047, Utilities and Systems Coordination, for requirements for locating and protecting existing utilities. Details of signal cable runs, conduit runs, and pullbox installations including number, size, and type of cable are shown in the signal drawings of the Contract Drawings. Information regarding new conduit runs and pullbox installations appear elsewhere in the Contract Drawings. Conduit runs and pullbox locations, as shown, are the preferred locations. In case of conflict between the signal drawings and other Contract Drawings, the signal drawings take precedence as to detail, and in the event of conflict as to placement of equipment, the Engineer will determine the correct placement.
 - 1. Make any minor deviations in location, minor meaning within 10 feet of the location as shown on the civil drawings of the Contract Drawings, as part of the Work. Deviations in excess of 10 feet may be subject to the changes provisions of General Provisions GP4, Scope of Work.

- T. All underground signal cables shall be in conduit or trough except for the final connection of the twisted two conductor number six track cable to the twisted flex to the rails.

1.05 FAIL-SAFE DESIGN REQUIREMENTS

- A. As used in these specifications, the fail-safe principle shall mean that whenever an equipment failure, human error or failure to act, or adverse environmental condition affects the specified operation of a system involved with the safety of life or property, that system shall revert to a state known to be safe.
- B. Failure of a circuit or equipment that results in an indication of a dangerous or restrictive condition, whether or not there is in fact actual danger, shall have met the fail-safe requirements. Conversely, a failure that results in an indication of safe or nonrestrictive condition when, in fact, a dangerous condition may exist shall not have met the fail-safe requirements.
- C. Vital applications, such as detector locking of switches, shall be based on the following principles that permit the attainment of fail-safe operation in all known or discovered failure modes:
 - 1. Closed Loops: Fail-safe circuits shall employ the closed loop principle and shall protect against open circuits, shorts, or any combination thereof.
 - 2. Vital Relays: Relays used in vital circuits
 - 3. Vital Circuits: All line circuits, which energize a vital relay, shall be two-wire, double-break circuits and shall be energized from an ungrounded direct current (dc) power supply line circuits are defined as any circuit that leaves the housing in which the relay or microprocessor input is controlled by that circuit from the relay or microprocessor input to the energy that controls that input.
 - 4. Grounds: Components or wires becoming grounded shall not cause an unsafe condition.
 - 5. Spurious Oscillations: Any amplifier, generator, or device element, active or passive, breaking into spurious oscillations shall not cause an unsafe condition.
 - 6. Filters: Filters used in fail-safe circuits shall be designed to prevent undesired signals from appearing at the filter output at levels which could cause an unsafe condition.
- D. Equipment failures and conditions which shall be considered in producing a fail-safe design shall include the following, at minimum:
 - 1. Relays (non-vital): Open coil, fused contacts, high contact resistance, shorted coil, armature sticking, contacts sticking, or broken spring

2. Relay (vital as defined by the AREMA C&S Manual): Open coil, shorted coil, or high contact resistance
 3. Transformers: Open primary, open secondary, shorted turns, primary-to-secondary shorts, or combinations thereof
 4. Capacitors: Short, open, or leakage
 5. Resistors: Increase or decrease in resistance
 6. Transistors: Short, open, leakage, or loss of Beta
 7. Diodes: Short, open, or reverse leakage
 8. Coils: Open or shorted turns
 9. Loss or degradation of power sources
 10. Appearance of abnormal signal levels, electrical noise levels, frequencies, and delays
 11. Effects of electrical interference
 12. Absent or abnormal input signals
 13. Opens or shorts in internal circuitry at inputs and at outputs
 14. Mechanical vibration or shock
 15. Drift or instability of amplifiers, receivers, transmitters, oscillators, switching circuits, and power supplies
 16. Deterioration of contacts, connectors, terminals, solder connections, printed circuits, circuit adjusting devices, and mechanical devices
- E. Fail-safe equipment proposed for vital signaling applications shall have been proven with a minimum of 5 years of successful rail service operation in the United States of America.

1.06 ENVIRONMENTAL PARAMETERS FOR EQUIPMENT

- A. Contractor provided material and equipment shall be fully operable with no impairment resulting from the effect of the environment throughout the range of worst values indicated below. The general operating environment shall be considered to be in salty atmosphere and in generally sunny weather.
- B. Ambient outdoor temperature range: From minus 40 degrees F (minus 40 degrees C) to plus 160 degrees F (70 degrees C).
- C. Relative humidity range: From zero to 100 percent.
- D. Maximum rainfall: 4 inches in 24 hours and 1.5 inches in 1 hour.

- E. Maximum wind velocity: 100 miles per hour.
- F. Seismic Zone Location of Work Site: Seismic Zone 4 as defined in the Uniform Building Code.
- G. Isokeraunic Level: Five per year.

1.07 DESIGN SUBMITTALS

- A. Undertake no work without the prior submittal to and approval by the Engineer of the relevant plans and procedures.
- B. Alternate Detailed Final Design: Submit proposed equivalent systems, components, and materials, if proposed, for Engineer's approval no later than 90 days after Notice to Proceed. Utilize, at a minimum, the symbols, nomenclature, and CADD standards depicted on the Contract Drawings and PCJPB Communications/Signal Design Standards. The Contractor's alternate final design drawings shall be approved and stamped by a professional electrical engineer registered in California. The Engineer will render a decision concerning alternative design within 60 days of the Contractor submittal.
- C. Submit marked-up Contract Drawings for approval, indicating any corrections or modifications to the final design that the Contractor may determine are required to conform to rules and regulations. Submit these revised drawings for the Engineer's approval within 60 days after Notice to Proceed.
- D. Submit proposed plans, procedures, data sheets of proposed materials, application logic, installation details, shop drawings, mechanical drawings, proofs of compliance with applicable standards, and other pertinent data required to fully demonstrate the Contractor's proposed plan for the manufacture, installation, testing, and maintenance of the various signaling systems. Submit for Engineer's approval within 60 days after Notice to Proceed. Plans shall include:
 - 1. Proposed plan for providing alternate methods of wayside signaling and highway crossing warning systems protection when signal components are relocated, deactivated, altered, or modified in order to accommodate construction work.
 - 2. Plan for point protection and fouling when crossover or turnouts are installed or removed.
- E. Signal system shop drawings and design submittals shall include any CADD files in AutoCAD formats. Signal circuit drawings shall conform to the PCJPB CADD standards. Submit electronic files on CD-ROM.
- F. As part of the Site Specific Work Plan (SSWP) submission for review and approval by the Engineer, prepare and submit a detailed Signaling Construction Sequencing Plan for each location where a signal system is to be modified, installed, or removed. The Plan, as a minimum, shall contain a wire-by-wire for each wire to be disconnected and/or connected, and the following:

1. A narrative description of the work to be undertaken at the designated location.
 2. A step-by-step sequence of work description which identifies those steps during which the existing system will be disabled, and a description of what steps will be taken to assure that the signal system will be tested and returned to full operation without causing a delay to any train movement.
 3. An estimate of time to complete the critical steps in the sequence specified in step-by-step sequence of work description.
- G. Submit circuit drawings indicating any required modifications to new systems or existing circuits where only a segment of the new work can be completed or the complete system must be placed in operation in phases. Submit these temporary interface drawings for the Engineer's approval a minimum of 30 days prior to the scheduled cutover.
1. Revisions to existing circuit plans shall use the "Xs" and "Os" convention to show changes. Encircling the change with "Xs" shall identify deletions. Encircling the change with "Os" shall identify additions. The Contractor may, with the prior approval of the Engineer, alternately use the "Red In"/"Yellow Out" convention if Contractor provides seven colored copies of the drawing.
- H. Request approval from the Engineer prior to making any deviation, modification, or changes to the approved design drawings. During the field testing/cut-over period, obtain the approval of the Engineer's representative on site for any deviations, changes, or modification to the design drawings.

1.08 SUBMITTALS

- A. Submit product information, references, shop drawings, and test data as detailed

1.09 DELIVERABLES

- A. Submit manufacturers' warranties, instruction sheets, and part lists supplied with materials to the Engineer prior to Final Acceptance.
- B. Operation and Maintenance Manuals: Refer to Section 01730, Operations and Maintenance Manuals. A minimum of 30 days prior to placing any system in-service, submit to the Engineer 10 sets of application, installation, operating, and maintenance manuals of all new equipment and systems utilized under this Contract which are provided by the Contractor. Include complete material ordering reference numbers for each type of product.

1.10 QUALIFICATIONS AND DUTIES OF SIGNALING PERSONNEL

- A. Refer to Section 01005, Contractor's Personnel and Equipment. Key employees of the Contractor engaged in the final adjustment and testing of the various signaling systems shall be qualified and have had experience on an operating

railroad in the type and level of signal installation and testing work as required herein.

- B. Signal Engineer as used herein shall be understood to mean Contractor's railroad signal engineer or engineers approved by the Engineer. Signal Manager as used herein shall be understood to mean Contractor's railroad signal manager or managers approved by the Engineer.
- C. Signal construction and installation personnel shall work under the authority of the Signal Engineer. The Contractor's signaling construction forces shall work under the authority of a Signal Engineer.
 - 1. Signal Engineer shall plan, direct, and oversee the adjustment, installation, and testing of signal related work and shall coordinate signal work with related track construction work.
 - 2. Signal Engineer shall be responsible for all work under his charge and must have the authority to remove any personnel from the project who are not performing the work in a satisfactory manner.
 - 3. Signal Engineer shall be on site whenever signal related work or track construction work is in progress in the vicinity of existing wayside signaling equipment, highway grade crossings, and/or cabling.
- D. The Signal Managers shall report to and work under the direct authority of the Signal Engineer and shall supervise and direct the work of all signal construction and installation personnel. The Signal Managers shall only perform one major and critical activities, such as cutovers under the direct supervision of the Signal Engineer.
- E. Signal Engineer shall direct and organize the performance of all tests on signaling equipment and systems, under direction of the Engineer, prior to releasing the systems for service. The Signal Engineer shall be responsible to ensure that all applicable test documentation other than that documentation provided by the Engineer, is completed prior to, or immediately after, in-service testing is completed.
- F. The proposed Signal Engineer shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The proposed Signal Engineer shall have a minimum of 10 years signal supervisory or management related experience on a Class I railroad. The proposed Signal Engineer shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Signal Engineer by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and PCJPB commuter trains. Candidate shall have a similar level of working experience to Caltrain system. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining Engineer's approval of the Signal Engineer. In addition, obtain the Engineer approval of each Signal Engineer prior to beginning any work that may affect the signal system. Obtain

approval of and provide additional Signal Engineers as required depending upon the level and type of work being performed. Propose alternate personnel if the original candidate is found unacceptable.

- G. The proposed Signal Managers shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The proposed Signal Managers shall have a minimum of 3 years signal supervisory or management related experience on a Class I railroad. The proposed Signal Managers shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Railroad Signal Managers by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and PCJPB commuter trains. Candidates shall have a similar level of working experience to Caltrain system. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining the Engineer's approval Signal Managers. Obtain approval of and provide additional Signal Managers as required depending upon the level and type of work being performed.
- H. Propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Engineer or Manager on other PCJPB projects does not constitute qualification as a Signal Engineer or Manager for this Contract.
- I. The Engineer reserves the right to disqualify any Signal Engineer or Signal Manager at any time during the course of the Work. This right is at the sole discretion of the Engineer and is not subject to protest or appeal.
- J. All Contractor field personnel shall receive safety training in accordance with Section 01005, Contractor's Personnel and Equipment, and 01545, Work Site Safety and Security.

1.11 AS-BUILT DOCUMENTATION

- A. Refer to Section 01720, Contract Record Documents, for requirements preparation and submittal of Record Documents.
- B. The following as-built documentation requirements augment requirements specified in Section 01720, Contract Record Documents. After a location is placed in service, submit as-built documentation as follows:
 - 1. Detailed circuit drawings within 3 working days.
 - 2. Submit four copies of as-built corrections to the Engineer within 3 working days.
 - 3. Civil Drawings which show the physical location of all signal apparatus and conduits, both along the tracks and perpendicular to it, and heights of all signal structures within 60 calendar days.

- C. Annotate the as-built drawing sets to show all approved circuiting and wiring changes made during installation and testing of the location prior to placing it in service, and any approved changes made after placement in service. Clearly identify all changes on the drawings using the "Red In"/"Yellow Out" convention. Changes shall be dated and initialed by the Contractor's responsible Signal Engineer. Identify the date that the location was tested and placed in service in the revision block of the drawings.
- D. In addition to the as-built drawings provided to the Engineer, one set shall be bound and shall be kept in the instrument enclosure at a location and manner approved by the Engineer. As-built drawings shall be clean and legible. The as-built drawings shall not be removed from the field location after the location is placed in service without the prior written approval of the Engineer.
- E. The final as-built drawings shall be 11 inches by 17 inches, unless authorized by the Engineer to substitute another size.
- F. Each circuit that continues on another drawing shall be annotated with drawing number and routing information for the continuation of the circuit.
- G. The circuit drawings shall show all individual circuits. Typical circuits will not be accepted.
- H. The location plans shall show all cable installed with the number of conductors, the size of conductors, the type of cable, termination points of conductors, and the circuit on each conductor. Separate cable plans shall be drawn if cable information cannot be shown in a neat and organized manner on the location plans.
- I. The shop drawings shall be detailed equipment drawings for each type of equipment installed.

1.12 TRACK AVAILABILITY REQUIREMENTS

- A. General: Refer to Sections 01011, Work Planning, and 01040, Work Hours and Track Access, for track access and related provisions. PCJPB Commute Service and any freight service may not be interrupted by the Work of this Contract, except as provided in the Contract Documents.
- B. Signal Cutovers may be required under traffic.
- C. Signal Cutovers under traffic will require coordination between the Contractor, PCJPB, other railroad, as applicable, and the Operator of Record to keep train delays to a minimum.

1.13 SCHEDULE OF VALUES

- A. Submit the Schedule of Values for signal bid items as required under General Provisions GP9.2, Schedule of Values, and in accordance with the following additional requirements:

1. Schedule of Values for the signal bid items shall include all interface circuits and staging necessary to place the location in service at each stage, all acceptance testing and transportation of materials, all equipment rental, and all pretesting and removal of old equipment.
2. Organize Schedule of Values for signal bid items to assign a value to each signal location. A location is defined as a grade crossing warning system, an intermediate signal location, or a Control Point.

1.14 WARRANTY

- A. Provide warranties for all equipment and material covering parts and labor for two years from the date equipment or material is "placed in service".

PART 2 – PRODUCTS

2.01 EQUIPMENT – GENERAL

- A. Signaling materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. The materials and equipment shall have shown proven performance in the US or Canada for a minimum of 5 years. Materials and equipment shall be delivered to the job-site in unbroken packages, reels, or other forms of containers.
- B. All materials and equipment shall conform to the recommendations of AREMA C&S Manual, except as modified in the Specifications and Contract Drawings.
- C. Reference to specific equipment and manufacturers is intended to establish quality, overall design, and fit, subject to compliance with all criteria specifications. Equipment equal to or exceeding the specifications and requirements may be used subject to the Engineer's written approval. Should alternate equipment be accepted, the Contractor shall perform all necessary work to fit the alternate equipment to these specifications and to revise the Contract Drawings at no additional cost to the PCJPB.

2.02 ELECTRICAL AND ELECTRONIC COMPONENTS

- A. Design and construct fusing of all dc power supplies and circuitry according to the following requirements:
 1. Circuit breakers and fuses shall be the correct side-band rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
 2. Fuses shall be sized to protect the wire
 3. Fuses shall be in the positive leg of the power supply
 4. Fuses shall be of the nonrenewable indicating type

5. All branch feeds for a circuit shall be from the same fuse to prevent fuse cascading due to branch fusing carrying loads for other circuits.
6. Fuses shall be no smaller than 5 amperes unless otherwise shown on the Drawings.
7. Loads shall be divided so that no normal operating current is more than 75 percent of the fuse rating.
8. Fusing shall be functionally oriented to minimize the equipment affected by a blown fuse (i.e., per track, switch control circuits, etc.)
9. Fuse clips shall be constructed to retain their resilience under all installation and service conditions and to ensure a positive contact between the clips and the fuse.

B. Printed Circuit (PC) Cards and Connectors:

1. The PC cards shall be mounted in 19-inch card files unless otherwise approved by the Engineer.
2. The PC wiring shall be organized so that wires serving the same function shall be connected to the same terminal of PC cards. PC cards containing the same circuitry and programming, where applicable, shall be interchangeable between subsystems.
3. The design and construction of PC cards of the same subsystems shall be the same. Cards of different subsystems shall be of the same design and construction wherever practicable.
4. PC cards shall be of glass epoxy construction. Card material shall meet the requirements of NEMA, Type FR-4. Cards shall have sufficient thickness to permit easy insertion and removal, and shall be physically keyed to protect against incorrect interchange. Circuits shall be formed by etching. Conductor material shall be copper and shall be protected from exposure to air.
5. PC cards containing components that may be damaged if a plug connector or plug-in unit is removed while the equipment is energized shall be clearly identified in the equipment maintenance manual. PC cards shall be marked or labeled with a warning note on the individual board, be conspicuously located on the module, or by an alternate means as approved by the Engineer. A means shall be provided to remove power from the module or card file.
6. Components mounted on the PC card, weighing more than 1/2 ounce or with a displacement of more than 1/2 cubic inch, shall have a mechanical supporting attachment to the card separate from all electrical connections.

7. Do no stacking or piggybacking of PC sections in order to accomplish changes or modifications to wiring or components on printed circuit cards.
 8. Connectors shall have plating with a minimum thickness of 0.00005 inch.
- C. Printed Circuit Card Files:
1. There shall be not more than one type of card file for each size of PC card. The card file plug boards shall be registered to agree with the registry of the associated PC card. PC cards shall not project beyond the front of the equipment rack when mounted in the card file.
 2. Card files shall be installed in dust-proof cabinets and protected with dust covers.
 3. Insulated cable clamping devices shall be located on the back of the file in such a way that wires terminating in the files shall be installed in a neat and secure bundle, rigidly supported, and protected to prevent chafing of insulation. Cabling provision on the file shall permit wires to enter or leave the file from both the right and left sides. Such cabling shall not restrict access to the card file when the rear covers of the card files are removed.

2.03 SHOP FINISHES

- A. Factory finish signal equipment with the exception of signal system parts which are stipulated as field finished in AREMA C&S Manual, Part 1.5.10, and aluminum alloy and galvanized metal components. If manufacturer typically provides factory painted finish for aluminum alloy and galvanized components, include such information in equipment submittals for Engineer's acceptance.
- B. Finishes shall comply with AREMA C&S Manual, Part 1.5.10, signal equipment manufacturer's standards, and provisions specified herein. It shall be understood that where AREMA C&S Manual, Part 1.5.10, uses the word "should" that the word "shall" shall be substituted except as accepted by the Engineer in writing.
1. Finish terminal boards and interior of shelters with white gloss fire retardant paint.
 2. Factory finish signal equipment with aluminum paint except as otherwise specified herein and in AREMA C&S Manual.
 3. For signal system parts which AREMA C&S Manual stipulates as shop primed and field finish, shop prime in accordance with requirements specified in Section 05200, Structural Steel.
 4. For signal system parts which AREMA C&S Manual stipulates to receive shop prime and finish coats followed by field finish coat, coordinate shop finish coat with field finish specified in Section 09900, Paints and Coatings.

2.04 FIELD PAINT MATERIALS

- A. Field finish as specified in Section 09900, Paints and Coatings, and AREMA C&S Manual, Part 1.5.10. Exterior surfaces shall receive heavy duty finish system.
- B. Touch-up Paint for Signal Manufacturer Finishes: Touch-up paints recommended by signal manufacturer, including aluminum touch-up paint.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Contractor shall make all necessary modifications to the existing signal system, protect or relocate existing cabling, signals, switches, and signal shelters; and modify associated signal and highway grade crossing systems to ensure the existing signal system operates as intended during construction and installation of the new signal system. Protect operating signal and highway grade crossing systems to ensure train operations are not interrupted and safety is maintained.
- B. Contractor shall take no action which will violate any rule or regulation as specified by CFR 49, the General Code of Operating Rules, timetable instructions, general order, bulletin, or special instruction; which will reduce the integrity of the signal system; or endanger railroad personnel, the public, or employees.
- C. All equipment installation as described herein or as shown in the Contract Drawings shall be in accordance with the Caltrain Standards.
- D. Ensure that equipment within the instrument shelters and relay cases is securely anchored or otherwise fastened in enclosure upon completion of enclosure installation. Securing equipment shall not negate the requirements to maintain isolation between ground systems as otherwise called for in these Specifications.
- E. An updated, detailed set of the approved signal design drawings shall be kept at the each field location for equipment as it is placed in-service.

3.02 FIELD FINISHES AND TOUCH UP

- A. For signal system parts which AREMA C&S Manual, Part 1.5.10, stipulates as shop primed and field painted, field finish as specified in Section 09900, Paints and Coatings, and AREMA C&S Manual, Part 1.5.10, including requirement to apply one field coat prior to field assembly and one field coat following field assembly.
- B. Touch-up signal manufacturer's finishes after installation.

END OF SECTION

SECTION 18050
COORDINATION WITH PCJPB PROCUREMENT CONTRACTOR

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements coordinating installation, inspection, and testing as well as receiving of new Owner-furnished material or equipment with the Engineer and with the Owner's vendor or supplier. Notify the Engineer in writing a minimum of 30 days prior to any installation, inspection and testing of such material or equipment.
- B. Refer to Section 01600, Materials, in the paragraph "Acceptance of Owner-Furnished Materials".

1.02 SUBMITTALS

- A. Submit Acceptance Test Procedure documentation on all Owner-furnished equipment prior to transport of the equipment.

1.03 WARRANTY

- A. Because the manufacturer's warranty for Owner-furnished material begins upon transfer of custody of the material, supplement the manufacturer's warranty for the amount of time elapsed between acceptance of the material and final cutover and as required under General Provisions GP4.6, Guaranty of Work. The supplemental warranty shall include all costs to repair or replace material which is damaged while in Contractor's care or fails prematurely and as required under General Provisions GP4.6, Guaranty of Work. Make arrangements for and pay costs of such repairs performed by and replacements provided from the original equipment manufacturer.

PART 2 – PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Test all Owner-furnished equipment before transporting it to the job site. Conduct this acceptance testing for all equipment in accordance with the Contractor's Acceptance Test Procedure. Prior to transportation, submit a copy of the documentation of acceptance testing to the Engineer.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 18100 INTERLOCKING CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for installing, testing, and documenting Owner-furnished pre-wired vital microprocessor based interlocking controller racks and local control panels that provide the functionality shown on the Contract Drawings.
- B. Final application logic programs, including EPROMS will be furnished by the Owner.

1.02 REFERENCE STANDARDS

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
 - 1. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.03 SUBMITTALS

- A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the vital interlocking controller.
- B. Submit certified acceptance reports.
- C. Submit test reports and verification of tests as described herein under Testing.

1.04 QUALITY ASSURANCE

- A. Install and test the interlocking controller and local control panel (LCP) so as to conform to and provide all applicable requirements of CFR 49, Part 236, and the recommendations of AREMA C&S Manual Part 2.2.10. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package plug in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.
- B. Clearly identify each controller unit, LCP, and their associated components on the packing crate, referencing its intended location.

1.06 WARRANTY

- A. Provide warranty from defects arising from improper handling for 2 years from the first date of service.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Solid State Micro-Processor Interlocking Controller, software, and local control panels will be Owner-furnished.

2.02 FACTORY TESTING

- A. Conduct an acceptance test on the unit prior to loading at the warehouse. Provide certified acceptance reports with each unit at time of delivery.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ensure that test and specialized installation equipment recommended by the manufacturer to make any readings or adjustments is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation

3.02 INSTALLATION

- A. Wire and install the microprocessor-interlocking controller and the LCP in accordance with rack layout provided in the Contract Drawings.
- B. Load all programmable and configurable modules with application software and perform any configuration necessary.

3.03 FIELD QUALITY CONTROL

- A. Conduct all applicable tests as recommended in AREMA C&S Manual Parts 2.4.1 and 7.4.1 to ensure proper operation of the signal and grade crossing warning systems.
- B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.
- C. Conduct all tests required under Section 18600, Signal Systems Testing.

- D. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with, signal lamps will not be allowed in pre-testing. An exception may be authorized by the Engineer where a signal or switch machine is in service and will be reconfigured for final cutover or cannot be installed or wired until final cutover.

END OF SECTION

SECTION 18110

SOLID-STATE CODED TRACK CIRCUITS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for furnishing, installing, testing, and documenting solid-state track circuit elements.
- B. Final application logic programs will be furnished by the Owner.

1.02 REFERENCE STANDARDS

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
 - 1. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communication and Signals Manual of Recommended Practices (C&S Manual).

1.03 SUBMITTALS

- A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the solid-state track circuit equipment.
- B. Submit certified acceptance reports.
- C. Submit test reports and verification of tests as described herein under Testing.

1.04 QUALITY ASSURANCE

- A. Install and test the solid-state track circuit equipment in accordance with all applicable requirements of CFR 49, Part 236 and the recommendations of the AREMA C&S Manual, Part 8.1.2. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.
- B. Perform operational testing of the equipment in accordance with the requirements specified in Section 18600, Signal Systems Testing.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Ship the solid-state modules separately from the wired card cages. Package modules individually in ESD safe packaging, in a sturdy carton with the type of module printed on the outside of the carton.
- B. Package plug-in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Electronic track circuits shall be compatible with highway grade crossing constant warning devices. Utilization of bi-directional, unidirectional, and auxiliary crossing control functions shall be provided per Contract Drawings and manufacturer's specifications. Track filters shall be installed in track leads, as shown on the Contract Drawings.
- B. Where new equipment is to be furnished and installed in existing locations, the equipment furnished shall be the same make as called for in the Contract Documents.
- C. Track circuit shall function to provide continuous train detection throughout the length of the circuit whenever a shunt of 0.06 ohms is applied to the rails, including the turnouts.
- D. Furnish any specialized test or calibration instruments, equipment, or tools that may be needed in order to test and place in-service the equipment installed under this Section, as shown on the Contract Drawings. Ensure all test and diagnostic equipment is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation.
- E. Conduct an acceptance test on Owner-furnished units prior to loading at the warehouse.
- F. Conduct acceptance testing of Owner-furnished components before transporting from the warehouse and installing. Provide certified acceptance reports at time of delivery.

2.02 APPLICATION LOGIC

- A. The Owner will provide the application logic for each programmable module to the Contractor. Application Logic will be furnished upon demonstration of readiness for pretest. This application logic will provide the functionality as shown in the Contract Drawings and shall conform to CFR 49, Part 236. Where specified in the Contract Documents, the Contractor shall furnish the program specified to the manufacturer for factory testing and certification.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install solid-state coded track circuits at locations indicated on the Contract Drawings.
- B. Install the solid-state track circuit equipment in signal instrument shelters or cases as shown on Contract Drawings.
- C. The solid-state track circuit equipment layouts shall provide for easy access to test points, indicators, and adjustments.
- D. Install equipment in accordance with the manufacturer's installation and adjustment procedures.

3.02 TESTING

- A. Conduct tests as recommended in AREMA C&S Manual Parts 2.4.1, 3.3.1, and 7.4.1 to ensure proper operation of the signal and grade crossing systems.
- B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.
- C. Conduct all tests required under Section 18600, Signal Systems Testing.
- D. Testing, including pre-testing, shall include operating any handthrow switches and lighting all signals. The use of lamp simulators in lieu of, or in parallel with signal lamps will not be allowed in pre-testing.

END OF SECTION

SECTION 18200

SIGNAL LAYOUTS, STRUCTURES AND FOUNDATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section shall include disassembling, relocating and installing existing or new signals.
- B. Signal layouts, as specified herein, shall consist of foundations, signal heads, and all structures including ground-mounted masts, ladders, platforms, and all mounting hardware required to construct signals.
- C. Contractor shall furnish and install signals and marker lights as shown on the Contract Drawings at existing and new signal locations.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 DESIGN REQUIREMENTS

- A. Signal Foundation Structure: The Contractor is responsible for the foundation structure type selection and its design. The design of the signal foundation's structure and stability shall be in accordance with the AREMA. Design calculations shall be prepared by a licensed California professional civil engineer with a minimum of 5 years experience in the design of similar foundation structures.
- B. Signal aspect shall be distinct and unmistakable when viewed from a height of 7 to 12 feet above top of rail at a distance of 1,000 feet. Nominal sighting distance shall be 2,000 feet. Where unobstructed sighting distance for a standard signal arrangement is less than 2,000 feet, supply and install wide angle or spread lens and adjust the signal head for the maximum sighting range possible. Contractor shall provide the Engineer with written notification with any sighting problems and location of where spread or wide-angle lenses are installed

1.04 SUBMITTALS

- A. Submit shop drawings for each type of signal unit and each type of signal layout to be furnished by Contractor. Show all ladders, masts, bases, arms, and required mounting hardware. Show location and method of mounting the signals to the structure.
 - 1. Provide necessary dimensions, hardware, method of mounting signal structures, and material specifications for all items to be furnished.

- B. Submit shop drawings for each type structure foundation.
- C. Submit Contractor's Installation Procedure for approved. The procedure shall include a detailed description of installation activity and sufficient detail to allow the Engineer to determine the validity of the installation procedure.
- D. Submit design calculations for the signal cantilever/bridge foundation.

1.05 QUALITY ASSURANCE

- A. Signals, structures, and related hardware shall meet the recommendations of AREMA C&S Manual, Section 7, and applicable portions of Manual Part 3.2.5 where they do not conflict with any requirements specified herein
- B. Inspect each signal layout after it has been installed in the field. This inspection shall conform to the Contractor's Installation Procedure as accepted by the Engineer.
- C. Foundations shall meet all recommendations of AREMA C&S Manual Parts 14.4.1.A through 14.4.36 inclusive, where requirements of the AREMA Specifications do not conflict with any requirements specified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship signal lamps or LEDs separately from the signal in which they will be used.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Furnish colorlight or searchlight signals, as indicated in the Contract Documents, and marker light assemblies. Signals and marker light assemblies shall be in accordance with Caltrain Engineering Standards.
- B. Furnish signal masts, signal cantilevers and signal bridges, as applicable, in accordance with Caltrain Engineering Standards.
- C. Furnish mounting brackets for marker light assemblies, ladders, junction boxes, housings, backgrounds, hoods and any other nuts, bolts, and associated hardware.
- D. Furnish foundations for signal masts, signal cantilevers, and signal bridges, as applicable, in accordance with Caltrain Engineering Standards.

2.02 SIGNALS

- A. Signal mounting shall conform to the Caltrain Engineering Standards.
- B. Signal lamps or LEDs shall be products specified in the Contract Documents or equal.

2.03 SIGNAL MASTS

- A. Mast assemblies for ground mounting shall conform to the Contract Drawings and Caltrain Engineering Standards.

2.04 SIGNAL BRIDGES AND CANTILEVERS

- A. Refer to the Contract Drawings for Signal Bridge and Cantilever requirements.
- B. The junction box shall have two terminals with insulated test links, as specified in Section 18360, Signal Systems Miscellaneous Products, for each cable conductor. Provide 10 percent spare terminals. Do not overcrowd terminals.
- C. Cable entry to the junction box shall be direct from the signal structure. External conduit construction is not acceptable. Provide an opening approximately four by six inches near the base of the signal structure under each junction box location to allow access for cable sealing at the foundation. Provide bolt-on access plate which will cover the opening under normal conditions.
- D. Locate junction box either at the base of a main support mast or on a main support mast at a height of between 3 and 5 feet above the finished grade level at the base.
- E. The method of routing cables from the junction box to each signal mounted on the structure shall be to route the cables within the tubular members of the structure to the greatest extent possible. Pull cables entirely through the structure members, mast, and signal mounting brackets, unless otherwise approved by the Engineer. To facilitate this, provide appropriate pull box locations as needed, located a maximum of 5 feet from each signal. Edges shall be smooth and rounded to accommodate cable installation. Provide a means to prevent entry of rodents and insects at the bases of the vertical masts without cable entrances.
 - 1. Use galvanized rigid steel conduit where wire is to be run external to the structural members, except as noted.
 - 2. Use flexible armored conduit to make the connection from the pull box to the individual signal heads.

2.05 SIGNAL FOUNDATIONS

- A. Furnish galvanized steel foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Specifications Section 18360, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.
- B. Construct galvanized steel foundations of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4 inch steel plate.
- C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.
- D. Concrete Foundations: Cast-in-place in accordance with Section 03300, Cast-in-Place Concrete, or precast concrete as manufactured by Dixie Precast or equal.

PART 3 - EXECUTION

3.01 INSTALLATION - SIGNALS

- A. Contractor shall install signal layouts in locations as indicated on the Contract Drawings and as shown on the accepted shop drawings. No part of any signal layout shall conflict with Caltrain Engineering Standards, Code of Federal Regulations, Part 49, or CPUC rules and regulations.
- B. Locate signals centered between insulated joints, except where physically not possible. In such instances, Contractor shall submit a recommendation to the Engineer for approval.
- C. Center line of signal mast shall be 12 feet 0 inches from centerline of track unless a deviation from this is approved by the Engineer, as shown on the Contract Drawings or required to meet CPUC clearance requirements.
- D. Install signal units level and plumb on their foundations. Leveling nuts shall be used as shown on the Caltrain Engineering Standards.
- E. Install signal layouts in accordance with the applicable recommendations of AREMA Signal Manual, Part 7.4.1 and Caltrain Engineering Standards.
- F. Install platforms for each signal unit level.
- G. Align signals for maximum viewing distance before placing in service.
- H. Refer to Design Requirements herein regarding signal aspect and sighting distances. Install signals and verify sighting distances. Provide the Engineer with written notification with any sighting problems and location of where spread or wide-angle lenses are installed
- I. Mount signal heads on an offset arm as shown in Caltrain Engineering Standards. Signal heads shall also be able to swivel on the offset arm and be adjustable.
- J. Signal nomenclature shall be as shown on the Contract Drawings.
- K. The underground cable shall be dressed, potheaded, tagged, and terminated in the signal junction box as specified in Section 18360, Signal Systems Miscellaneous Products. The conductor size of the underground cables shall be at least as large as that shown in the Contract Drawings.
- L. Wiring from the junction box base to the signal heads shall be minimum No. 10 AWG copper stranded wire or larger as shown on the Contract Drawings.
- M. Install identification tags on each wire. These tags shall bear the nomenclature shown on the accepted Shop Drawings.
- N. Install signal cantilevers as shown on Contract Drawings.

3.02 INSTALLATION - SIGNAL BRIDGES AND CANTILEVERS

- A. Signal bridges and cantilevers shall be installed as shown on Contract Drawings.

3.03 INSTALLATION - FOUNDATIONS

- A. Install each foundation in accordance with the approved Contractor's Installation Procedure for each type of foundation, as herein specified, and as shown on the Contract Drawings. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation.
- B. Refer to Section 01047, Utilities and Systems Coordination, for requirements for locating and protecting existing utilities. Advise the Engineer immediately if any utility or cable interferes with the foundation work. After locating an interference, allow 72 hours for the Engineer to relocate or mitigate the interference.
- C. Prior to placing steel foundations in the excavations, place and compact a crushed stone base in accordance with Section 02300, Earthwork.
- D. When placing foundations, exercise care and ensure that anchor bolts are not bent or threads damaged. Protect anchor bolt threads, washers, and nuts by applying friction tape or other accepted method satisfactory to the Engineer, until the unit to be supported is installed.
- E. After backfilling foundations, ensure that the foundation is plumb and level. Where galvanized steel foundations are installed, top of final grade shall be no more than 24 inches below top of foundation.
- F. Install foundations to the lines, grades and dimensions required as determined by the Contractor and accepted by the Engineer. Mounting bolts shall be of sufficient length to accommodate use of leveling nuts between the base of the equipment to be supported and the top of the foundation.
- G. Where marker lights are located on signals, install new signal foundations or adjust existing signal foundations so the top of the marker assembly is not more than distance above top of rail indicated in the Contract Documents.

3.04 PAINTING

- A. Touch up any damaged painted finish.

3.05 FIELD TESTS

- A. Make tests for proper operation and setting of lamp operating voltages in accordance with Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18300

RELAYS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for relays. Unless indicated as Owner Furnished in Section 01600, Materials, or as relocated on the Contract Drawings, relays shall be Contractor furnished.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

- A. Contractor shall provide acceptance testing and documentation for each relay when it is transported from the warehouse to the job site.
- B. Complete Test Report Form provided by the Engineer for each vital relay installed under this Contract. Use typewritten characters to fill in all information requested on the form.

1.04 QUALITY ASSURANCE

- A. Vital relays shall meet the recommendations of AREMA C&S Manual Part 6.2.1, where they do not conflict with any requirements specified herein. Vital Relays shall be of the type as designated in the PCJPB Standard Drawings.
- B. Factory testing of each relay shall be the manufacturer's standard.
- C. Before any relay is used, obtain the Engineer's written acceptance. Acceptance will be based on the test results and the proper completion of the Test Report Form.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Ship vital relays separately from the wired racks in which they are to be used. Package relays individually; each in a sturdy corrugated cardboard carton with the drawing number of the relay printed on the outside of the carton. Store relays in a protected area until tested and installed.

1.06 SPARE PARTS AND SPECIAL TOOLS

- A. Refer to Section 01600, Materials, for details regarding packaging and delivery of spare parts and special tools.
- B. Furnish spare relays in the quantities indicated on the Contract Drawings.
- C. Furnish one test tool or relay wrench for each shelter where relays are installed.
- D. Furnish 12 inserting/extracting tools for each type of contact requiring a special tool.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Relays shall be in dustproof enclosures, except a provision shall be made for ventilation where required for heat dissipation.

2.02 VITAL DC RELAYS

- A. General:
 - 1. Vital Relays shall be Alstom Type B, Invensys Rail Type "ST", or equal. Contractor shall use the specific relays shown on the Contract Drawings.
 - 2. Vital dc relays, unless otherwise indicated on the Contract Drawings, 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 recommendations of the AREMA C&S Manual Part 6.2.1.
 - 7. When three dc vital relays, suppressed as specified herein, are connected in parallel and operated as a test load from normal working voltage, a vital relay front or back contact that breaks this load shall be capable of at least five million operations at this load without the contact resistance, measured with ten milliamp current, exceeding five ohms.

8. Arc suppression for vital relays shall be built into the relay or into its plugboard.
9. Equip vital plug-in relays, except vital time-element relays and special application relays, with front current testing facilities. Where shown on the Contract Drawings, provide facilities to enable the testing of voltage from the front of the relay, without having to remove the relay or remove adjacent relays.
10. Equip vital relays with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plugboard.

2.03 IDENTIFICATION

- A. Facilities shall be included for mounting an approved typed or printed relay nametag for each relay, either on the relay cover or on the relay cabinet front plate, as applicable. The nametag shall be easily replaceable, but shall not come off during normal service.
- B. Identification shall be in accordance with Section 18360, Signal Systems Miscellaneous Products.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ensure that the relay operating characteristics have not been altered due to damage during shipping procedures.
- B. Ensure that all ac and dc power buses are open while installing relays. Do not reconnect buses until all relays have been installed.
- C. Install and wire the relays as shown on the Contract Drawings.
- D. Identify each relay with nametag.

3.02 FIELD QUALITY CONTROL

- A. All dc vital relays shall be tested and inspected in accordance with AREMA C&S Manual Part 6.4.1.
- B. Perform tests in accordance with Section 18600, Signal Systems Testing.
- C. Record test measurements on Test Report Form provided by the Engineer.

END OF SECTION

SECTION 18310

SIGNAL SHELTERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for new factory-wired equipment shelters and relocating existing equipment shelters.

1.02 REFERENCE STANDARDS

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
 - 1. Part 234 Grade Crossing Signal System Safety
 - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

- A. Submit proposed Installation Test Procedures.
- B. Submit load calculations, indicating sizes of load center panel, voltage drops, and all other 240/120 Vac equipment.
- C. Submit Contractor's Inspection and Acceptance Procedure.

1.04 QUALITY ASSURANCE

- A. The Contractor shall provide documentation of acceptance "in good condition" before removing and transporting existing shelters to the job site.
- B. The Contractor shall provide documentation of Factory Acceptance Testing before transporting new shelters to the job site.
- C. Each shelter and case will be inspected after they have been installed and the Contractor shall correct any deficiencies. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Inspection and Acceptance Procedure.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Properly fasten and brace equipment shipped within shelters and cases to prevent damage during transit. Replace any equipment damaged during transit or prior to in-service operation at no cost to the Owner.
- B. Package all vital relays, batteries, and electronic plug-in modules in separate containers for shipment and do not install until the shelter is set at its final location.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Furnish factory-wired equipment shelters or junction cases, as described herein and as shown on the Contract Drawings. These shelters shall be complete with all the equipment shown on the Contract Drawings. Wiring shall conform to NEMA Standard ICS-70, or National Electrical Code (NEC), and the recommendations of the AREMA C&S Manual, as applicable.
- B. Equipment shelters shall be products manufactured by P.T.M.W., Invensys Rail, GETSGS, or equal.
- C. Equipment shelters shall be the size and layout shown on the Contract Drawings.
- D. Equipment shelters shall be rain-tight and dust-tight, National Electrical Manufacturers Association (NEMA) 3R, ventilated, and have hinged doors with three point latch and handle.
- E. Equipment shelters shall be constructed of 12-gauge galvanized steel for floors, walls, and doors. Roofs shall be no less than 14-gauge galvanized steel with a minimum of 50 lb/ft² loading.
- F. The entire structure shall be powder coated on the outside with TGIC Polyester Powder (or equal polyester powder) with a nominal thickness of four mils, but no less than three mils at any point on the surface of the enclosure in accordance with AREMA C&S Manual Part 1.5.10. The exterior color shall be light gray.
- G. The steel instrument enclosures shall be complete with moveable shelves, wire chase, and backboard.
- H. The equipment shelters shall provide access to underground and aerial cable entrance behind the main terminal rack. The top and sides shall be lined with heat and cold insulating material and constructed to prevent sweating. Provide ventilation openings as required for the size of the shelter proposed. No ventilation opening shall be made in the roof of the shelter. Provide lift rings to facilitate the movement of the shelter.
- I. Provide ventilation openings in each door. The exterior of the ventilation openings shall be hooded to minimize the entrance of precipitation. Equip the interior of ventilation opening with sliding plate to allow the adjustment of airflow and with a replaceable dust filter. The doors shall be hinged and gasketed so that they will

provide a dust proof and weatherproof seal. Provide doors with exterior and interior handles, (interior handles not required on cases) welded to a three point locking device to ensure that the door cannot be locked until it is in the fully closed position. Provide doors with a two-position retaining device to secure the door when open.

- J. Door openings shall be 32 inches wide by 86 inches tall unless otherwise specified on the Contract Drawings.
- K. Provide thermostatically controlled exhaust fans, operated from 120 Vac and fused separately, in each shelter, as shown on the Contract Drawings. The thermostat that activates the fan control shall be adjustable and operate in the range of 70 degrees to 130 degrees Fahrenheit. Locate fans relative to the fresh air inlets to draw air over the equipment and size to renew the air within the shelter every 3 minutes. Exhaust fans shall have removable dust filters. Dust filters shall be either replaceable or cleanable.
- L. Hinges shall be separate castings, securely fastened to the shelter and door. The hinges shall be equipped with bronze hinge pins, shall be lubricated by the manufacturer before the case is shipped, and shall have grease fittings for later lubrication.
- M. Furnish equipment shelters with interior lighting and duplex 120 Vac power receptacles. Equip shelters and cases with double tube fluorescent lights, minimum 40 watts each, as required to provide complete illumination for all passages and sides, and operated from a switch conveniently placed near each entrance door. Furnish convenience outlets as part of each switch.
- N. Shelter lighting and receptacle loads shall be fed from a ground fault interrupt circuit breaker used exclusively for these loads. Signaling logic and signal appliance power loads shall be fed from separate circuit breakers. The signal logic power and signal appliance power shall be ungrounded. The Contractor shall size circuit breakers and wiring.
- O. Furnish shelters complete with a 120/240 Vac power distribution panel, circuit protective devices, and all appurtenances necessary to supply the ac power required at each site.

2.02 EQUIPMENT MOUNTING

- A. General:
 - 1. Mount equipment as shown in the Contract Drawings.
 - 2. Mount all equipment in such a manner that a seismic event within the parameters of Section 18000, General Signal Requirements, will not cause damage or excessive motion.
- B. Relay Plugboards:
 - 1. Design plugboards for insertion of removable type contacts. The method of attaching the wires to the removable contacts shall be solderless connections. Design plugboard so that the removable contact will have a

direct connection with the contact and coil prongs. The plugboards shall be in accordance with the applicable sections of AREMA C&S Manual, Part 6.2.1.

2. All wires shall be of sufficient length to permit them to be moved to any contact on the same relay.
3. Equip the plugboards for vital relays with a registration plate to prevent relays of the wrong type, contact arrangement, or operating characteristics from being inserted.

2.03 IDENTIFICATION

- A. Stencil a white identification number at the top of the front and rear frames of each rack or panel.
- B. There shall be an identifying nameplate for each relay, or other instrument mounted on the rack or panel.
- C. Equip the back and front of the relay plugboards with a tag, as specified in Section 18360, Signal Systems Miscellaneous Products. This tag shall indicate the nomenclature of the relay.
- D. Identify terminals and both ends of all wires with a wraparound tag printed with the circuit nomenclatures and terminal designations as shown on the Contract Drawings and as specified in Section 18360, Signal Systems Miscellaneous Products.
- E. Wire and cable conductor identification tags for terminal board mounting shall be as specified in Section 18360, Signal Systems Miscellaneous Products.

2.04 CABLE ENTRANCE TERMINAL BOARDS

- A. Cable Entrance Terminal Boards shall be 3/4-inch Type AB exterior (five ply) plywood, mounted on a rack and painted with a fire retarding paint.
- B. Cable Entrance Terminal Boards shall be located as shown on the Contract Drawings.
- C. Multiple-unit terminal blocks for wire and cable conductors shall be in accordance with AREMA C&S Drawing 14.1.6. Furnish each binding post with two binding nuts, one clamp nut, and three washers.
- D. Provide Invensys Rail or equal test links on all terminal pairs where conductors enter shelters.
- E. Equip binding posts and exposed terminals of other apparatus for circuits exceeding 50 volts or greater (ac or dc) with insulating nuts and sleeves.
- F. Cable entrance facilities shall be located as shown on the Contract Drawings.
- G. Lightning arresters shall be as specified in Section 18360, Signal Systems Miscellaneous Products.

2.05 CABLE ENTRANCE PIPES

- A. Cable entrance pipes shall be supplied by Contractor as specified in Section 18360, Signal Systems Miscellaneous Products.

2.06 GROUNDING

- A. Shelter shall be fitted with four 36-inch long No. 2 ground wires cadwelded to exterior of the shelter at each corner. Cadwelding shall take place prior to powder coating the structure.
- B. Grounding material shall be supplied by Contractor and installed as specified in Section 18450, Grounding.

2.07 INTERNAL WIRING

- A. Internal wiring shall be in accordance with Section 18370, Signal Wire and Cable.
- B. Minimum wire conductor sizes shall be as shown on the Contract Drawings unless otherwise approved by the Engineer.
- C. Adhering to minimum wire size specifications does not relieve the Contractor's responsibility of using wire sized large enough to safely and effectively provide power to the circuit it serves.
- D. Solderless terminals, for stranded wire, shall be in accordance with Section 18360, Signal Systems Miscellaneous Products.
- E. Solid terminal connectors shall be used for all short terminal jumpers.
- F. Wire shall conform to the requirements in Section 18370, Signal Wire and Cable.

2.08 PAINTING - INSULATION

- A. All instrument enclosures shall be furnished complete with a layer of rigid insulation on the walls, doors, and ceiling. Instrument shelters shall have a minimum 2-inch thick layer of rigid closed cell foam insulation rated R13. Instrument cases shall have a minimum 1/2-inch thick layer of rigid closed cell foam insulation rated R3.3. Insulation shall be suitable for residential installation.
- B. The interior including the ceiling, walls, terminal boards, and shelves shall be finished with a primer and two coats of white latex enamel paint.
- C. All paint shall be fire-retarding type.
- D. Contractor shall apply typical legend for control point shelters, highway grade crossing shelters and cases as indicated on Caltrain Standard Drawings (SD-5000 series). Contractor shall consult with manufacturer of shelter prior to paint application.

2.09 EQUIPMENT RACKS

- A. Equipment racks shall be the manufacturer's standard for the type of equipment furnished and shall be sized in conformance to the Contract Drawings.
- B. Equipment racks shall include all necessary supports for wire and equipment.
- C. Secure equipment racks by bolts attached to a threaded mounting plate structurally secured to the floor of the shelter. Attach stabilizing straps to the top of the racks as needed. Racks and mounting shall be secure enough to withstand a seismic event as specified in Section 18000, General Signal Requirements.

2.10 OTHER EQUIPMENT

- A. Wiring Raceway (Wire Routing): Internal case wiring shall be contained within surface-mounted plastic raceway. Raceway shall be of a polycarbonate, low smoke type with a solid snap-on cover and flexible sidewalls. The sidewalls shall be of "finger" type construction allowing for insertion and removal of wire runs with terminations attached. The manufacturer shall determine sizes. Fill capacity shall not exceed 60 percent.
- B. Panel Board: Furnish a single-phase, three-wire 120/240 VAC, 60 Hz panel board for each shelter furnished under this Contract. Size panel board as shown on the Contract Drawings. The capacity rating shall be in accordance with the Contractor's load calculations and the Contract Drawings.
- C. Service meters shall conform to local codes.

2.11 GALVANIZED SHELTER FOUNDATIONS

- A. All shelters shall be equipped with telescoping foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Section 18360, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.
- B. Galvanized steel foundations for cases shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4-inch steel plate.
- C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount shelters and cases level and plumb and secure thereon with the hardware provided. Do not use shims, spacers, or other filler devices to level and plumb shelters or cases.
- B. Install cable entrance pipes through the cable knockout holes provided in the floor of the shelter behind the terminal board(s) as shown on Contract Drawings. Fill pipes

with a substance designed for the purpose that prevents entrance of debris, rodents, and other pests.

- C. Ground shelters as specified in Section 18450, Signal Grounding.
- D. Locate shelter as indicated on the Contract Drawings. If conditions do not allow placement as shown on the Contract Drawings, submit alternate placement for Engineer's approval.
- E. Install relays on the relay plugboards corresponding to the relay nomenclature and identification plate, and securely fasten in place with the hardware provided by the relay manufacturer.
- F. Place batteries on rubber matting on the floor of the house or bottom shelf of the case. Coat battery posts with approved grease and securely fasten battery connectors to the battery posts. Strap batteries or otherwise secure using a method approved by the manufacturer so that they will not tip or move in the event of an earthquake.
- G. Mark each grade crossing warning device case or shelter with the street name, milepost location, emergency response number, and DOT inventory number per PCJPB Standards.
- H. Install pullboxes and conduits. Provide slotted pullbox covers to accommodate the cable chute at new house locations. Place the house so the chute aligns with the slotted cover.
- I. Make any modifications to the cable chute required to fit the pullbox and accommodate the cable installation. If it is necessary to cut the cable chute, ensure no rough edges, sharp edges, burrs, or other surfaces exist which have the potential to injure the cable.
- J. Install foundations, including telescoping foundations, for shelters including Owner-furnished shelters.

3.02 AC POWER

- A. Wall mount load center as shown on the Contract Drawings. Mounting height from floor, wire terminations, and clearances shall be in accordance with the NEC.
- B. Install service meters as described in Section 18500, Service Meters.

3.03 FIELD QUALITY CONTROL

- A. Test the functioning of the equipment contained within the instrument shelter in accordance with the requirements of Section 18600, Signal Systems Testing, CFR Title 49, Parts 234 and 236, and the recommendations of AREMA C&S Manual Part 2.4.1.

END OF SECTION

SECTION 18320

POWER SWITCH AND LOCK MOVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for dual control switch and lock movement, including switch target, for each interlocked track switch at new switch locations as shown on the Drawings. In addition, relocate existing switch machines where indicated on the Contract Drawings
- B. Refer to Division 19, Trackwork, for track construction requirements.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

- A. Submit installation drawings showing the tie straps and the mounting details of the switch and lock movement, including the connections to the track switch points and target.
- B. Submit Acceptance Test documentation on switch and lock movement prior to shipment of the movements.
- C. Submit copies of all field test reports.

1.04 QUALITY ASSURANCE

- A. Switch and lock movements shall meet the recommendations of AREMA C&S Manual Part 12.2.1 for dual control high voltage applications, where they do not conflict with any requirements specified herein.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect switch and lock movements and their component layout parts against damage during handling and shipment.
- B. During storage, properly lubricate and maintain switch and lock movement layouts on a regular timed program.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Furnish complete dual control Electric Switch and Lock Movement Layouts, including switch targets.
- B. Contractor-furnished Junction Box shall be RSE 6K1 Model N349656 manufactured by Ansaldo STS USA or Engineer approved equal.
- C. Furnish Insulated Vertical No. 1 Rod with Basket.
- D. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch and lock movement layout including 18-inch-long, 2-inch-diameter flexible conduit and connectors from movement to junction box.

2.02 SECURITY

- A. Padlocks will be Owner-furnished.

2.03 SOURCE QUALITY CONTROL

- A. Test each switch and lock movement before shipping it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for switch and lock movements. Submit a copy of the Contractor's documentation of acceptance testing to the Engineer prior to shipping.

PART 3 - EXECUTION

3.01 GENERAL

- A. Mount and adjust the complete switch and lock movement layout as specified herein and as indicated on the Contract Drawings.
- B. Wire control and indication circuits for power-operated switches as shown on the Contract Drawings.

3.02 INSTALLATION

- A. Prior to installation, coat all parts of the switch and lock movement that are not painted, or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.
- B. Where existing concrete ties are not used, install two 14 foot long timber ties for mounting the switch mechanisms where shown on the Contract Drawings. If a helper assembly is required, one of the switch mounting ties shall be 16 foot long.
- C. Prior to mounting the switch mechanism on either concrete or timber ties, align the switch headblock ties at right angles to the straight stock rail, and space the

ties in accordance with the switch shop drawings, and condition the switch points to move without binding.

- D. Install the switch and lock movements at the locations shown on the Contract Drawings.
 - 1. Secure switch and lock movement to the switch ties using eight 7/8-inch bolts.
- E. Remove any ballast necessary for the installation of each switch and lock movement layout and replace and tamp ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout. Remove ballast from between ties to allow unrestricted movement of switch rods.
- F. Make a preliminary adjustment of switch and lock layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the recommendations of AREMA C&S Manual Parts 12.2.1 and 2.4.1, and the PCJPB Test and Maintenance Manual Chapter 2.
- G. Do not apply power to the motor until the switch machine has been fully lubricated, thrown, and adjusted in hand throw. There shall be no rubbing or binding of switch rods or points on gauge plates, rails or ties. Follow manufacturer's adjustment and installation procedure.
- H. During storage and after installation, properly lubricate and maintain switch and lock movement layouts on a regular timed program until accepted by the Engineer.
- I. Exercise care and ensure that the switches, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- J. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.

3.03 SECURITY

- A. Install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

3.04 TOUCH-UP

- A. Touch-up the finish of equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Color shall match factory finish.

3.05 FIELD QUALITY CONTROL

- A. Inspect each switch and lock movement after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.
- B. Conduct final operational tests of switch and lock movements as described in Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18330

SWITCH CIRCUIT CONTROLLER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for switch circuit controllers.

1.02 GENERAL

- A. Switch circuit controller layouts shall include the controller unit, junction box, point lug, detector rod, shims, all required bolts, nuts, washers, pins, grease fittings, cotter keys, plates, adjusting brackets, and all hardware to mechanically couple the switch circuit controller to the track switch points and mount it on the ties.
- B. Refer to Division 19, Trackwork, for track construction requirements.

1.03 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.04 SUBMITTALS

- A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points.
- B. Submit Contractors Acceptance Test Documentation on switch circuit controllers prior to transport.
- C. Submit copies of all field-test reports.

1.05 QUALITY ASSURANCE

- A. Switch circuit controllers shall meet the recommendations of AREMA C&S Manual, Part 12.1.1, for a four front/back contact configuration where they do not conflict with any requirements specified herein. Mounting details shall conform to the Caltrain Design Standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect switch circuit controllers and their component layout parts against damage during handling and shipment.
- B. During storage, properly lubricate and maintain switch circuit controller layouts on a regular timed program.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Furnish Electric Switch Circuit Controller Layout complete with rod, lug, and associated hardware.
- B. Contractor furnished Switch Circuit Controllers and layouts, if required, shall be: Model 7J as manufactured by Alstom Signaling, Model U-5 as manufactured by Union Switch and Signal (now Ansaldo), or Engineer approved equal, complete with rod, lug and associated hardware.
- C. Contractor furnished Junction Box shall be Model 091 428-ABX manufactured by Safetran Systems (now Invensys) or Engineer approved equal.
- D. Furnish Insulated Vertical No. 1 Rod with Basket.
- E. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch and lock movement layout including 18-inch-long, two-inch-diameter flexible conduit and connectors from movement to junction box.

2.02 GENERAL

- A. Stranded wire: Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 18370, Signal Wire and Cable.
- B. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch circuit controller layout.

2.03 SECURITY

- A. Padlocks will be Owner-furnished.

2.04 SOURCE QUALITY CONTROL

- A. Test each switch circuit controller before transporting it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for switch circuit controllers.

PART 3 - EXECUTION

3.01 GENERAL

- A. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings.
- B. Circuits for switch circuit controllers shall be as shown on the Contract Drawings.

3.02 INSTALLATION

- A. Prior to installation, coat all parts of the switch circuit controller that are not painted or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.
- B. Install one 10-foot long timber tie or concrete tie for mounting the controllers as shown on the Contract Drawings
- C. Mount controllers on new and existing timber or concrete ties in conformance to Caltrain Design Standards.
- D. Dap and drill timber ties to meet the requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.
- E. Secure the switch circuit controller to the switch ties, by 3/4 inch by 10 1/2 inch bolts.
- F. Remove any ballast necessary for the installation of each hand throw switch layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout.
- G. Make a preliminary adjustment of the controller layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.1.1 and 2.4.1.
- H. Underground cable terminating in the controller junction box shall be dressed and potheaded as specified in Section 18370, Signal Wire and Cable. Fan the individual conductors in a neat workmanlike manner, properly tagged and terminated. Wiring between switch junction box and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the controller junction box and the controller mechanism in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.
- I. After installation, properly lubricate and maintain switch circuit controller layouts on a regular timed program until accepted by the Engineer.
- J. Exercise care and ensure that the controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- K. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam cleaned the plates to remove all oil or grease prior

to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.

- L. Connect switch circuit controller rods to the normally closed switch point.

3.03 SECURITY

- A. Install Owner-furnished switch padlocks on trainman's access side of electric locks and hand-throw levers of switch and lock movements.

3.04 TOUCH-UP

- A. Touch-up the finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch-up shall match factory finish.

3.05 FIELD QUALITY CONTROL

- A. Inspect each switch circuit controller after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.
- B. Conduct final operational tests of switch circuit controllers as described in Section 18600, Signal Systems Testing.
- C. Test all functions of each switch and lock movement layout in accordance with Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18340

ELECTRIC SWITCH LOCK LAYOUTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for Electric Switch Lock layouts.

1.02 GENERAL

- A. Refer to Division 19, Trackwork, for track construction requirements.

1.03 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.04 SUBMITTALS

- A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points.
- B. Submit copies of all field-test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prior to installation, coat all parts of the Electric Switch Lock layout that are not painted or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.
- B. During storage, lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular time program until installation. The Engineer shall have the right to monitor the Contractor's compliance with this maintenance required from time to time.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Furnish new Low Style Electric Lock Operating Mechanisms and layouts, such as G & B Specialties Model 854 or Alstom Model 10A.
- B. Furnish new High Style Electric Lock Operating Mechanisms and layouts, such as Alstom Model 9B or United Switch and Signal (now Ansaldo) US&S Model SL6A.
- C. Rods and Hardware. Each Low Style Electric Switch Lock shall securely lock the switch hand throw lever in the normal position only. Provide a single color LED with

the assembly to indicate switch lock release. Each High Style Electric Lock shall have a separate lock rod attached to the vertical front rod.

- D. Junction Boxes. Each Electric Switch Lock layout shall be installed with an individual pedestal mounted junction box. These junction boxes shall be as specified in Section 18360, Signal Systems Miscellaneous Products.
- E. Electrical Fittings. All conduit, connectors, and electrical fittings, as required, for each electrical lock layout.
- F. Switch Circuit Controller and Rod. Switch circuit controller layouts shall be installed as specified in Section 18330, Switch Circuit Controller.
- G. Stranded wire: Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 18370, Signal Wire and Cable.

2.02 SECURITY

- A. Provisions shall be made for the use of standard padlocks:
 - 1. A switch padlock to restrict entry into the operating handle location of the Electric Switch Lock.
 - 2. Signal padlocks to restrict entry into the Electric Switch Lock operating mechanism, the circuit controller, and the junction box.
- B. Padlocks will be Owner-furnished.

2.03 SOURCE QUALITY CONTROL

- A. Perform Contractor's acceptance test of each Electric Switch Lock layout prior to transporting the Electric Switch Lock layout.

PART 3 - EXECUTION

3.01 GENERAL

- A. The circuits for Electric Switch Lock layouts shall be as shown on the Contract Drawings.
- B. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings.

3.02 INSTALLATION

- A. Install two 16-foot long timber ties or concrete ties for mounting the Electric Switch Lock where Alstom Model 9B or US&S Style SL-6A Electric Locks are used and controller by the Contractor, as shown on the Contract Drawings.
- B. Mount Electric Switch Lock and controller on new and existing timber or concrete ties in conformance to Caltrain Design Standards.

- C. Dap and drill timber ties to meet the requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.
- D. Secure the Electric Switch Lock and switch circuit controller to the switch ties, by 3/4 inch by 10 1/2 inch bolts.
- E. Remove any ballast necessary for the installation of each Electric Switch Lock layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout.
- F. Make a preliminary adjustment of the Electric Switch Lock and switch circuit controller layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.5.5 and 2.4.1.
- G. Underground cable terminating in the Electric Switch Lock and switch circuit controller junction boxes shall be dressed and potheaded as specified in Section 18370, Signal Wire and Cable. Fan the individual conductors in a neat workmanlike manner, properly tagged and terminated. Wiring between switch junction box and Electric Switch Lock and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the Electric Switch Lock and switch circuit controller junction box and the Electric Switch Lock and switch circuit controller mechanisms in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.
- H. After installation, properly lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular timed program until accepted by the Engineer.
- I. Exercise care and ensure that the Electric Switch Lock and switch circuit controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.
- J. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.
- K. Connect electric switch lock rod and switch circuit controller rods to the normally closed switch point.

3.03 SECURITY

- A. Install Owner-furnished padlocks.

3.04 TOUCH-UP

- A. Touch-up finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch-up shall match factory finish.

3.05 FIELD QUALITY CONTROL

- A. Inspect each Electric Switch Lock after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.
- B. Conduct the final operational tests of switch circuit controllers as described in 18600, Signal System Testing.

END OF SECTION

SECTION 18350

RECTIFIERS, BATTERIES AND BATTERY CHARGING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for rectifiers, batteries, and battery charging equipment.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 DESIGN REQUIREMENTS

- A. Calculate the loads based upon the equipment proposed. Size all batteries to provide a minimum 48 hours standby capacity for all systems based on normal operating conditions. Verify the ampere-hour capacity shown on the Contract Drawings is adequate to provide a minimum of 48 hours standby capacity.
 - 1. Size battery to provide a minimum of 48 hours of uninterrupted power to the signal systems at the normal operating load.
- B. Size batteries which provide power for crossing warning devices, such as gates and flashing lights, to provide 12 hours of continuous operation with the gate arms in the horizontal position and all lights flashing. This requirement is in addition to the requirement for 48 hours standby capacity in the previous paragraph.

1.04 SUBMITTALS

- A. Load calculations of each dc and ac load. Submit calculations identifying normal and worst-case conditions for each load.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MATERIALS

- A. SPL Batteries: Batteries conforming to the requirements specified herein as manufactured by Saft America, Inc. or Engineer approved equal.
 - 1. Model (SPL 340, 340AH)
 - 2. Model (SPL 380, 380AH)
- B. National Railway Supply Battery Charger: Charger conforming to the requirements specified herein or Engineer approved equal:

1. Model ERBC (24/30 1/36V, 30A)
2. Model ERBC (12/40 1/20V, 40A)
3. Model ERBC (12/20 1/20V, 20A)

2.02 EQUIPMENT DETAILS

- A. Battery charging equipment shall be designed for continuous operation.
- B. Battery charging equipment shall be designed to deliver rated outputs with input voltage of 100 V to 130 V at 60 Hz, single phase, two wire input.
- C. Battery charging equipment shall have a reserve capacity of at least 25 percent above the calculated high load requirements.
- D. Each charger shall be provided with programmable output voltage adjustment.
- E. Terminal markings for ac and dc terminals shall be permanent.
- F. The charger shall provide a stabilized output voltage, temperature compensated with output current limiting. The capacity of the battery charger shall be determined by the Contractor and approved by the Engineer. The charger shall adjust its output current automatically, according to the load and to the demand on the battery.
- G. Battery charger shall conform to requirements in AREMA C&S Manual Part 9.2.1. The output of the charger shall be sufficiently filtered to be compatible with the input voltage requirements of the solid-state interlocking units, and all other electronic equipment for the signaling system.
- H. Batteries shall be recombination pocket plate nickel cadmium.
- I. Batteries shall be capable of a minimum of 1,500 charge-discharge cycles to 80 percent discharge without loss of capacity. Totally discharged batteries, even if polarity has reversed, shall be capable of being recharged to rated capacity with charging voltage of no more than 1.60 volts per cell.

2.03 MISCELLANEOUS MATERIALS

- A. Furnish all mounting hardware, terminals, and terminators, and similar items for mounting chargers and batteries in wayside cases and signal instrument shelters.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install batteries and battery charging systems as shown on the Contract Drawings.

3.02 TESTS

- A. Perform tests specified in Section 18600, Signal Systems Testing, ensuring system operation.
- B. Test batteries and battery chargers in accordance with the manufacturer's standard when installed.

END OF SECTION

SECTION 18360

SIGNAL SYSTEMS MISCELLANEOUS PRODUCTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for miscellaneous components and products for signal systems.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
 - 1. C80.1 Electrical Rigid Steel Conduit
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog cuts, material descriptions, specifications, and other data pertinent to the miscellaneous products required.
- B. Submit samples of solderless crimp-on type terminals.

1.04 EXTRA MATERIALS

- A. Furnish two gallons or equivalent volume of corrosion preventive compound. Compound shall be the same product as approved for use in the Work.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All electrical components shall be rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those which the components will be subject to in service, unless otherwise specified herein.
- B. Miscellaneous components and products shall be clearly and permanently labeled with value or type identification.

2.02 CIRCUIT BREAKERS AND FUSES

- A. Circuit breakers and fuses shall be of suitable capacity to protect the various pieces of signal apparatus from the effects of short circuits or overloads. All circuit breakers

and fuses required for the equipment and systems shall be in accordance with these Specifications.

- B. Circuit fuses shall be non-renewable, and shall be of the fiber-case, time lag, fusion type.
- C. The circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.
- D. All circuit breakers and fuses shall be centrally located on the power distribution panel and power racks.
- E. Fuse clips shall be constructed so that they shall retain their resilience under all installation and service conditions, to ensure a positive contact between the clips and the fuse.

2.03 DIODES

- A. Diodes to be furnished under this Contract shall carry a JEDEC number or shall be available from more than one manufacturer, and shall be used within the published specifications for such number. All diodes shall be silicon type, unless otherwise accepted by the Engineer.

2.04 RESISTORS

- A. Resistors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.15.

2.05 REACTORS

- A. Reactors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.20.

2.06 SIGNAL TERMINAL BLOCKS

- A. Signal system terminal blocks shall be in accordance with the applicable recommendations of AREMA C&S Manual Part 14.1.5.

2.07 TERMINAL BINDING POSTS

- A. Signal system terminal binding posts shall be in accordance with the applicable recommendations of AREMA C&S Manual Part 14.1.10.
- B. Terminal binding posts for interface with plug-coupled wires to rack mounted electronic equipment shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.1.2.

2.08 TERMINAL POST INSULATORS

- A. All terminal posts, located on terminal boards in the wayside cases, signal instrument shelters used to terminate 50V, or greater, ac or dc circuits shall be provided with a protective insulator.
- B. The type of insulator shall be individual for each terminal post and shall be fire-resistant.

2.09 INSULATED TEST LINK

- A. Type 024620-1X as manufactured by Invensys Rail, or Engineer approved equal.

2.10 LIGHTNING ARRESTERS AND EQUALIZERS

- A. Invensys Rail Clearview No. 022485-28X, Equalizer No. 022700-1X, or engineer approved equal. Lightning arresters and equalizers shall be mounted on accepted type base and shall be in accordance with the recommendations of AREMA C&S Manual Part 11.3.1.

2.11 SURGE PROTECTORS

- A. Invensys Rail SP-17, SP-18, SP-19, SP-20, or equal. Surge Protectors shall be in accordance with the recommendations of AREMA C&S Manual Part 11.3.3.

2.12 TERMINALS FOR WIRES AND CABLES

- A. Solderless terminals shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.1.1, unless otherwise specified herein.
- B. Terminals shall be of the solderless crimp-on type. Samples of all solderless terminals shall be submitted for approval.
- C. Stranded copper wire shall be fitted with an approved type of terminal at all points where the wires are to be terminated on terminal binding posts.
- D. The terminating means shall be of four types:
 - 1. A lug for terminating heavy wires or signal power wires.
 - 2. A solderless type of terminal as manufactured by TE Connectivity, Inc., under the trade name of "Pre-Insulated Flags" with translucent insulation similar to Catalog No. 322313, or equal, for terminating No. 16 and No. 14, American Wire Gauge (AWG) stranded wires.
 - 3. An AMP Solistrand "Ring Tongue-Flat" terminal, similar to that shown on the AMP Drawing P64044, together with slip-on nylon post insulator, similar to that shown on AMP Drawing P64-0264, or equal, for terminating wires larger than No. 14 AWG to a maximum diameter over the insulation of 0.40 inch.
 - 4. An AMP preinsulated; diamond grip ring nylon insulated wire terminal shall be used for terminating other stranded wires, No. 20 and No. 18 AWG,

having maximum diameter of 0.125 inch. AMP Catalog No. 320554, or equal, shall be furnished for No. 8 studs and AMP Catalog No. 320571, or equal, shall be furnished for 1/4-inch studs.

- E. Terminals shall be for attaching to the ends of the conductor in such a manner that the flexibility of the conductor will not be destroyed and the possibility of breakage at the terminal will be reduced to a minimum.
- F. Terminals shall be for attaching to the wire with a tool made by the manufacturer of the terminal and recommended by the manufacturer for the terminals being furnished.
- G. The tool shall be equipped with a ratchet device to ensure proper indentation of the terminal, which will not release until proper indentation is complete.

2.13 TAGGING FOR CABLES, WIRES AND EQUIPMENT

- A. Except as otherwise specified in this Section, permanently identify with a tag both ends of each cable, each cable wire, and all single wires that terminate in the junction boxes, switch mechanisms, signal instrument shelters, on equipment racks, relay bases, shelter and any equipment of the signal system outside of such locations. Install tags so that they may be read with a minimum of disturbance of the tags. Each conductor of the cable shall be rung out and identified before applying the tag. Tagging shall follow the three-line convention with the termination in the first line, nomenclature in the second line, and termination of the other end of the wire in the third line. (From - To)
- B. Tags for wire and cable identification and for identification of transformers, resistors, reactors and other components shall meet the following requirements and shall be subject to Engineer's acceptance:
 - 1. Sleeve Type Tags:
 - a. Tags for identifying individual cable conductors and field-installed wires within the signal instrument shelters, wayside cases, switch mechanisms, switch layout junction boxes, base of signal junction boxes, and similar applications, shall be the sleeve type as manufactured by Raychem Corporation, Thermofit Marker System (TMS), or equal. The application of the conductor nomenclature shall be in accordance with the manufacturer's instructions and shall result in a permanently bonded and legible identification.
 - 2. Flat Plastic Tags:
 - a. Tags for identification of vital relay plug boards, individual transformers, resistors, reactors, terminals, and other miscellaneous components within the signal instrument shelters, wayside cases, and outside terminal cases, shall be the flat plastic laminated type.
 - b. These tags shall be 1-1/2 inches long by 1/2-inch-wide. The untreated tag shall be milk white "vinylite", or Engineer approved equal.

- c. The identifying nomenclature space shall allow for two rows of lettering, and the tag material shall be capable of receiving typed-on characters by conventional means. The height of the lettering shall not be less than 1/8 inch.
- d. After lettering, both the face and backside of the tag shall be covered with a clear plastic coating, "vinylite", or Engineer approved equal.

2.14 HARDWARE

- A. Mounting hardware exposed to the elements and used for signal equipment, cases, conduit, hangers, brackets, clamps, and the like, shall be hot-dip galvanized in accordance with AREMA C&S Manual Part 15.3.1, except as otherwise accepted by the Engineer.
- B. Galvanizing:
 - 1. The hot-dip process of galvanizing shall be used. All parts shall be picked so that all scale and adhering impurities are removed. The zinc coating shall be of commercially pure zinc, and shall be continuous and thorough. It shall not scale, blister, or be removable by any of the processes of handling or installation. The finished surface shall be free from fine line cracks, holes, or other indications of faulty galvanizing. It shall be smooth and free from adhering flux and other impurities. The edges and ends of parts shall be free from lumps and globules. Parts shall be coated with at least two ounces of zinc per square foot of galvanized surface, after all bending, cutting, drilling, and final fabrication.
- C. Cadmium Plating:
 - 1. Nuts, bolts, and washers shall be cadmium plated or stainless.
 - 2. Cadmium plating shall be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries and shall completely cover the surface of the part in a smooth, bright layer. Plating on raised or prominent portions shall show no evidence of blackness or loose crystalline structure. It shall have a minimum thickness of six ten thousandths of an inch and shall withstand the salt spray test for at least 1,000 hours or an equivalent test accepted by the Engineer.

2.15 CONDUIT

- A. Rigid conduit:
 - 1. Steel Conduit: Steel conduit shall conform to ANSI C80.1 and shall be installed as shown on the Contract Drawings. Where elbows are used, they shall be long radius type. Steel conduits shall be protected in shipping and handling by approved thread protectors.

2. Polyvinyl Chloride (PVC) Conduit: Thick wall polyvinyl chloride conduit, high impact schedule 80, herein referred to as PVC conduit, shall be installed as shown in the Contract Drawings. Where elbows are used, they shall be the long radius type.
- B. Flexible Conduit
1. Conduit for track circuit leads, switch-and-lock movements, and electric lock layouts shall be Liquid-Tite flexible conduit or equal. The conduit shall be clamped at both ends with stainless steel clamps. Clamps are not required for track wire risers.
 2. Metallic Flexible Conduit: Where acceptable to the Engineer, metallic flexible conduit, Type UA, or engineer approved equal may be used.
- C. Fittings
1. Approved fittings for flexible conduit shall be used.
 2. Approved fittings for PVC conduit shall be used.
 3. Fittings for rigid steel conduit shall be of cast malleable iron and shall be protected by hot-dip galvanizing.

2.16 PADLOCKS

- A. Switch padlocks will be Owner-furnished.
- B. Signal padlocks will be Owner-furnished. The Contractor shall provide temporary padlocks until such time the equipment is placed in-service.

2.17 SEALING COMPOUND

- A. Sealing compound for use in sealing cable entrances shall be in accordance with AREMA C&S Manual Part 15.2.15.

2.18 CABLE ENTRANCE PIPES

- A. Cable entrance pipes for wayside signal shelters shall be 4-inch PVC, Schedule 80, and 3 feet 6 inches long and extend 18 inches below the final grade.
- B. Cable entrance for wayside signals shall be 4 inch Liquid-Tite flexible conduit or equal. Entrance pipe shall extend 18 inches below finished grade around signal.
- C. Cable entrance pipes are not required where a cable chute directly enters a pullbox.

2.19 JUNCTION BOXES

- A. All junction boxes shall be provided with gaskets to prevent the entrance of moisture and dust, in accordance with AREMA C&S Manual Part 15.2.10.

- B. Junction boxes shall be provided to terminate underground cables at all switch and lock movements and all switch circuit controllers.
- C. Junction boxes shall be provided with means for applying padlock.

2.20 LUBRICATION

- A. Lubrication for switch tie plates for all switch and lock movement layouts installed by the Contractor shall be an accepted graphite lubricant, similar to Dixon's Graphite "Railroad 60".

2.21 ENVIRONMENTAL PROTECTION (CORROSION PREVENTIVE COMPOUND)

- A. Protection, as hereinafter specified for machine-finished surfaces, threaded rods, nuts, and other parts that are susceptible to rusting or corroding, shall be a corroding preventive compound, NO-OX-IDE No. 90918, or equal. The product shall have sufficient body to resist weather and rusting for at least 6 months.

2.22 DC TRACK CIRCUITS

- A. Transmitters shall be a 1TC, 2TC, or 3TC manufactured by GETS Global Signaling or Engineer approved equal.

2.23 STYLE C TRACK CIRCUITS

- A. Transmitter shall be a TD-1A driven by an ACG-2T or TD-4 manufactured by GETS Global Signaling or Engineer approved equal.

2.24 AUDIO FREQUENCY ISLAND TRACK CIRCUITS

- A. Audio frequency island track circuits shall be AFTAC-II manufactured by GETS Global Signaling, PSO manufactured by Invensys Rail, or Engineer approved equal.

2.25 AC TRACK CIRCUITS

- A. AC Track Circuits shall be steady energy such as the SE-3 manufactured by Invensys Rail or Engineer approved equal. Vane Relays shall not be used.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Material and apparatus specified herein shall be installed in accordance with the details of respective Sections of these Specifications, manufacturer's recommendations, and in accordance with the Contractor's accepted installation drawings approved by the engineer.

END OF SECTION

SECTION 18370

SIGNAL WIRE AND CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for all cable and wire required for signal and signal power system wiring to wayside shelters, junction boxes, and factory wired mechanisms.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.
- B. International Organization of Standardization (ISO):
 - 1. 9001 Quality Management Systems Requirements

1.03 SYSTEM DESCRIPTION

- A. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. Cables shall be suitable for use in the environment to be encountered on a railroad signal system, and shall be certified for continuous operation, in wet or dry locations, with no conductor failing in continuity or with loss of insulation to cross or ground less than one megohm.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, material descriptions, and specifications for each type of wire and cable the Contractor proposes to provide.
- B. Quality Assurance: Submit a list of cable manufacturer's installations complying with the past performance and experience requirements specified herein.

1.05 QUALITY ASSURANCE

- A. Cable manufacturer's qualifications shall be as follows:
 - 1. Past Performance and Experience: Demonstrated previous successful experience in supplying cable to the railway or transit industry for use as vital signal control cables. A list of such installations shall be provided for each cable manufacturer to be considered.

2. Quality Assurance Program: 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 ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Shipping, storage, and handling shall be in accordance with the recommendations of AREMA Signal Manual, Part 10.4.1.
- B. During storage and handling, prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.

PART 2 – PRODUCTS

2.01 INTERNAL WIRE AND CABLE

- A. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.
- B. Internal wire and cable shall conform to the recommendations of AREMA C&S Manual, Part 10.3.14, and the following requirements:
 1. Solid conductors shall be Type I in accordance with AREMA C&S Manual Part 10.3.14.
 2. Stranded conductors shall be Type II in accordance with AREMA C&S Manual Part 10.3.14.
- C. Internal wire and cable insulation shall conform to the recommendations AREMA C&S Manual Part 10.3.24 and the following requirements:
 1. The minimum insulation rating shall be 600 volts.

2.02 EXTERNAL WIRE AND CABLE

- A. General
 1. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.
 2. Conductors shall be soft or annealed copper, coated with tin in accordance with Type I wire as shown in the applicable AREMA C&S Manual Part.
 3. Stranded conductors shall be soft or annealed copper, coated with tin in accordance with Type II wire as shown in the applicable AREMA C&S Manual Part.
- B. Track Wire
 1. Track wire shall be Okonite-Okolene(EP-PE) manufactured by Okonite Co., or Engineer approved equal.

2. Track wire shall meet the recommendations of AREMA C&S Manual, Part 10.3.15.
- C. Signal, Switch, and Express Cable
1. Wire and cable used for direct burial to signals, to switches and express cable shall be Okonite (EP) Armored Underground Signal Cable manufactured by Okonite Co., or Engineer approved equal.
 2. Conductors number six (#6AWG) and smaller shall be solid. Conductors number 4 (#4AWG) and larger shall be stranded.
 3. Armored cable used for direct burial shall be furnished with a 10-mil flat bronze tape between the conductors and the outer jacket, helically applied, and adequately cushioned from the conductors.
 4. Armored cable shall meet the recommendations of AREMA C&S Manual, Part 10.3.17.
 5. Any cable installed in conduit or trough for its entire run need not be armored, but shall meet the recommendations of AREMA C&S Manual Part 10.3.16.
- D. AC Power Cable
1. AC power shall be Okonite-FMR (EP) Okolon (CSPE) Type TC Cable manufactured by Okonite Co., or Engineer approved equal.
 2. Cable shall meet the recommendations of AREMA Signal Manual, Part 10.3.16.
- E. Modem Cable
1. Modem cables shall be C-L-X Type SP-OS manufactured by Okonite Co., or Engineer approved equal.
 2. Modem cable shall be protected by a moisture impervious, continuously welded, corrugated, aluminum sheath with an overall EFTE fluoropolymer jacket.
 3. Individual twisted pairs shall be separately shielded with an aluminum polyester tape to provide shield isolation between pairs of 100 megohms per 1000 ft. minimum.
 4. Modem cable shall meet the requirements of AREMA Signal Manual, Part 10.3.17 except as specified herein.

2.03 SOURCE QUALITY CONTROL

- A. Coordinate with the Engineer for Engineer's inspections and tests at point of product.
- B. Provide, at the point of production, apparatus and labor for the following tests:

1. Conductor size and physical characteristics
2. Insulation HV and IR tests
3. Physical dimension tests
4. Special tests on materials in coverings
5. Final HV, IR, and conductor resistance tests on shipping reels

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. The installation of wire and cable shall conform to AREMA C&S Manual Parts 10.4.1, 10.4.30, except as specified herein.
2. All external cable runs shall be direct burial or in conduit in accordance with the PCJPB Communication & Signaling Standard Drawings, and as called for in the Contract Drawings.
3. The Contractor shall separate signaling cables from parallel run of ac feeder cables, where adjacent locations are fed from one ac service location.
4. Give the Engineer 24 hours notice prior to installing cables.
5. Provide sufficient slack in cable conductors at all terminating posts to enable three terminations of the conductor, due to broken eyelets without re-servicing or repotheading the cable.
6. In certain types of installation, the cable cannot be constrained; therefore, ample cable slack shall be provided for additional flexibility due to vibration of such equipment.
7. Do not bend cables to a radius less than manufacturer's recommendation.
8. Distribution cable runs shall be continuous without splices between cable terminating locations. Express cable runs longer than cable lengths shall be spliced together in junction box, instrument case, or other acceptable shelter. Prior to any cable or wire splicing, obtain the Engineer's approval. Approval will not be granted for cables damaged by the Contractor or vandalized by others. It is the responsibility of the Contractor to protect all cables until final installation.
9. Identify individual cable conductors at each cable termination with plastic tags, as specified in Section 18360, Signal Systems Miscellaneous Products. Identify and terminate all spare conductors in each cable.

10. Seal cable entrance openings in equipment enclosures and junction boxes with either compression type fitting or pliable sealing compound after the cable is in place. Use sealing compound to seal the area around cable where the cable emerges from the end of a conduit or pipe. Seal and plug all spare conduits.
11. Wherever multiple conductor cables are terminated, carefully remove the outer sheath of the cable to a minimum point of 3 inches from the cable entrance. At the end of the cable sheath or covering, apply two layers of plastic electrical tape.
12. Terminate all cable conductors in conductor sequence from top to bottom.
13. Cable shields or sheaths shall be grounded at the entrance to signal shelters and shall float when terminated in field apparatus.

B. Underground Buried Installation

1. Bury cable to a uniform minimum depth of 36 inches as measured from bottom of tie to top of cable, unless installed in a cable trough. When paralleling the tracks, bury cable a minimum depth of 36 inches as measured from the finished grade to top of cable. Lay cable loosely in trench with a sand bed and backfill as specified in these Specifications. Install cable within four-inch PVC schedule 80 conduit at a uniform minimum cover depth of 36 inches below grade when passing under tracks.
2. Upon request and only under extreme circumstances because of installation hardship will installation of a cable be allowed to a depth of less than 36 inches, subject to the Engineer's acceptance. Protect the cable in a manner acceptable to the Engineer.
3. Whenever any signal cable is to pass under pavement or roadway, if existing conduit is not provided, install cable in a 4-inch PVC Schedule 80 conduit and extend conduit 2 feet beyond the edges of the pavement. Installation of conduits and pull boxes shall be in accordance with Caltrain Standard Drawings (SD-5000 series), for typical installations. Restore pavement or roadway to its original condition, subject to the Engineer's acceptance.
4. Whenever any signal cable is to pass under the hot-mix asphalt concrete (HMAC) underlay installed at interlockings, install cable in conduit with pull boxes in accordance with Caltrain Standard Drawings (SD-5000 series).
5. Where cable leaves the ground at other than buildings or in foundations, protect cable by a bootleg or other covering extending above the ground line. Fill top of such protective coverings with a sealing compound.
6. Where buried cables enter a concrete foundation, junction box, shelter or case, leave sufficient slack in each cable in the nearest pullbox to allow an additional one foot of cable to be pulled into the shelter or junction box.
7. The potheading of buried cables shall be applied whenever cable is terminated in signal equipment, and such termination is within two feet

of the grade level. This neoprene and seal pothead shall be installed in accordance with the manufacturer's instructions.

8. Cables shall not cross one another when they are pulled into a conduit or pipe; the conductors shall not be pulled tight or kinked in conduit fittings or boxes. All cables to be installed in a conduit or pipe shall be pulled and installed simultaneously.
 9. Cables, track wire, and conduits shall be installed per Contract Drawings and Sections 02300 Earthwork.
 10. All cables except final connection of flex wires to rail shall be installed in a conduit system as shown on the Contract Drawings.
- C. Special Protection: Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as vibration or sharp corners on equipment. Replace any cable that is installed but subsequently damaged prior to acceptance as a result of the Contractor's failure to provide such special protection.
- D. AC Power Cable
1. AC power cable shall be installed in dedicated conduit from the service meters to the signal shelters and between signal shelters.

3.02 REPAIR

- A. Immediately call to the Engineer's attention any instance of damaged cable observed at any time, whether prior to installation, occurring during construction, or discovered by test observation after installation. The method of correction shall be in accordance with the Engineer's written instruction. Promptly repair such damage.

3.03 FIELD QUALITY CONTROL

- A. Test all installed external cable in accordance with the requirements of Section 18600, Signal Systems Testing, and AREMA C&S Manual, Part 10.4.30.

END OF SECTION

SECTION 18400

RAIL BONDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for rail bonds, fouling bonds, frog bonds, track circuit connections, and all other material required for bonding of track circuit joints, track frog and switch bonding, and track circuit connections.

1.02 SYSTEM DESCRIPTION

- A. Welded Bonds and track connections shall be in accordance with the requirements of PCJPB Standards.
- B. Rail track joints shall be bonded with welded railhead bonds per PCJPB standards.
- C. Track switch, frog fouling bonds, and track connections shall be stranded bonds.
- D. Crimped sleeves shall not be used for any fouling or frog bonding unless allowed by PCJPB Manager of Signals and Communications through the Engineer.

1.03 QUALITY ASSURANCE

- A. Install and test the track bonds in accordance with all applicable requirements of CFR 49, Part 236 and the recommendations of the AREMA C&S Manual, Part 8.1.20. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, material specifications, installation and maintenance instructions, and other data pertinent to the bonding material, staples, and circuit connections, specified herein and as shown on the Contract Drawings.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Rail Head Bonds: Railhead bonds shall be 3/16-inch in diameter with steel terminals welded to the conductors. They shall have a nominal length of 6 1/2 inches.
- B. Web Bonds: Web Bonds shall be 3/16-inch, 12-inch long welded to the web.
- C. Track Circuit Rail Connectors: Track circuit connectors shall be 3/16-inch stranded bronze conductor, 1-inch tap for welded connection on one end and compression sleeve on the other end for a direct crimp type connection to the

track wire, and shall have a nominal length of 4 inches. Use no crimped connections on fouling wires or frog bonding unless authorized by the PCJPB Manager of Signals and Communications through the Engineer.

- D. Bond Strand: Bond strand for fouling wires shall be 3/16-inch single strand with 1/16-inch black PVC insulation.
- E. Acceptable Manufacturers:
 - 1. Erico International Corporation or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF WELDED BONDS

- A. Install welded bonds at all non-insulated rail joints within the limits of this Contract that are not equipped with a bond.
- B. Grind clean with a vitrified grinding wheel the surfaces of the rails where the bond is to be applied. After grinding, clean surface with an approved non-toxic solvent to remove all traces of grease and dirt. After the surface has been ground and cleaned, weld the bond wire to the rail in a manner that will ensure a thorough mechanical and electrical connection.
- C. Before beginning work on these bonds, weld in the field, under conditions similar to those of the regular installation, not less than three complete bond connections, and as many more as the Engineer considers necessary to determine that the welds are being made satisfactorily. Such welds shall be subject to inspection and testing by the Engineer, and acceptance as to the method and quality of workmanship will depend on the results of these inspections and tests.
- D. Ensure that each bond connection is thoroughly welded to the rail. The Engineer reserves the right to require a test of each weld by hammer and striker, or in any other manner, which in the opinion of the Engineer is reasonable.
- E. Remove any welded bond installed by the Contractor that is found to be defective prior to acceptance, and install a new bond.

3.02 INSTALLATION OF TRACK CIRCUIT CONNECTIONS

- A. The plug end of the track circuit connector shall be as specified herein, at a maximum distance of 3 inches from the end of the insulated joint.
- B. Strip back underground cable a sufficient distance for the exposed conductor to be fully inserted into the compression sleeve. Then compress sleeve with the type of compression tool designed for that purpose.
- C. Track wire installation shall conform to PCJPB Standards.

- D. All track circuit connections shall be installed by the Contractor. Remove any found to be defective prior to acceptance, and install a new track circuit connection.

3.03 TESTING

- A. Test all track circuits for continuity of circuit and ensure main line track circuit is de-energized with 0.06-ohm shunt at any point within the track block.

END OF SECTION

SECTION 18450 SIGNAL GROUNDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for a grounding system for the equipment shelter and all other wayside equipment apparatus.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.
- B. ASTM International (ASTM):
 - 1. B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. National Fire Protection Association (NFPA):
 - 1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

- A. Submit Schematic Drawings showing the design and detail of the proposed grounding system for the signal and power equipment proposed to be furnished and installed.
- B. Submit catalog cuts or drawings showing the type of components to be used for the proposed grounding system(s).
- C. Submit Installation and Test Procedure proposed for all equipment grounding.
- D. Submit test reports.

1.04 QUALITY ASSURANCE

- A. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations and the National Electrical Code (NEC).

PART 2 – PRODUCTS

2.01 GENERAL

- A. Ground rods shall be copper-clad stainless steel, in accordance with AREMA C&S Manual Part 11.3.4. The rod shall be at least 10 feet in length and at least 3/4-inch diameter.
- B. Ground rod clamps shall be made of a cast bronze clamp body, with non-ferrous set-screws in accordance with the recommendations of AREMA C&S Manual Part 11.3.4.
- C. Internal ground wire, from the equipment to the ground bus, shall be insulated No. 6 AWG standard copper wire in accordance with the recommendations of AREMA C&S Manual Part 11.4.1. Insulated ground wire shall be colored green.
- D. Provide a grounding bus of nickel-plated hard drawn pure copper in the equipment shelters.
- E. Bare Ground Wire: Soft drawn copper, Class A or Class B stranded, shall meet the requirements of ASTM B8. Sizing of ground wire shall be in accordance with the NEC, except where sizes specified herein or shown on the Contract Drawings are larger than those required by NEC; UL listed, Label A for lightning protection conductors. Grounding cable shall be continuous without joints or splices throughout its length.
- F. Bolted Grounding Connectors: Use connectors made of high strength electrical bronze, with silicon bronze clamping bolts and hardware in accordance with AREMA C&S Manual Part 11.3.4; designed such that bolts, nuts, lock washers, and similar hardware which might nick or otherwise damage the ground wire, shall not make direct contact with the ground wire.

2.02 MATERIALS

- A. Ground rods: As manufactured by Copperweld Corp. or Engineer approved equal.
- B. Ground wire as specified herein.
- C. Cadweld connections: As manufactured by Erico International Corp. or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General
 - 1. Ground the following as described herein and in accordance with the applicable requirements of the National Electrical Code (NEC) and local city electrical codes: Service equipment, motor frames, switchgear and equipment enclosures, lighting and power panelboards, transformers,

raceways, fences and gates, building or structure steel frames, lighting standards, floodlight poles, and power/light pullboxes/maintenance holes.

2. The grounding system shall preclude any closed loop grounding arrangements.
3. Do not ground connection(s) to the track rails; do not use the neutral conductors of the ac power supply.
4. Grounding under these specifications shall conform to AREMA C&S Manual Part 11.4.1. In cases where these instructions differ, the Engineer will make final decision.
5. Ground wire/cable runs shall be as short and straight as possible and shall not be interrupted by any device.

B. Exterior: Equipment Shelter Grounding

1. At equipment shelters, drive four ground rods into the ground, one near each corner of a structure. At equipment cases, drive two ground rods into the ground, at opposite corners of the structure. The ground rods shall be a minimum of 6 feet apart and shall be driven below ground level. Dig a 12 inch deep trench between the ground rods. Electrically connect each of the ground rods connected to the others, using a No. 2 AWG bare stranded copper cable, welded using "Cadweld" or an equivalent thermal process. Coat Cadweld connections with epoxy resin. Place the ground wires in the bottom of the trench. Backfill trench, returning the soils removed during construction of the trench.
2. Cadweld shelter's copper ground cables to the ground rods.
3. Ground resistance, as measured by the "Fall-Of Potential" method, shall not exceed 15 ohms.
4. Where flexible conduit is used, provide a bonding jumper.

C. Interior: Equipment Grounding

1. Equip shelters with a prime ground terminal securely attached electrically to the shelter structure and to the made ground network.
2. Run ground connections from lightning arresters and equipment chassis separately to ground buses in the shelters, as shown on Contract Drawings. Connect ground buses to the prime ground with green insulated No. 2 AWG stranded wire.
3. Properly ground equipment that is powered by or switches voltages greater than 35 volts ac or dc.
4. Properly ground equipment that has conductors that leave the shelter.

3.02 TESTING AND INSPECTION

- A. Ground Resistance Testing: Verify that resistance between ground buses and absolute earth, as measured by the "Fall-Of Potential" method, does not exceed 15 ohms without benefit of chemical treatment or other artificial means.
- B. Test Reports: Provide test reports to the Engineer upon completion of ground tests that completely describe ground resistance test procedures and test results. Test reports shall be signed by a technician and witnessed by a representative of the Engineer.
- C. Prior to final acceptance by the Engineer, the Contractor shall have the new ac power service inspected by state and local jurisdictional authority(s) as required.

END OF SECTION

SECTION 18500

SERVICE METERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for 120/240, 100A three-wire, single-phase meter service and upgrading existing meter service to 120/240, 100A, 3-wire, single-phase meter service.
- B. Provide all interface with and in conformance to the standards of the power provider, in order to obtain the commercial metered power service at the locations shown on the Contract Drawings and as required by the Engineer.

1.02 REFERENCE STANDARDS

- A. National Fire Protection Association (NFPA):
 - 1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

- A. Submit Meter Service Drawings, indicating mounting pole, meter base, breaker box, and grounding.
- B. Submit Peak load calculation for each meter location. Submit load calculation within 90 days of Notice to Proceed.
- C. Submit letter certifying that the installation of the meter service has been approved by the local electrical inspector.

1.04 QUALITY ASSURANCE

- A. Electrical service shall conform to the provisions in NFPA 70 National Electrical Code and these Specifications.
- B. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations, and the National Electrical Code (NEC).

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Circuit Breakers
 - 1. Circuit breakers shall be sized by the Contractor for the projected loads. Circuit breakers for 120 Vac power shall be 2 pole rated for 240 Vac. Panels shall contain 25 percent spare circuit breaker space.

2. One double pole circuit breaker shall be provided for future use, in addition to the 25 percent space circuit breaker space, specified herein.
- B. Meter Bases: Shall meet the requirements of the power provider.
- C. Ground Rods and Ground Rod Clamps: Ground rods and ground rod clamps shall meet the requirements of Section 18450, Signal Grounding, and those of the power provider.
- D. Wood Poles: Shall meet the requirements of the power provider.
- E. Meter Pedestals and Bases: Shall meet the requirements of the power provider.

PART 3 - EXECUTION

3.01 GENERAL

- A. Make the necessary arrangements with the power provider and pay all fees in connection with having the new meter service hooked up at least one month prior to placing signal system in service.
- B. Arrange to obtain the service connection from the power provider. Pay the power provider charges for this service connection.
- C. Where the Contract Documents specify that the Owner will make arrangements with the power provider, Contractor shall be responsible for installation and coordination with the power provider.

3.02 COORDINATION

- A. Coordinate the connection and interface of new cables and equipment with the power provider in accordance with its standards.

3.03 INSTALLATION

- A. The installation of the various equipment and materials for the signal power distribution system that are specified herein shall be in accordance with the power provider requirements and the NEC.
- B. The requirements included within this Section shall cover all incidental installation work necessary to effect an integrated, tested, and operable signal power system for the Work as shown on the Contract Drawings.
- C. Arrange utility power service at all equipment shelter locations requiring such services. Connections to equipment shelters from meter may be by underground or aerial connection. Where aerial connection is used, maximum aerial length between meter and shelter shall not exceed 125 feet without the Engineer's prior acceptance.
- D. In collaboration with the Engineer, meet as necessary with LPC representatives to negotiate for the upgrade, relocation, or addition of the power provider required power services needed to complete system operation.

3.04 GROUNDING

- A. Meter service grounding shall be in accordance with Section 18450, Signal Grounding, the NEC, and the power provider requirements. If there is a conflict between the above specifications, the power provider requirements shall govern.

3.05 TESTING AND INSPECTION

- A. Simulated load tests, in accordance with approved signal power system test procedure, shall be satisfactorily completed prior to final connection of signal facilities at each equipment location.
- B. Prior to final acceptance by the Engineer, obtain inspection of the new AC power service by state and local jurisdictional authority(s), as required.

END OF SECTION

SECTION 18600

SIGNAL SYSTEMS TESTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for tests and inspections to demonstrate that systems, subsystems, assemblies, subassemblies, and components supplied and installed under this Contract are in compliance with these Specifications and with all applicable regulatory requirements.

1.02 REFERENCE STANDARDS

- A. Code of Federal Regulations (CFR), Title 49, Transportation:
 - 1. Part 234 Grade Crossing Signal System Safety
 - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- B. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following recommendations of the AREMA, substitute the word "should" with "shall".

1.03 TEST SYSTEM DESCRIPTION

- A. It shall be understood where this Section states "as authorized by the PCJPB Signal Manager or PCJPB Signal Engineer" or "submit to the PCJPB Signal Manager or PCJPB Signal Engineer" such authorization or submittal shall be through the Engineer.
- B. Tests and inspections shall be made both during the progress of this Contract and after completing installation of equipment, and shall consist of factory tests of Contractor Furnished equipment, circuit breakdown tests, wiring verification tests, continuity tests, resistance tests, voltage and current tests, applicable locking tests, operating tests, simulation tests, and other electrical and mechanical tests and inspections.
- C. The work shall include all tests required to ensure proper and safe operation of all systems and subsystems, and to prove the adequacy and acceptability of the total installation specified herein. Tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.
- D. Each Contractor furnished component and unit of the wayside signal and highway grade crossing system shall have an inspection performed at its point of manufacture

and evidence of this inspection and acceptability shall be indicated on the item where practicable.

- E. Conduct an acceptance test on all Owner furnished equipment prior to loading at the warehouse. Provide certified acceptance reports with each unit at time of delivery.
- F. Work shall include costs of the Contractor's personnel and any special equipment and assistance required to conduct all tests with complete documentation.
- G. Test equipment of proper type, capacity, range, and accuracy shall be supplied by the Contractor to perform required tests and inspections.
- H. Test equipment used shall be in good working order and properly calibrated within 6 months of the date of the tests. This equipment shall display a sticker indicating its calibration date and the agency that performed the calibration.
 - 1. Calibration of each instrument shall be certified by a recognized testing facility. Instruments with out-of-date calibrations will be considered non-certified. Tests conducted with non-certified instruments will be rejected.
- I. In the event that the system does not meet requirements, necessary corrections and retesting shall be made by the Contractor. The Contractor shall successfully complete all tests and inspections possible prior to performing final in-service tests.
- J. Work shall include all necessary disconnecting and reconnecting in order to perform the specified tests.
- K. Signal systems test work specified elsewhere in these Specifications shall be construed as related to and inclusive with the testing described herein.
- L. Field tests shall be coordinated with the Engineer. As many tests and inspections as possible shall be completed prior to the final cutover to avoid train delay, inconvenience to the travel public, and cost to the Owner. The Contractor shall place systems in-service in phases where possible, thus reducing the actual cutover period.
- M. Tests shall ensure conformance with CFR 49, Parts 234 and 236, and shall be recorded on forms provided by the Engineer and signed by the Contractor's Signal Engineer directing each test and inspection.
- N. Tests and inspections shall conform to the PCJPB's Test and Maintenance Manual. Three copies of this Manual will be provided to the Contractor at the Pre-Construction meeting. Refer to Section 01200, Meetings. The Contractor shall request guidance from the Engineer where the test and inspection requirements written herein conflict with the PCJPB's Test and Maintenance Manual.
- O. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with signal lamps will not be allowed in pre-testing. An exception may be authorized by the PCJPB Signal Manager or PCJPB Signal Engineer where a signal or switch

machine is in service and will be reconfigured for final cutover, or cannot be installed or wired until final cutover.

- P. An appropriate meter shall be used when testing circuits. Visual observation of a relay is only valid when coil voltage or current or contact voltage, as applicable, is also measured.
- Q. Test and inspection procedures shall be subject to the PCJPB Signal Manager or PCJPB Signal Engineer's acceptance and shall comply with all regulatory requirements and the manufacturer's recommended test procedure.
- R. Notify the Engineer in writing at least 48 hours prior to each field test. No part of the signal system shall be placed in service without an authorized representative of the Engineer being present and witnessing the in-service tests.

1.04 SUBMITTALS

- A. Submit the following pre-test information to the Engineer for acceptance:
 - 1. Submit a Pre-testing authorization request 15 days in advance of proposed pre-testing. Such request shall include:
 - a. Names of Contractor's Signal Engineer in charge of pre-testing.
 - b. Other personnel assigned to the pre-test who will be performing the tests or assisting with the tests.
 - c. List the assigned location(s) of the Contractor's personnel and their designated duties during the pre-test.
 - d. An outline of the tests to be performed on each type of component, unit, or system, together with samples of the corresponding test records. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit. In addition, the date and time will be shown for each test.
 - e. Description of each test to be performed, including the operating parameter to be tested. Test equipment to be used for the test, including the model number, serial number, calibration period, last calibration date and a brief description of the purpose of the test equipment.
 - f. Description of equipment to be used for communication purposes.
 - 2. Schedule of pre-testing Contractor proposes to perform which includes beginning and ending dates, times, and locations in a time-line format.
 - 3. Identify any test or operation that may disrupt or disarrange the existing signal circuits or systems. Include description of proposed safety provisions and back-up contingency plans.

- B. Submit the following in-service testing information to the Engineer for acceptance:
1. Submit, 30 days in advance of any in-service testing, a detailed cutover and in-service test procedure. This procedure shall indicate the Contractor's personnel involved, their assigned location, and responsibility during the in-service testing. Include the following for Contractor-directed signal cutovers (the following does not apply to Owner-directed signal cutovers): The test procedure shall adequately reflect the test to be performed and the sequence in which the tests shall be performed. A signal aspect chart indicating the appropriate signal aspect to be displayed as train simulation tests are made shall be included. The signal aspect chart shall indicate the progressive down grading of signals and track codes and shall reflect the resulting signal aspect displayed as a result of a light-out condition.
 2. The test procedure shall include an outline of the tests to be performed on each type of component, unit, or system, together with corresponding samples of test record forms and cards. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit; the numbers of each type of component or unit to be tested to demonstrate adequacy of design and quality control; and a line diagram showing the grouping and sequencing of system and subsystem
- C. Contractor's testing procedures and cut-over plan must pass the PCJPB Signal Manager or PCJPB Signal Engineer's and the Operating Railroads review. Contractor shall allow 30 days for this approval process.
- D. Record the results of each test, as herein specified, and submit copies of the field test reports to the Engineer immediately at the completion of the cut-over testing. Prepare final type-written test reports as indicated herein and submit to the Engineer within five (5) days after the completion of each test. Final Type-written test reports shall include complete details of the test results and corrections or adjustments performed or which remain to be completed. The type-written test reports shall be signed and dated by the Contractor's responsible employee. Furnish certified test results for tests performed by any subcontractors, when such tests are required within these Specifications.
- E. Where required in this Section, submit test results on completed PCJPB test record forms.
- F. Submit test reports for any additional tests required by the Contractor to ensure the safe operation of the system to the Engineer.
- G. Upon completion of all tests, submit a letter certifying that all tests necessary to comply with all current regulatory requirements of these specifications have been performed.

1.05 QUALITY ASSURANCE

- A. The Work and testing shall comply with the following standards and regulatory requirements: AREMA Communications and Signals Manual, Part 2.4.1. and CFR, Title 49, Parts 234 and 236. When following the recommendations of the AREMA

C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

PART 2 – PRODUCTS

2.01 SITE TEST INSTRUMENTS AND EQUIPMENT

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

2.02 TEMPORARY TEST MATERIALS

- A. Temporary or interim test related materials, special tools, connections, jumpers, and similar items shall be furnished and available not less than one week in advance of the test need.

2.03 FACTORY TESTS AND INSPECTIONS

- A. All wiring and equipment shall be checked to verify conformance to the Contract Drawings and the Specifications.
- B. Each control point, intermediate signal, grade crossing warning system shelter or any other signal equipment shelter shall be tested to verify that it functions properly before it is shipped to the field for installation. These tests shall involve connecting all control systems (excluding signals, switches, and similar equipment) that make up a control point, intermediate signal, grade crossing warning system shelter, or any other signal equipment shelter; applying power; and then exercising each function of the system and verify proper result.
- C. Confirmation shall be provided by the Contractor that all required factory tests of Systems, sub-systems, assemblies, sub-assemblies and components supplied under this Contract have been performed. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated. Certified test reports shall be furnished.

PART 3 - EXECUTION

3.01 FIELD TEST PROCEDURES

- A. Perform as many pre-tests as possible in advance of in-service testing. Include, at a minimum, the adjustment of tunable joint couplers, microprocessor based coded track circuits, verify signal aspects against received and transmitted codes. Verify operation of, calibrate grade crossing prediction units, and adjust grade crossing signal control equipment as required to assure proper operation. In order to have a successful cut-over, it is essential that as much pre-testing and advance wiring be completed on the Main tracks before in-service testing begins.
 - 1. Condition precedent for in-service testing and cut-over will be the completion of pre-testing and the PCJPB Signal Manager or PCJPB Signal Engineer's

acceptance of the results. Complete pre-testing and submit the results to the Engineer not less than one (1) week prior to the proposed cut-over date.

- B. The field tests performed shall cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.
- C. Demonstrate the quality of installation by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection, and any other tests required by these Specifications. Perform these tests prior to any operational testing of systems or subsystems.
- D. The Contractor's test procedures shall consist of preprinted data sheets or inspection forms. Where applicable, results of test results shall be recorded on PCJPB forms. These forms will be provided by the Engineer. When completed by the field test personnel and checked for accuracy and completeness, submit the sheet as the test report.
- E. When tests require specific meter or test instrument readings, the preprinted data sheet shall show the allowable range of values, for each part of the test. The test report shall also contain a check off system for each action and a blank space adjacent to the expected value in which to record the test readings.
- F. All test reports shall be dated and signed by the responsible employee of the Contractor or subcontractor on the day the test is performed. Space also shall be provided for the signature of the witnessing inspector.
- G. The report shall show the specific test instruments used on each test, with instruments identified by name, type, serial number, calibration date, and calibration due date.
- H. Should an error be discovered during field testing due to field wiring and connections that do not agree with the accepted circuit plans, the Contractor may correct such errors without prior acceptance of the Engineer. The Contractor shall not, however, make any changes that deviate from the Contract Drawings without prior written acceptance of the Engineer.
- I. The Engineer will make all final determinations as to whether only a part, or the whole test, shall be rerun when any specific field test does not meet the requirements specified for the test.
- J. Any changes made after completion of test procedure shall be re-tested in accordance with the applicable test procedure and regulatory requirement.

3.02 GENERAL FIELD TESTS AND INSPECTION

- A. Perform general field tests including the tests listed herein.
- B. Ground verification test.
- C. Dielectric Breakdown test of all vital circuitry.

- D. Wiring verification of all non-vital circuitry.
- E. Vital function tests.
- F. Operating tests.
- G. All applicable tests prescribed by AREMA C&S Manual Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these Specifications
- H. All applicable tests as required to ensure systems comply with CFR 49, Parts 234 and 236.

3.03 SPECIFIC FIELD TESTS AND INSPECTION

- A. Perform specific field tests listed herein.
- B. Grounds:
 - 1. Ground resistance shall be tested and reported as described in Section 18450.
 - 2. All low voltage dc circuits shall be tested to verify that they are free of grounds.
 - 3. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.
- C. Insulation Resistance:
 - 1. Insulation resistance tests shall be made between all conductors and ground, and between conductors in each cable in accordance with FRA rule 236.108. The insulation resistance of wires and cables installed by the Contractor shall provide an "infinite" reading when using a direct reading instrument (megger) having a self-contained source of direct current test voltage. The megger scale shall have a minimum range of zero to 20 megohms and be rated at 250 volts minimum and 650 volts maximum.
 - 2. All insulation tests shall be performed after the equipment and cables are installed in the field.
 - 3. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.
- D. Vital Relays:
 - 1. All dc vital relays shall be tested for pick-up and drop-away values. These values shall be in accordance with field requirement values stated in Table I of AREMA C&S manual, Part 6.4.1.

2. Contractor shall perform all tests required to complete the appropriate PCJPB form.
 3. These tests shall be performed at the shelter locations after the shelter has been set.
 4. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.
- E. Energy Distribution: Energy-Off Tests: With all power to the signal instrument shelter or wayside case off, the following checks and tests shall be performed. These tests shall include:
1. Removing all fuses.
 2. Verifying that circuit breaker size compares to that of Contract Drawings.
 3. Comparing wire gages with those called for on the Contract Drawings. All discrepancies in wire sizes shall be replaced with the proper size wire.
 4. During energy distribution breakdown, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the Contract Drawings is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected and additional wires, if found, shall be removed.
 5. Verify proper system voltage for each power supply, ac and dc.
 6. Verify all power supplies for correct setting quantities.
 7. Verify that no cross, shorts, or grounds exist.
 8. Tags shall be verified for proper nomenclature and terminal location.
- F. Breakdown of Control Circuits:
1. All circuits shall be tested in their entirety for the correct operation of and response to each contact on each circuit element, such as relays and contactors. Where parallel paths exist, the tests shall validate each path, and circuits shall be opened when required to ensure the proper test.
 2. Each circuit shall be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and accepted plans.
- G. Electric Switch and Lock Movements (when applicable):
1. Continuity checks of field wires to switch-and-lock movements to verify all nomenclature.

2. Adjust throw bar so that proper tension is placed on switch points in both directions.
 3. Manually operate switch machine normal and adjust lock rods and point detector rods to allow switch machine to lock up with no obstruction. Repeat above for switch machine in reverse position.
 4. Turn on switch machine power, call switch machine normal and observe in field that switch machine corresponds to position called, and observe in wayside instrument shelter that proper switch correspondence relay is energized.
 5. With switch machine called normal, check gaps on circuit controller contacts to see that they meet equipment specifications. Operate machine reverse and repeat.
 6. Break down each contact in switch circuit controller and observe that proper switch correspondence relay drops. Repeat this procedure for both positions of the switch.
 7. Place ammeter in series with motor control energy and adjust clutch such that it causes overload relay to pick up in less than ten seconds with 1/4-inch obstruction in switch point. Record current reading. Repeat for opposite position.
 8. Place switch and lock movement in "hand" operation and observe switch mechanism cannot be operated by power. Place back in "motor" and verify that switch mechanism can be powered.
 9. Operate switch, then shunt detector track circuit and observe that switch machine is stopped in middle of stroke and not allowed to complete movement. Remove shunt and verify switch completes movement.
 10. Contractor shall record test results on the appropriate PCJPB form and submit this completed form the Engineer in order to obtain acceptance of this test requirement.
- H. Signal Layouts: Tests shall be performed on all signal layouts. These tests shall include the following:
1. Continuity check of field wires and verification of all nomenclature.
 2. Apply energy to signal lighting circuits and adjust all lamp voltages to 10 percent less than the lamp rating.
 3. Sight signals for maximum visibility.
 4. Check that light-out feature, where used, complies with FRA Rule 236.23(f).
- I. Line Circuits: The purpose of this test procedure shall be to verify the integrity of line circuits between wayside instrument locations. These tests shall include the following:

1. All nomenclature shall be verified and line circuits tested for continuity.
 2. Each repeater relay shall be tested to determine that it follows all the proper track relays de-energized in the signal shelters.
- J. Control Office to Wayside Interface (when applicable): Upon completion of the wayside tests, a system test shall be performed to ensure continuity of operation of wayside equipment by the supervisory control system. This test shall consist of controlling all office wayside functions from the supervisory control console, and the transmission back to the control office of all indications from the field stations. The functions to be tested shall include the following:
1. Controls from Supervisory Control Console
 - a. Control of switch machines.
 - b. Lining of routes.
 2. Indications to Supervisory Control Console
 - a. Switch machine positions
 - b. Track circuit occupancy.
 - c. Signal indications.
 - d. Power-off and alarm indications.
 3. All design changes found necessary to obtain proper operation shall be submitted to the PCJPB Signal Manager or PCJPB Signal Engineer for acceptance.
- K. Local Panel Test (when applicable):
1. Verify proper operation of all controls and indications.
- L. Switch Circuit Controllers (when applicable):
1. Each switch circuit controller shall be tested to verify wiring, mechanical connectors, point obstruction, and point detection in accordance with AREMA C&S Manual, Part 12.5.1.
 2. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.
- M. Track Circuits:
1. Each track circuit shall be tested for shunting sensitivity and polarity in accordance with the AREMA C&S Manual, Part 8.6.1.

- N. Insulated joints:
 - 1. Each insulated joint installed by the Contractor shall be tested with S&C Model 324 Track Circuit Short Finder, or Engineer accepted equal, and shall measure no less than 100 ohms across the joint.

- O. Interlocking and Control Point Tests (when applicable):
 - 1. A detailed list of the tests and complete test procedures shall be provided by the Engineer to establish safe and proper operation of interlockings. The Contractor shall provide the necessary personnel and equipment, along with support functions, as part of the Signal Test Crew. The test sequence shall be designed to test each function for correct performance, in accordance with these Specifications and the accepted plans. Furthermore, the test sequence shall include simulated unusual conditions to determine that the interlocking circuits will respond in a safe and desirable way.

 - 2. The functions to be tested shall include the following:
 - a. Time locking
 - b. Route locking
 - c. Verification of timing of time releases
 - d. Indication locking
 - e. Signal operation in accordance with route and aspect charts
 - f. Interconnection with existing block signal systems
 - g. Interconnection with existing interlockings. With an established direction of traffic, the controlled signal governing entrance to that particular route shall be put to stop. Traffic in the opposite direction shall not be established until a predetermined time has passed. This predetermined time shall be as indicated on the accepted plans. It shall be ascertained that time locking is effective for this test.

 - 3. Time tests shall be as follows:
 - a. Loss of shunt
 - b. Time locking
 - c. Flashing rate time

 - 4. Contractor shall record test results on the appropriate PCJPB forms. Submit these completed forms to the Engineer in order to obtain acceptance of these test requirements.

END OF SECTION

SECTION 18700

HIGHWAY GRADE CROSSING WARNING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for highway grade crossing warning systems.
- B. Where shown on the Contract Drawings or as required to accommodate associated other work of the Contract, make modifications to the existing highway grade crossing warning systems including such work as replacing, rewiring, or relocating of existing equipment or providing new control equipment and trackside equipment.
- C. Provide continuous operation of the highway grade crossing warning systems in preparation for, and during, track installation and rehabilitation work.

1.02 REFERENCE STANDARDS

- A. American Railway Engineering and Maintenance of Way Association (AREMA):
 - 1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.
- B. Code of Federal Regulations (CFR), Title 49, Transportation:
 - 1. Part 234 Grade Crossing Signal System Safety
 - 2. Part 236 Rules, Standards, and Instructions for Railroad Signal System
- C. General Orders (G.O.) of the State of California Public Utilities Commission (CPUC) shall apply:
 - 1. G.O. 75D: Protection of Crossing at Grade of Roads, Highways, and Streets with Railroads

1.03 SYSTEM DESCRIPTION

- A. Furnish and install new train detection equipment, wideband shunts, narrowband shunts, tuned joint couplers, dummy loads, shunt housings, insulated joints, and track connections for designated existing crossings.
- B. Provide continuous highway grade crossing warning during all phases of rail construction. Refer to Section 01011, Work Planning. At no time shall the work of the Contractor cause delay to train operation, cause an unsafe signaling condition to exist, or reduce the effectiveness or quality of the existing or new grade crossing warning systems.

- C. Provide rail bonding for new or modified rail joints or turnouts as shown on the Contract Drawings. Provide rail bonding, as necessary, to maintain existing systems during construction.
- D. Protect existing signaling cabling and, where necessary, relocate existing cabling in order to prevent damage to the cabling during track installation, profiling, or grade crossing work.
- E. Record the final as-built conditions of the crossing warning system for each crossing.
- F. Perform and document all tests and inspections in accordance with CFR 49 regulations and these specifications.

1.04 SUBMITTALS

- A. Provide submittals for highway grade crossing devices, equipment, systems, assemblies, and detailed design in accordance with the requirements of Section 18000, General Signaling Requirements.
 - 1. Submit, for approval by the Engineer, proposed plan for providing alternate methods of crossing warning during cutover and whenever the existing automatic crossing warning devices are deactivated, altered, or modified in order to accommodate construction work. Alternate methods shall conform to applicable parts of CFR, Title 49, including Part 234, and local ordinances.
 - 2. Alternative Foundation Design: If the Contractor proposes foundations different from those shown on the Contract Drawings, submit drawings of the type of foundations, including size and details of the galvanized anchor bolts, nuts, and washers the Engineer's approval. Include structural calculations with loadings and wind shear parameters. The Contractor's alternate final design drawings and calculations shall be approved and stamped by a professional engineer registered in California.
- B. Detailed Work Plan: The following work plan shall be coordinated with and integrated with submittals made under Section 01011, Work Planning. Submit a detailed work plan, for approval and coordination by the Engineer, prior to making the changeover from the existing crossing warning system to the new crossing warning system. The Contractor's proposed plan shall detail the amount of time the warning system will be out-of-service and the substitute warning which will be provided to allow normal railroad operations to be maintained. Change over of control, testing, and temporary-warning procedures shall be coordinated with the Engineer.
- C. Submit for approval of the Engineer a procedure plan for conducting quality assurance, component integrity, circuit continuity, circuit breakdown, and system operation tests.
- D. Submit product data for products furnished under this Section.

- E. Submit documentation of acceptance testing.
- F. Submit test reports.

1.05 DELIVERY, HANDLING, AND STORAGE

- A. Package printed circuit cards separate from the constant warning time (CWT) units and all other electronic components with removable cards for shipment to the field. Protect each CWT unit and printed circuit card from damage or loss during handling and shipment.
- B. Protect precast concrete foundation units during handling to avoid damage in transit and at storage locations. Support, cushion, and stack to protect the edges of the units. Replace chipped, cracked, or damaged units.

1.06 SPARE PARTS AND SPECIAL TOOLS

- A. Refer to Section 01600, Materials, for general requirements for spare parts. Furnish for spare parts a constant warning type (CWT) crossing train detection equipment cabinet complete with modules for a two-track operation, associated surge panels, and programming keypad.

PART 2 – PRODUCTS

2.01 EQUIPMENT - GENERAL

- A. Furnish materials and equipment for installation and for interconnection of the highway crossing warning as indicated on the Contract Drawings and specified herein. Materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. Signaling materials and equipment shall be of a type and model that are in standard operation on major railway systems.
- B. Only those existing materials and equipment specifically identified on the Contract Drawings for re-use, relocation, or modification shall be incorporated in the highway grade crossing warning systems. Materials and equipment shall conform to the provisions of AREMA Signal Manual, except as modified in this Section.
- C. Furnish trackside equipment, such as tuned joint couplers, narrow band shunts, and wideband shunts, as shown on the Contract Drawings. Furnish equipment shelters, predictors, track filters, chokes, and other equipment as shown on the Contract Drawings and as required for complete installation.
- D. Refer to Section 01600, Materials, for lists of Owner-furnished equipment. Conduct and document acceptance testing of all components prior to transporting them from Owner-designated storage location.

2.02 ELECTRICAL AND ELECTRONIC COMPONENTS - GENERAL

- A. Design fusing and furnish fuses and printed circuit cards, connectors, and files in accordance with Section 18000, General Signaling Requirements.

2.03 CROSSING WARNING TRAIN DETECTION EQUIPMENT

- A. Furnish constant warning time (CWT) type crossing train detection equipment, terminating shunts, surge panels, and arresters for the crossing configurations shown on the Contract Drawings.
- B. Furnish each CWT unit complete with the basic complement of printed circuit cards and additional circuit card(s) for functions such as upstream detection, downstream detection, preemption initiation, event recording, and the like, as shown on the Contract Drawings.
- C. Make CWT unit audio frequency assignments following manufacturers' application guidelines with special attention being paid to frequency versus approach length and placement of adjacent channel narrow band termination shunts. Acceptable primary frequencies in Hz are 86, 114, 156, 211, 285, 348, 430, 525, 645, 790, and 970. Constant warning time systems shall include a high frequency, AFO track circuit for the island circuit. Acceptable island frequencies are 10.0, 11.5, 13.2, and 15.2 kHz or the Harmon (GETSGS) Random Signature Island frequency.
- D. Each highway grade crossing unit shall consist of a primary grade crossing CWT controller and a redundant standby grade crossing CWT controller. Provide an automatic transfer unit to transfer the approach control function from the primary CWT controller to the standby CWT controller in event of the failure of the primary unit and back to the primary unit if the standby unit were to fail. House the automatic transfer unit in the same cabinet as the CWT normal and standby controller.
- E. Furnish constant warning time controller capable of detecting train movements on two separate track sections. Design CWT unit to allow selection of a different frequency for each track.
- F. Constant warning time crossing train detection equipment shall be GETSGS (Harmon Electronics') Model HXP-3R2 or equivalent. Termination shunts shall be the CWT manufacturer's recommended type shunt for the frequency and application used. Furnish multi-frequency selectable termination shunts.
- G. Furnish termination shunts, adjustable inductors, filters, code isolation units, and the like, as recommended by the CWT controller equipment manufacturer, as shown on the Contract Drawings.
- H. Provide solid-state vital "AND" gate or equal as shown on the Contract Drawings.
- I. The placement of the crossing approach start shunts shown on the Contract Drawings is based upon the maximum authorized train speed of 79 MPH and a crossing warning time of 25 seconds. Four seconds has been added to account for equipment reaction time. Additional time, if required to accommodate the individual crossings' unique characteristics or as required for traffic signal preemption requirements, shall be as specified in the Contract Documents. Take

necessary field measurements at the grade crossing and verify that the crossing warning time and shunt placement are valid for site conditions. Bring any discrepancies to the attention of the Engineer.

- J. Furnish data recorder with the CWT unit capable of recording train speed, warning time, time and date, adjacent and auxiliary crossing detection times, and equipment errors. The recorder shall be capable of furnishing a report with only warning time, train speed, and time and date information and a separate report that includes error data.

2.04 CROSSING WARNING GATES AND FLASHING LIGHTS

- A. Furnish each highway grade crossing warning device assembly complete with all associated hardware consisting of mast mounted gate mechanism, mast, junction box base, gate arm, flashing light unit(s), bell, signs, and miscellaneous hardware as shown on the Contract Drawings and as specified herein.
- B. The crossing gate warning device assembly shall conform to the requirements of CPUC GO No. 75D; CFR, Title 49, Part 234; and the recommendations of the relevant sub-parts of the AREMA C&S Manual Section 3.
- C. The gate mechanism housing shall be cast aluminum for mounting on a 5-inch diameter 16 feet aluminum pole and furnished complete with mounting brackets, counter-weight assembly, and counter-weights. Provide either single sided counter-weight brackets or double-sided counter-weight brackets as recommended by the manufacturer. Fit gate arm bracket with a breakaway arm adapter as shown in the AREMA C&S Manual, Part 3.2.21.
- D. The gate mechanism shall be of the power-up, power-down electro-mechanical type complete with internal relay and adjustable snubbing resistor. .
- E. Furnish gate arms lengths required per PCJPB signal standards and site conditions. Arms shall be of the aluminum with fiberglass extensions and fiberglass tip type. Gate arm lamps shall be 4-inch diameter conforming to the recommendations of AREMA C&S Manual, Part 3.2.40 except that LED lamps shall be used. Provide high intensity lamps when shown on the Contract Drawings. Fit lamp wiring harness with a five wire pull-apart connector for interconnection to the gate mechanism and securely fasten to the gate arm.
- F. Provide gate arm wind guards conforming to AREMA C&S Manual Part 3.2.22 with each gate assembly.
- G. Provide flashing light crossing signal units as shown on the Contract Drawings. Light units shall have 12-inch roundels with LED's and be complete with steel backgrounds, steel hoods, junction box, and cross-arm brackets.
- H. Provide a crossing warning bell conforming to the recommendations of AREMA C&S Manual, Part 3.2.61 with each gate assembly, except that the bell shall be mounted on the cantilever structure when a cantilever is shown.
- I. Railroad crossing signs, multiple track signs, and the like, shall be extruded aluminum, reflex-reflective sheet type as recommended in the AREMA C&S

Manual Parts, 3.2.70 and 3.2.75, respectively. Provide signs complete with all hardware for mounting on 5-inch mast or on a cantilever mast. All highway grade crossings shall conform to CPUC required signage.

2.05 FOUNDATIONS

- A. Provide foundations for wayside equipment cases, highway grade crossing gates, flashers, and cantilevers as specified herein.
- B. Precast or cast-in-place reinforced concrete foundations shall be monolithic or sectional construction and shall conform to the requirements for concrete work as specified in Sections 03300, Cast-in-Place Concrete, and 03400, Precast Concrete Structures.
- C. Provide precast concrete foundations complete with anchor bolts, nuts, and washers in accordance with the recommendations of AREMA C&S Manual, Part 14.4.
- D. All galvanized steel foundations to be furnished and installed shall be complete with Section 18360, Signal Systems Miscellaneous Products, and the recommendations of AREMA C&S Manual, Part 15.3.1.
- E. Galvanized steel foundations shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4 inch steel plate.
- F. Bolts, nuts, and washers shall be galvanized. Nuts and threads shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.6.20. Plain washers shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.6.21. Steel shall be in accordance with the recommendations of AREMA C&S Manual, Part 15.1.4, Section 1. Bolts shall be of sufficient length to provide for leveling of the device.
- G. Place a conduit with a minimum 3-inch inside diameter in cast-in-place cantilever structure foundations for routing of cables to the cantilever junction box. The conduit shall protrude from the foundation sufficiently to enter cantilever structure ensuring cable is not exposed.

2.06 HARDWARE

- A. Furnish hardware in accordance with Section 18360, Signal Systems Miscellaneous Products.

2.07 CONDUIT

- A. Conduit shall conform to the specifications in Section 18360, Signal Systems Miscellaneous Products.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install and adjust equipment and materials in accordance with the appropriate requirements and recommendations of the equipment manufacturer, in conformance with the recommendations of the applicable parts of the AREMA C&S Manual; as required by CFR 49, Parts 234 and 236; applicable CPUC regulations; or as otherwise specified herein.
- B. Where existing Grade Crossing Warning System Shelters and gate assemblies are indicated to be relocated, remove, protect, transport, store, disassemble, re-configure where necessary, reassemble and reinstall as shown in the Contract Drawings.

3.02 INSULATED JOINTS

- A. Install insulated joints as specified in Section 20120, Track Appurtenances and Other Track Materials. Test each insulated joint in accordance with the requirements of the AREMA C&S Manual, Part 8.6.35, and per bonded joint and insulated joint section.

3.03 RAIL BONDING

- A. Install new, or maintain existing, and test rail bonding for electrical continuity as required for continuous train detection within the approach limits of the crossings.
- B. Double bond frog assemblies, switch points, and rail joints as specified in Section 18400, Rail Bonding, with the type of bonds specified in Section 18400, Rail Bonding.
- C. Make signal connection to rails using weld type track circuit connectors per PCJPB standards.

3.04 CROSSING WARNING SYSTEM

- A. Install, connect, and test new equipment and cabling to the greatest extent practicable without disruption of the existing highway grade crossing or signal systems.

3.05 TRACK CIRCUITS

- A. Install and adjust all track circuits in accordance with the requirements of CFR49, Parts 234 and 236, the recommendations of AREMA C&S Manual, Parts 8.6.1, and as specified herein.
- B. Make all track circuit rail connections using weld type connectors.
- C. Adjust each track circuit for a detection sensitivity of 0.06 ohm throughout the length of the track circuit, including within the shunt fouling limits of turnouts.

- D. Record voltage and current measurements at both feed and receive ends of each track circuit in a format approved by the Engineer.

3.06 HIGHWAY GRADE CROSSING EQUIPMENT

- A. Install grade crossing warning equipment in conformance with CFR, Title 49 Part 234; CPUC G.O. 75D; approved submittals; and as shown on the Contract Drawings.
- B. The final voltage adjustment and alignment of the flashing light units and final balancing of the gate arms shall be made at the time of the functional test. Final adjustments and alignments shall be made in conformance with the requirements of CFR 49 Part 234 and the recommendations of the AREMA C&S Manual, Parts 3.3.1 and 3.3.5 and.
- C. Provide new cabling between the wayside gate/flasher and the crossing control shelter except where the Contract Drawings specifically specify the re-use of the existing cabling.
- D. Install Owner-furnished/Contractor -furnished pedestrian gates in accordance with the Contract Drawings and installation instructions furnished by the Engineer.

3.07 FOUNDATIONS

- A. Excavate, backfill, compact, and clean-up excavation as specified in Section 02300, Earthwork.
- B. Install each foundation in accordance with the approved installation detail for each type of foundation and as specified herein. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation. The installation tasks that must be completed by the Contractor are included herein.
- C. Prior to placing precast foundation or constructing cast-in-place foundations, excavate completely to the lines and grades required and install crushed stone base in accordance with the requirements specified.
- D. Install foundations to the lines, grades, and dimensions required as determined by the Contractor and approved by the Engineer. Install mounting bolts of sufficient length to accommodate use of leveling nuts between the base of the mechanism and the top of the foundation.
- E. When placing foundations, ensure that anchor bolts have not been bent and that the threads are undamaged. Protect anchor bolt thread, washers, and nuts by applying friction tape, or other method approved by the Engineer, until such time as the wayside equipment is installed. Bring damaged anchor bolts to the immediate attention of the Engineer. Do not use damaged anchor bolts. Remove and replace damaged anchor bolts and completely or partially remove and replace foundation as determined by the Engineer.

- F. Refer to Section 03170, Concrete Finishing, for requirements for finishing formed surfaces, smooth rubbed finish. Exposed poured concrete foundations shall be rubbed to obtain a uniformly smooth, clean surface of even texture and appearance.
- G. Provide nonconductive material between the foundations and the mounted apparatus to prevent direct contact between the concrete and metal surfaces.

3.08 CONDUIT

- A. Install conduit where shown on the Contract Drawings and as specified herein.
- B. After conductors have been installed, seal ends of conduits terminating in instrument shelters, junction boxes, and equipment cases with an approved type of sealing compound.
- C. Bore or jack conduit under the existing trackbed at any traverse, except that conduit may be placed under the track prior to the track renewal.
- D. Place conduit to a minimum depth of 36 inches below finished grade except where specifically noted otherwise.

3.09 REMOVING, REINSTALLING AND SALVAGING EQUIPMENT

- A. Relocate, reuse, modify, and salvage existing equipment as shown on the Contract Drawings. Refer to Section 02100, Demolition, for salvage requirements. Inventory existing relays and controlling equipment prior to delivering to the Engineer's designated storage location.
 - 1. Newly re-wire any existing equipment designated to be reused except where noted on the Contract Drawings.
- B. Removed equipment and materials not designated for reuse or salvage shall become the property of the Contractor and disposed of. Refer to Section 02110, Site Clearing, for disposal requirements.
- C. Change existing crossing warning systems over to the new systems as expeditiously as practicable. Remove retired equipment immediately and keep work site kept free of debris and packaging materials.

3.10 FIELD QUALITY CONTROL

- A. Perform testing in accordance with Section 18600, Signal Systems Testing, including documentation requirements.
- B. Prepare test procedures and perform and document tests on the highway grade crossing components and systems as follows:
 - 1. Include all tests herein specified, as specified in the FRA Rules, Standards, Instructions for Railroad Signal Systems, CFR 49 Part 234 and 236 and the appropriate sections of the AREMA C&S Manual.

2. Perform pretests on all procedures in advance of actual testing.
 3. Perform applicable tests to each interim signal system, if any, before placing in service.
 4. Actual testing shall be witnessed by the Engineer.
- C. Make measurements at each piece of wayside equipment and record on the as-built record drawings verifying that the equipment is located where shown on the Contract Drawings and as approved by the Engineer. Verify, by measurement, that the equipment does not violate the train dynamic clearance envelope.
- D. Test each grade crossing warning installation in accordance with Section 18600, Signal Systems Testing, and the AREMA C&S Manual, Parts 3.3.1 and 3.3.5. In addition, perform all applicable tests as described in the PCJPB Signals and Communications Test and Maintenance Manual, all manufacturer's recommended test and adjustment procedures, and any tests required by regulation.
- E. Disconnect and ground associated signal equipment not under test. Disconnect or unplug electronic devices or signal equipment prior to any testing.
- F. Follow manufacturer's instructions for testing of operation and electronic equipment.
- G. Submit test data and results to the Engineer's information and approval within 24 hours of placing the apparatus or system in operation.

END OF SECTION