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**Highway-Rail Grade Crossings**

<table>
<thead>
<tr>
<th>SECTION NO.</th>
<th>TITLE</th>
<th>PAGES</th>
<th>REVISION DATE</th>
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<td>34 71 50</td>
<td>Highway-Rail Grade Crossings</td>
<td>9</td>
<td>05.08.2016</td>
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**Track Construction**

<table>
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<tr>
<th>SECTION NO.</th>
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<tr>
<td>34 72 00</td>
<td>Trackwork</td>
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<tr>
<td>34 72 20</td>
<td>Track Shifting, Relocation and Resurfacing</td>
<td>8</td>
<td>01.07.2013</td>
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<tr>
<td>34 72 30</td>
<td>Field Welding Rail</td>
<td>7</td>
<td>08.18.2016</td>
</tr>
<tr>
<td>34 72 40</td>
<td>Track Collector Pan System</td>
<td>4</td>
<td>01.07.2013</td>
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**Railroad Bridges**

<table>
<thead>
<tr>
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<th>TITLE</th>
<th>PAGES</th>
<th>REVISION DATE</th>
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<td>Stone Revetment (Riprap)</td>
<td>9</td>
<td>05.08.2016</td>
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<td>34 80 21</td>
<td>Piling</td>
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<td>01.07.2013</td>
</tr>
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<td>34 80 22</td>
<td>Cast-In-Drilled Hole (CIDH) Piles</td>
<td>27</td>
<td>01.07.2013</td>
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<tr>
<td>34 80 23</td>
<td>Subdrainage System for Railroad Bridges and Retaining Walls</td>
<td>8</td>
<td>01.07.2013</td>
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<tr>
<td>34 80 31</td>
<td>Bridge Deck Drainage System</td>
<td>5</td>
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<tr>
<td>34 80 32</td>
<td>Adhered Elastomeric Waterproofing for Railroad Bridges</td>
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<td>01.07.2013</td>
</tr>
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<td>Hot Mix Asphalt (HMA) for Bridges</td>
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<td>Precast and Prestressed Concrete for Bridges</td>
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<td>Metal Fabrications for Railroad Bridges</td>
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</tr>
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<td>34 80 61</td>
<td>Painting and Protective Coating for Bridges</td>
<td>25</td>
<td>01.07.2013</td>
</tr>
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</table>
SECTION SS 34 11 10
CONTINUOUS WELDED RAIL (CWR)

PART 1 – GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for the Continuous Welded Rail (CWR) to be furnished in accordance with Contract Documents or required by the Engineer.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):
   1. Manual for Railway Engineering
   2. Portfolio of Trackwork Plans
   3. Specifications for Special Trackwork

B. Association of American Railroads (AAR)
   1. AAR: Manual of Standards and Rec. Practices
   2. AAR Section J: Quality Assurance M-1003

C. American Society for Testing and Materials (ASTM):
   1. ASTM E10: Test Method for Brinell Hardness of Metallic Materials
   2. ASTM E94: Recommended Practice for Radiographic Testing
   3. ASTM E164: Standard Practice for Ultrasonic Contact Examination of Weldments

D. American Welding Society (AWS):
   1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
   2. AWS D1.1: Structural Welding Code

E. SCRRA: Engineering Standards.
1.03 DEFINITIONS

A. Detail Fractures – A progressive fracture originating near the rail surface from a shell or head check

B. Rail Wear – The change in shape of the cross-sectional area of the rail head due to the passage of rail traffic and grinding

C. Shelling – A rail condition consisting of one or more horizontal separation that may originate in the rail head and may crack out at the gage side of the rail. Shelling normally originates towards the gage side of the rail head and extends longitudinally

D. Spalling – A rail surface condition that is the direct result of micro-cracking, often with material separating from the surface of the rail head.

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the CWR have been placed in service.

B. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing CWR to Class 1 Freight, passenger or commuter railroads.

C. The Vendor shall submit for SCRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality CWR included in the Schedule of Quantities and Prices.

D. The Vendor shall submit certification that materials delivered to site are in conformance with specifications. For CWR, include weld test results. Include all material testing results and submittals stipulated in the AREMA Manual.

E. Prior to the start of welding, submit a schedule of lengths of CWR strings to be fabricated and the location of each string in the delivery train.

F. The Vendor shall submit drawings and specifications of the proposed equipment, materials, methods and procedures to be used for the electric flash butt welding process for joining of rail. Include layouts of the welding line showing locations of welding components.

G. The Vendor shall submit procedure for transportation of CWR to site, unloading and handling.

H. The Vendor shall submit qualifications of welding supervisor demonstrating flash butt welding experience of no less than three years.
1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.

B. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

C. Testing and inspection of CWR manufacture shall be performed by Vendor in conformance with AREMA Manual.

D. Material not meeting the requirements of this Specification shall not be used.

E. SCRRA shall have access to Vendor’s plant during normal working hours and all Project related procurement and production records for inspection any time during the Contract period of performance.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Vendor shall load, transport, and deliver CWR in a manner which will prevent damage to the CWR. Vendor shall submit to SCRRA the procedures and equipment information for loading, unloading, handling, and storing rail.

B. SCRRA will review the Vendor’s methods and procedures for unloading and handling continuous welded rail.

C. The material will be supplied to the SCRRA in accordance with the delivery requirements. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA. The delivery must be coordinated with SCRRA prior to shipping and loading. Orders can be combined and shipped on or before the delivery scheduled with approval by SCRRA. Delivery time and minimum quantities shall be as follows:

F. Delivery delays due to Rail Train (carrier) unavailability are excusable when the Vendor has made a best efforts attempt to schedule a carrier, and these best efforts, at minimum included 14 days advance communication with at least three carriers. Documentation of these best efforts and approval is required by SCRRA.

PART 2 – PRODUCTS

2.01 CWR

A. Rail shall be new 136 RE CWR (continuous welded rail) Head Hardened rail conforming to AREMA Volume 1, Chapter 4, Section 2.1, Specifications for Steel Rails. The rail shall be controlled cooled low alloy high strength rail, Grade HH (Head Hardened) or LH (Low Alloy Head Hardened) and shall meet or exceed
370 HB (Brinell Hardness).

B. If the Vendor furnished CWR are in sections of strings, CWR shall be manufactured on-site by welding rail sections in nominal 80 feet length into 1,400 feet strings.

2.02 SOURCE QUALITY CONTROL

A. Rail and welds shall be ultrasonically tested as per AREMA Section 2.1.8.

B. Surface and internal hardness shall be determined as per AREMA Section 2.1.3.

C. Perform ultrasonic testing on all welds in accordance with ASTM E164.

D. For fabrication of CWR, flash butt production welds shall be tested by an inspection agency approved by the SCRRA during the fabrication process using the dry powder method of magnetic particle inspection (or ultrasonic method) in accordance with ASTM E709 and the AREMA Manual of Railway Engineering, Chapter 4.

2.03 SPECIFICATIONS, SECTION, AND STANDARDS

A. Unless otherwise shown on the drawings or listed in the Schedule of Quantities and Prices, rail shall conform to the 136 RE section shown on SCRRA Engineering Standard ES 2301.

2.04 MANUFACTURE

A. Melting and Casting:

The steel for rails shall be made by purifying molten iron from the blast furnace (plus any added scrap steel) using the Basic Oxygen Steelmaking process, or by melting scrap steel using the Electric Arc Furnace Steelmaking process. The resulting molten steel from either process shall be cast into strands by a continuous casting process. Strands shall be cut into blooms of an appropriate length for further processing and rolling.

B. Hydrogen Elimination:

1. The rail shall be free from shatter cracks and other inclusions caused by hydrogen. Hydrogen elimination shall be accomplished by at least one of the following processes:
   
   a. Control Cooling of Rails (CC)
   b. Control Cooling of Blooms (BC)
   c. Vacuum Treated (VT)

2. Other processes (OP) for hydrogen and inclusion elimination in steel shall be accepted in the production of steel rail, and be approved by SCRRA.
3. When controlled cooling of rails is used for elimination of hydrogen, all rails shall be cooled on the hot beds or runways until full transformation is accomplished and then charged immediately into insulated cooling containers. In no case should the rail be charged into the containers at a temperature below 725 degrees F. The temperature of the rails before charging shall be determined at the head of the rail at least 12 inches from the end of the rail.

4. A cover shall be placed on the container immediately after completion of the charge and shall remain in place for at least 10 hours. The container shall be so protected and insulated that the control temperature shall not drop below 300 degrees F in 7 hours for rails 100 lbs. per yd. in weight or heavier from the time the bottom tier is placed in the container and 5 hours for rails of less than 100 lbs. per yd. in weight. The control temperature shall be established by measuring and recording the temperature of an outside rail or between an outside rail and the adjacent rail in the bottom tier of the container, at a location not less than 12 inches but not more than 36 inches from the rail end.

5. If the above cooling requirement is not met, the rails may be considered control-cooled, provided that the temperature at a location not less than 12 inches from the end of a rail at approximately the center of the middle tier does not drop below 300 degrees F in less than 15 hours.

6. After removal or raising of the lid of the container, no rail shall be removed until the temperature of the top layer of rails has fallen to 300 degrees F or lower. The manufacturer shall maintain a complete record of the cooling process for each container of rails.

2.05 CHEMICAL AND MATERIAL PROPERTIES

A. Chemical Composition:

The chemical composition of a rail steel grade must be within the limits given in Table 1 for standard chemistry rail steel. Rail steel with a high carbon content in a range from 0.9 to 1.1 percent by weight and chemistry similar to that disclosed in United States Patent No. 7,288,159 is also acceptable provided that rail rolled this specification has been in successful use for more than five years by a Class I railroad operating in North America.
Table 1: Product and Chemical Analysis Table for Standard Chemistry Rail Steel

<table>
<thead>
<tr>
<th>Elements</th>
<th>Notes</th>
<th>Chemical Analysis Weight Percent</th>
<th>Product Analysis, Weight Percent Allowance Beyond Limits of Specified Chemical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Carbon</td>
<td>1</td>
<td>0.740</td>
<td>0.860</td>
</tr>
<tr>
<td>Manganese</td>
<td></td>
<td>0.750</td>
<td>1.250</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>2</td>
<td></td>
<td>0.020</td>
</tr>
<tr>
<td>Sulfur</td>
<td>3</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td></td>
<td>0.100</td>
<td>0.600</td>
</tr>
<tr>
<td>Nickel</td>
<td></td>
<td></td>
<td>0.250</td>
</tr>
<tr>
<td>Chromium</td>
<td>1</td>
<td>0.300</td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td>Vanadium</td>
<td></td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: The chemical composition of head-hardened rails will be subject to the requirements of standard strength rails. Any alteration of the chemical composition may require modification of welding procedures.

Note 2: Up to 5% of the order may exceed 0.020, but in no case may the phosphorus exceed 0.025.

Note 3: Up to 5% of the order may exceed 0.020, but in no case may the sulfur exceed 0.025.

Note 4: Additional elements may be included in the chemistry and the chemical analysis when agreed upon by the purchaser and supplier.

B. Surface Hardness:

Rails furnished shall be high strength or high carbon pearlite. The minimum Brinell hardness of the surface shall be within the limits found in Table 2.

Table 2 – Rail Hardness Table for Standard Chemistry Rail Steel

<table>
<thead>
<tr>
<th>Type of Rail</th>
<th>Minimum Surface Brinell Hardness, HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Strength Rail</td>
<td>370</td>
</tr>
<tr>
<td>High Carbon Pearlite (Patent No. 7,288,159)</td>
<td>390</td>
</tr>
</tbody>
</table>

Note 3: If 410 HB is exceeded, the microstructure through the head shall be examined at 100X or higher for confirmation of a fully pearlitic microstructure in the head.

Note 4: No untampered martensite shall be present within the rail.

A fully pearlitic microstructure shall be maintained in the head of the rail for all ranges of rail chemistry and no un-tempered martensite may be present within the rail at any point of the rail section.

C. Tensile Properties:
The tensile properties of rails shall be produced within the limits found in Table 3 for a particular grade of rail steel.

### Table 3 – Tensile Properties Table for Standard Chemistry Rail Steel

<table>
<thead>
<tr>
<th>Description</th>
<th>High-Strength</th>
<th>High Carbon Pearlite (United States Patent No. 7,288,159)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Yield Strength</td>
<td>120,000 psi</td>
<td>120,000 psi</td>
</tr>
<tr>
<td>Minimum Tensile Strength</td>
<td>171,000 psi</td>
<td>174,000 psi</td>
</tr>
<tr>
<td>Minimum Elongation in 2 in.</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Note 1: Up to 5% of the order may be less than 10% elongation for high-strength rail, but in no case may the elongation be less than 9%

#### 2.06 ROLLING, CUTTING, AND PREPARING RAIL ENDS

A. Rolling:

The length of rails for welding into CWR strings shall be not less than 80 feet when corrected to a temperature of 60 degrees F. Not more than 10 percent of standard length rail of the total tonnage accepted from each individual rolling may be comprised of shorter lengths corresponding to 78, 74, 70, 66, 60, or 39 feet.

Individual rails not welded into CWR strings as part of the purchase shall be furnished to the length shown on the Schedule of Quantities and Prices. The allowance for 10 percent shorter lengths will not apply to individual rails ordered to a specific length.

B. Straightening:

Rails shall be straightened cold in a press or roller machine to remove twists, waves and kinks until they meet the surface and line requirements within the tolerances specified.

C. Drilling:

Rails to be welded into CWR strings shall be furnished undrilled (blank). Individual rails not welded into CWR strings shall be furnished to SCRRA undrilled but chamfered and finished on both ends in accordance with SCRRA Engineering Standard No. ES 2301.

#### 2.07 IDENTIFYING RAIL LENGTH AND TYPE

A. Rails shall be marked to identify the length and grade with colored paint or other identifying markings. Individual rails shall be paint-marked only one color according to grade or length. High-strength rails shall be marked by either a metal plate permanently attached to the neutral axis, hot stamped in the web, or
rolled in the brand. The marking shall give the manufacturer, type, and method of treatment.

B. Heat treated rail shall be paint-marked orange. Alloy rail shall be paint-marked aluminum color. Short rails (less than 80 feet) shall be paint-marked green. Rails meeting the tolerances for Special Trackwork shall be paint-marked white. The length of each rail shall be painted at the end of the rails in accordance with the standard practices of the manufacturer.

C. Rails not meeting the requirements of this specification but acceptable under another specification for use in low speed industry tracks shall be paint-marked yellow. Industrial quality rails shall also be permanently identified by cutting diagonally through every “RE” or other designation within the rolled branding of the rail. Each designation brand shall be ground or milled diagonally from the top right-hand corner to the bottom left-hand corner, a minimum of 1/4” in width and to within 0.010” of the parent rail web surface.

D. Rail Branding:

   Branding shall be rolled in raised characters on the side of the web of each rail at a minimum of every 16 feet. The design of the letters and numerals shall be determined by the manufacturer. The data and order of arrangement of the branding shall be as shown in the following typical brand:

<table>
<thead>
<tr>
<th>136</th>
<th>RE</th>
<th>Manufacturer</th>
<th>2003</th>
<th>Ill or 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Weight)</td>
<td>(Section)</td>
<td>(Mill Brand)</td>
<td>(Year Rolled)</td>
<td>(Month Rolled)</td>
</tr>
</tbody>
</table>

The method of Hydrogen Elimination shall be located in the brand when a Hydrogen Elimination method other than Vacuum Treated (VT) is used.

E. Rail Stamping:

1. The web of each rail shall be hot stamped a minimum of 3 times per rail (short rails must contain a minimum of one full stamp) on the side opposite the brand, except that stamping shall not occur within 2 feet of either end of rails.

2. Rails from continuous cast blooms shall be identified by a designation for heat number, strand number, and bloom number. The rail shall be identified by an alphabetical designation beginning with “P”, and succeeding “S”, “T”, “U”, etc., consecutively, or any other identification of the position of the rail within the cast, as agreed between the purchaser and manufacturer.

3. The data shall be shown in the following typical stamping, except that strand and bloom numbers may be joined or may be coded at the manufacturer’s option. The height of the letters and numerals shall be 5/8 inch.
### Table 4 – Example Stamping Markings

<table>
<thead>
<tr>
<th>Stamping Markings</th>
<th>297165</th>
<th>PSTU</th>
<th>12</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS, HH, LA, IH or LH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rail Type</strong></td>
<td>Heat Number</td>
<td>Rail Letter</td>
<td>Strand and Bloom Number</td>
<td>Method of Hydrogen Elimination, if indicated in stamping</td>
</tr>
<tr>
<td>SS = Standard Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HH = Head Hardened</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA = Low Alloy Standard Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IH = Low Alloy Intermediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LH = Low Alloy Head Hardened</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. The 5/8 inch stamped characters shall have a flat or radius face (0.040 inch to 0.060 inch wide) with bevels on each side so as not to produce metallurgical stress risers. The letters and numbers shall be rotated to a 10 degree angle from vertical and shall have rounded corners. No sharp corners are permitted. The stamping shall be between 0.020 inch and 0.060 inch in depth along the center of the web. The design shall be as shown in **Figure 1**.

![Design of Special Letters and Numbers for Rail Stamps](image)

**Figure 1 – Design of Special Letters and Numbers for Rail Stamps**

### 2.08 RAIL MANUFACTURE TESTING

A. Chemistry Testing:
1. Steel from each heat must be tested to ensure that the chemistry of the finished rail conforms to the limits shown in Table 1, or the limits for any permitted alternative chemistry rail steel. Separate analyses shall be made from test samples representing the front, middle (optional), and back of the heat taken during pouring of the heat. Determination of the chemical composition may be made chemically or spectrographically. Any portion of the heat meeting the chemical analysis requirements of Table 1 (below) may be applied.

2. Upon request by the purchaser, samples shall be furnished to verify the analysis. The analysis, most representative of the heat (clear of the transition zone for continuous cast steel), shall be recorded as the official heat analysis, but the purchaser shall have access to all chemical analysis determinations.

3. Rail heats shall be tested for hydrogen content using a sampling/analytical method or a direct measurement method. The testing shall be performed during the continuous casting process. Hydrogen content shall be recorded and available for review or reporting at the request of the purchaser. The producer shall define the method used to determine hydrogen content, which of the following methods are used for hydrogen removal, and present evidence of applicable procedures used to control the final rail hydrogen.

   a. Vacuum Degassing.
   b. Bloom Controlled Cooling.
   c. Rail Controlled Cooling.

4. Product analysis limits may be applied only in testing for chemical composition after the rail manufacturing process is completed and will not supersede chemical composition limits done for the same heats when the steel is in the molten state.

B. Tensile Strength Testing:

1. One longitudinal tension test specimen shall be taken from the gage corner of the rail head, centered ½ inch from the gage side and ½ inch from the running surface. The specimen shall be 0.5 inch diameter and shall be tested per ASTM A370, “Standard Test Methods and Definitions for Mechanical Testing of Steel Products.”

2. If any test specimen fails because of a malfunction of the test equipment or a flaw in the specimen, it shall be discarded and another one taken. If a test specimen fails to meet the required tensile properties, two additional test specimens shall be cut from rails from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the tests fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of the tests must be satisfactory for the lot to be accepted. If one of these tests is unsatisfactory, each individual rail may be sampled and tested for acceptance. If the results
for off-line head hardened rail fail to meet the requirements, the rails represented by the test may be re-treated and re-tested.

3. Except for high-strength rail, the test frequency shall be one test for each heat for the first one hundred heats, one test for every fifth heat for the second hundred heats and one test for every tenth heat thereafter for heats furnished to the same manufacturing practice. In addition, a minimum of one tensile test per order shall be furnished at the request of SCRRA, from a heat supplied on the order. For high-strength rail of all steel grades, the testing frequency shall be one test for each heat or 10,000 feet of rail, whichever represents the smaller amount of rail.

C. Ultrasonic Testing:

1. Rails shall be ultrasonically tested for internal imperfections. The full length of the rail shall be tested using in line ultrasonic testing equipment at the rolling mill. The rail shall be free from rough surfaces, loose scale or foreign matter which would interfere with the ultrasonic detection of defects. Testing shall be done when the rail temperature is below 150 degrees F.

2. The calibration test rail shall be a full section rail of the same section as that being tested. The test rail shall be long enough to allow a calibration at the same rate of speed as the production rail. The size, shape, location and orientation of calibration references to be placed in the test rail shall be agreed upon by the purchaser and manufacturer. At least one reference shall be put into the test rail to represent each search unit in the system.

3. The in-line testing system sensitivity level, using the calibration rail, shall be adjusted to detect a minimum 1/16 inch diameter defect anywhere in the sound path in the head, a minimum of 3/32 inch diameter in the web, and longitudinal imperfections exceeding ½ inch length and greater than 1/16 inch depth occurring in the base. Any indication equal to or greater than the above defect sizes when scanning the rail at the production speed shall be cause for initial rejection. A record shall be made of each suspect rail. This record shall be made available to SCRRA upon request.

4. The calibration rail shall be run through the ultrasonic testing equipment at the start of each shift or at least once each 8 hour operating turn and additionally at any section change or at any indication of equipment malfunction. A record shall be maintained by the manufacturer of each time the calibration test rail is run through the test system. This record shall be made available to SCRRA upon request. In the event of a calibration failure, all rails processed since the last successful calibration shall be retested.

5. Rejected rails may be cut back to sound metal as indicated by the ultrasonic testing. Rails shall be cut to one of the specified non-standard short lengths. The cut shall be a minimum of 12 inches from any indication.
D. Brinell Hardness:

1. The Brinell hardness test shall be performed, using a tungsten carbide indentor, on a piece of rail not less than 6 inches long. The test piece shall be cut from a rail taken from each heat of steel or heat-treatment lot, or from a ground/milled transverse sample cut from the 6 inch sample rail. A copy of the report of each test shall be furnished to SCRRA.

2. The test shall be conducted in accordance with the current version ASTM E 10, “Standard Test Method for Brinell Hardness of Metallic Materials.” The test shall be made on the side or top of the rail head after decarburized material has been removed to permit an accurate determination of hardness. Alternately, the test may be made on the prepared transverse ground/milled sample no less than 3/8 inch inward from all rail surfaces.

3. If any test result fails to meet the specifications, two additional checks shall be made on the same piece. If both checks meet the specified hardness, the heat or heat treatment lot meets the hardness requirement. If either of the additional checks fails, two additional rails in the heat or lot shall be checked. Both of these checks must be satisfactory for the heat or lot to be accepted. If any one of these two checks fails, individual rails may be tested for acceptance.

4. If the results for off-line head hardened rails fail to meet the requirements shown in Table 5 (below), the rails may be retreated at the option of the manufacturer, and the retreated rails shall be re-tested.

E. Internal Hardness of High-Strength Rail:

1. The internal hardness of high-strength rail of any rail steel grade shall be determined on a transverse specimen cut from the head and at least 6 inches from the end of the rail. The specimen shall be ground or milled so that the transverse surfaces are parallel. The hardness test shall be conducted in accordance with ASTM E-18, “Standard Test Methods for Rockwell Hardness of Metallic Materials.” The results shall be reported in Brinell using the conversions in Table 5.

2. The hardness shall be determined at intervals of not greater than 1/8 inch along traverses 1, 2, and 3 and at positions 4 and 5 as shown in Figure 2. Hardness gradient of head hardened rail along lines 1, 2, and 3 shall be gradual towards the center of the rail, with no sharp drop or discontinuity. Traverse 2 can extend into the web of the rail (X + 1.6 inch).
### Table 5 – AREMA HRC TO HB Conversion for Rail Steels (Developed by AREMA Committee 4 specifically for rail steel)

<table>
<thead>
<tr>
<th>HRC</th>
<th>HB</th>
<th>HRC</th>
<th>HB</th>
<th>HRC</th>
<th>HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>244</td>
<td>30</td>
<td>306</td>
<td>41.8</td>
<td>400</td>
</tr>
<tr>
<td>21</td>
<td>250</td>
<td>31</td>
<td>314</td>
<td>42</td>
<td>402</td>
</tr>
<tr>
<td>22</td>
<td>255</td>
<td>32</td>
<td>321</td>
<td>43</td>
<td>411</td>
</tr>
<tr>
<td>23</td>
<td>261</td>
<td>33</td>
<td>328</td>
<td>44</td>
<td>420</td>
</tr>
<tr>
<td>24</td>
<td>267</td>
<td>34</td>
<td>336</td>
<td>45</td>
<td>429</td>
</tr>
<tr>
<td>25</td>
<td>273</td>
<td>35</td>
<td>344</td>
<td>46</td>
<td>439</td>
</tr>
<tr>
<td>26</td>
<td>280</td>
<td>36</td>
<td>351</td>
<td>47</td>
<td>448</td>
</tr>
<tr>
<td>27</td>
<td>286</td>
<td>37</td>
<td>359</td>
<td>48</td>
<td>458</td>
</tr>
<tr>
<td>28</td>
<td>293</td>
<td>38</td>
<td>368</td>
<td>49</td>
<td>468</td>
</tr>
<tr>
<td>29</td>
<td>300</td>
<td>39</td>
<td>376</td>
<td>50</td>
<td>478</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>384</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
HB = 165.77 + 2.3597\text{HRC} + 0.0777\text{HRC}^2
\]

3. The hardness at a depth of 0.6 inch on lines 1, 2 and 3 and at points 4 and 5 of (depth of 3/8 inch) Figure 2 shall be 352 HB or higher for high strength rail. For the low alloy head hardened rail steel grade (LH) the hardness at a depth of 7/8 inch on lines 1, 2, and 3 shall be 341 HB or higher. The testing frequency shall be one test per heat or 10,000 feet of rail, whichever is the smaller amount of rail.
4. If any test specimen fails to meet the required hardness, two additional test specimens shall be obtained from the same lot and tested. If both meet the requirements, the lot shall be accepted. If one of the specimens fails to meet the requirements, two additional rails from the lot shall be sampled and tested. Both of these tests must be satisfactory for the lot to be accepted. If one of the tests is unsatisfactory, individual rails may be sampled and tested for acceptance. If the results for off-line head hardened rail fail to meet the requirements for internal hard, the rails represented by the test may be re-treated and re-tested.

F. Interior Condition and Macroetch Standard Tests:

1. Sample Location and Frequency

   a. A test piece representing a rail from each strand from the beginning of each sequence and whenever a new ladle is begun shall be shall be macroetched which is the point representative of the lowest level in the tundish (i.e. the point of the lowest ferrostatic pressure.) One additional sample from the end of each strand of the last heat in the sequence shall also be tested. A new tundish is considered to be the beginning of a new sequence.

   b. SCRRA may, upon receipt, examine and test any rail from any part of a heat at its option, and if the determines that the rail sample selected in rejectable, the entire heat shall be reevaluated according to Section 2.06, Part F, Paragraph D, below.

2. Sample Preparation

   a. A full transverse section of the rail can be cut by abrasive or mechanical means as long as care is maintained in preventing metallurgical damage. The face to be etched shall have at least a 125 microinch finish. The sample shall be degreased and totally immersed in a hot (160 degrees to 180 degrees F) one to one mixture, by volume, of concentrated hydrochloric acid (38 volume percent) and water to sufficiently etch the specimen.

   b. Etching time shall be between ten and twenty minutes. The solution surface shall be at least one inch above the etched surface. Upon removal from the bath, the sample shall be rinsed and brushed under hot water and dried. The sample shall not be blotted dry. A rust inhibitor may be applied to the etched face at the option of the manufacturer.

3. Macroetch Evaluation and Rejectable Conditions

   The areas of cross section shall be defined as head, web, and base in accordance with Figure 4-2-9 of Chapter 4 of the AREMA Manual for Railway Engineering. A description of each of the rejectable conditions and corresponding figure in Chapter 4 of the AREMA Manual for Railway Engineering are given in Table 6.
Table 6 – Macroetch Evaluations and Rejectable Conditions

<table>
<thead>
<tr>
<th>AREMA Figure Number</th>
<th>Rejectable Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-2-9</td>
<td>Definition of rail cross sectional areas for macroetch evaluation</td>
</tr>
<tr>
<td>4-2-10 and 4-2-11</td>
<td>Hydrogen flakes</td>
</tr>
<tr>
<td>4-2-12 and 4-2-13</td>
<td>Pipe; any size.</td>
</tr>
<tr>
<td>4-2-14 and 4-2-15</td>
<td>Central web streaking extending into the head or base</td>
</tr>
<tr>
<td>4-2-16 and 4-2-17</td>
<td>Streaking greater than 2-1/2 inches in length</td>
</tr>
<tr>
<td>4-2-18</td>
<td>Scattered central web streaking from the web into the head and base.</td>
</tr>
<tr>
<td>4-2-19</td>
<td>Scattered segregation extending more than one inch into the head or base.</td>
</tr>
<tr>
<td>4-2-20</td>
<td>Subsurface porosity</td>
</tr>
<tr>
<td>4-2-21</td>
<td>Inverse or negative segregation having a width greater than 3 inches and extending more than ½ inches into the head or base</td>
</tr>
<tr>
<td>4-2-22</td>
<td>Streaking greater than 1/8 inches in the head from radial streaks, radial cracks, halfway cracks, or hinged cracks</td>
</tr>
<tr>
<td>4-2-23</td>
<td>Other defects that could cause premature failure (i.e. slag, refractory, etc.)</td>
</tr>
<tr>
<td>4-2-24 and 4-2-25</td>
<td>Segregation extending into the head or base</td>
</tr>
<tr>
<td>4-2-26</td>
<td>Segregation greater than 1/8 inches wide in the head or base.</td>
</tr>
<tr>
<td>4-2-27</td>
<td>Scattered central web segregation extending into the head and base.</td>
</tr>
</tbody>
</table>

4. Retesting

a. If any specimen fails to meet the macroetch standard for interior quality, two additional samples of rail representative of the same strand shall be obtained. These retests shall be taken from positions selected by the manufacturer and the material from between the two retest positions shall be rejected. If any retest fails, testing shall continue until acceptable internal quality is exhibited.

b. All rails represented by failed tests shall be rejected. If finished rail from the beginning of a strand shows defects, successive rails from that strand shall be tested until sound metal is identified. Those portions of rails exhibiting sound metal may be cut from longer rails and accepted as short rail, subject to the limitations of length.

c. In the event that there is a question of the seriousness of the indication, further examination may be performed with a stereo microscope up to 5X. A polished sample may be inspected at 100X for metallographic interpretation.
G. Interior Condition and Microcleanliness Standard Tests:

1. Sampling

   a. The metallurgical cleanliness of the rail steel shall be determined from samples taken from the finished rail section. A minimum of every tenth heat must be tested. A minimum of three one-inch long full section samples per heat tested shall be taken, one from the end of the first acceptable rail, one from the end of a rail representing the approximate middle of the heat, and one from the end of the last acceptable rail. Test specimens will be sectioned and surface analyzed as shown in Figure 3.

   b. Each ¾” by ¾” section (Sample A in Figure 3) shall be carefully prepared and evaluated according to Method A of ASTM Standard E45, “Standard Test Methods for Determining the Inclusion Content of Steel.” Each individual metallographic sample shall have a maximum average rating of 2 and a maximum individual rating of 3 for inclusions type, thin or heavy. Results shall be furnished to SCRRA purchaser upon request.

![Figure 3 – Sample “A” location in rail head – Shaded area denotes area to be analyzed](image)

H. Tolerances:

1. Section and Length

   Rail shall be rolled to the standard section shown on the drawings or
listed in the Schedule of Quantities and Prices within the section tolerances given in Table 5, and to the specified length within the tolerances given in Table 4.

Gauges for checking basic rail dimensions shall conform to those illustrated in Figure 4-2-28 through and including Figure 4-2-40 of Chapter 4 of the AREMA Manual for Railway Engineering.

### Table 4 – Tolerance in Length

<table>
<thead>
<tr>
<th>End Condition</th>
<th>Length &gt; 40 ft.</th>
<th>Length ≤ 40 ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undrilled</td>
<td>-0, +6 inch</td>
<td>-0, +4 inch</td>
</tr>
<tr>
<td>Drilled one end</td>
<td>-0, +6 inch</td>
<td>-0, +4 inch</td>
</tr>
<tr>
<td>Drilled both ends</td>
<td>±7/8 inch</td>
<td>±7/16 inch</td>
</tr>
</tbody>
</table>

### Table 5 – Section Tolerances

<table>
<thead>
<tr>
<th>Description</th>
<th>Tolerance, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rail</td>
</tr>
<tr>
<td></td>
<td>Plus</td>
</tr>
<tr>
<td>Height of rail (measured within one foot from end)</td>
<td>0.030</td>
</tr>
<tr>
<td>Width of rail head (measured within one foot from end)</td>
<td>0.025</td>
</tr>
<tr>
<td>Thickness of web</td>
<td>0.040</td>
</tr>
<tr>
<td>Fishing template standout</td>
<td>0.060</td>
</tr>
<tr>
<td>Asymmetry of head with respect to base</td>
<td>0.050</td>
</tr>
<tr>
<td>Width of base</td>
<td>0.040</td>
</tr>
<tr>
<td>Flange height</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Note 1: Base concavity shall not exceed 0.010 inch. Convexity is not permitted.

Note 2: No variation will be allowed in dimensions affecting the fit of the joint bars, except that the fishing template may stand out not to exceed 0.060 inch laterally.

Note 3: All four corners of the rail base shall have the radii according to the drawing ± 1/32 inch. Any disputes shall be analyzed on an Optical Comparator.

Note 4: The section of the rails to be used in AREMA trackwork shall conform to the design specified by the purchaser subject to the tolerances listed under trackwork rail above.

Note 5: Head radius to be within (±) 2 inches per Figure 4-2-40.

Note 6: On up to 5% of the order, the height of the rail plus tolerance can be between 0.030 and 0.040 inches. This exception does not apply to trackwork rail.

2. Rail Straightness

2a. When placed head up on a horizontal support, rails that have ends higher than the middle will be accepted, if they have a uniform upsweep, the maximum ordinate of which does not exceed ¾ inch in any 80 feet as illustrated in Figure 4.
b. The uniform surface upsweep at the rail ends shall not exceed a maximum ordinate of 0.020 inch in 3 feet and the 0.020 inch maximum ordinate shall not occur at a point closer than 18 inches from the rail end as illustrated in Figure 5. Surface down-sweep and droop must not be accepted.

c. Deviations of the lateral (horizontal) line in either direction at the rail ends shall not exceed: 1) a maximum mid-ordinate of 0.020 inch in 3 feet using a straight edge and of 0.010 inch at the end quarter point as illustrated in Figure 6a.; 2) a maximum of 0.040 inch measured by the tangent offset method at the end of the rail as illustrated in Figure 6b.
d. Uniform lateral sidesweep in any 80 feet shall not exceed ¾ inch as illustrated in Figure 7. When required, proof of compliance with, “Side Uniform Upsweep” tolerance shall be determined by string (wire) lining, and a straight edge and taper gage shall be used to determine rail end surface and line characteristics specified in “Uniform Surface Upsweep” tolerance and “Rail Lateral Line” tolerance. Surface downsweep and droop shall not be accepted.

Figure 7 – Top View of Uniform Lateral Sidesweep Tolerance

e. Rails shall be hot sawed, cold sawed, milled abrasive wheel cut, or ground to length. Rail ends shall be square with a variation of not more than 1/32 inch allowed. The method of finishing the ends of rails shall not cause metallurgical or mechanical damage to the rail.

f. If the rail shows evidence of twist while being laid head up on the final inspection bed, it will be checked by inserting a taper or feeler gage between the base and the rail skid nearest the end. If the gap exceeds 0.060 inch the rail will be rejected. Alternatively, a twist gage may be used and if the rail exceeds 1.5 degrees in 80 feet the rail will be rejected. Rejected rails may be subject to straightening.

I. Evaluation of Residual Stresses in Rail by Web Saw Cut:

1. Preparation and Test

a. Finished rail shall meet the requirements of a web saw cut test conducted of a fully roller-straightened rail sample of a regular production rail. The rail ends not affected by the roller
straightening process shall not be used for the test. For those production rails that are not roller-straightened, the rail shall also meet the following requirements of a web saw cut test.

b. The test sample shall be 24” in length and cut from a production rail. The sample end face furthest from the end of the rail from which the sample is cut shall be punch marked with two central, vertically aligned sharp cone pointed marks, one on each side of the neutral axis a sufficient distance apart such that the marks are not affected or obliterated by the subsequent saw cut. The caliper measurement shall be taken at a distance no more than 0.25” (6mm) from the rail end at the vertical centerline of the rail. The caliper point locations shall be marked and this measurement shall be recorded.

c. The initial vertical distance between the two punch marks shall be measured with a calibrated vernier or digital caliper and recorded. Alternatively, a calibrated vernier or digital caliper may be used to measure the initial height of the de-buried end of the rail to be saw-cut.

d. The web of the test sample shall then be saw cut on a straight line along the neutral axis of the web for a distance (L) of 16”. If the rail closes during the saw cut, sufficient material shall be removed from the mouth of the saw cut to prevent the top portion of the rail
from touching the bottom portion of the rail. The sawing process shall employ a procedure and sufficient precautions such that there is no induced distortion or heating of the rail.

e. Immediately after cutting, the distance between the two vertical punch marks shall again be measured with the vernier caliper and recorded. For the alternate method the rail height shall be re-measured by placing the caliper points at the same position on the top and base of the rail as initially measured. This value shall be recorded.

f. For either procedure, the value after subtracting the final measurement from the initial measurement is called the vertical displacement (d). The vertical displacement may be a positive or negative value depending upon whether the longitudinal and vertical residual tensile stresses of the rail sample are in tension (+) or compression (-). The web saw cut test shall be the primary method used to evaluate the magnitude of the residual stresses in rail.

2. Rail Acceptance Criteria

Any rail demonstrating a vertical displacement (+ or -) of greater than 0.148" (3.75 mm) shall be rejected. For fully-hardened rails, that have significantly higher fracture toughness properties in the web of the rail, an alternate acceptance criteria based on stress intensity and fracture toughness measurements may be used if it is the standard practice of the mill to use such a test. If the stress intensity level is less than the fracture toughness level the rail may be considered acceptable.

3. Re-Test and Acceptance Criteria

Any rail that does not meet the acceptance criteria of the primary saw cut test, may be accepted if a steel wedge forced into the mouth of the saw cut generates crack propagation and completed fracture through either the base or head of the rail.

Alternately, any rail that does not meet the acceptance criteria in may be accepted if two additional rails from the same week’s production are secured, saw cut tested and pass the primary acceptance criteria.

4. Testing Frequency

A rail manufacturer that has developed a continuous statistical control process and monitoring tests for control of their critical processing steps during production of rail may test a rail not less than a frequency of once each week. If a changes occur in the critical rail manufacturing processes in the course of production, tests must be taken at a frequency of one rail per 24 hours for a one week period of that change.
These monitoring tests shall demonstrate to SCRRA that there exists a positive correlation between the continuous process monitoring and the saw cut test measurements performed on the finished rail. During development of a statistical control and monitoring process, a saw cut test shall be taken at a frequency of one rail per 24 hours for a two week period.

PART 3 - EXECUTION

3.01 GENERAL

A. Flash butt welding and testing of rail shall conform to the current AREMA Manual, Chapter 4, Part 2, Section, "Specification for Fabrication of Continuous Welded Rail" unless otherwise specified herein.

B. Vendor must fabricate CWR off site.

C. Lengths of CWR strings delivered to site shall be not less than 1,200 feet unless otherwise approved by SCRRA.

D. Fabrication shall be in accordance with this specification.

E. Rejected welds shall be cut out and rewelded with a minimum of 19'-6" plugs at Vendor's expense.

F. Bolt holes for the end of CWR strings are acceptable and must be approved (size, location and number) with the SCRRA prior to shipment.

3.02 EQUIPMENT

A. The welding machine shall be capable of automatically recording pertinent data including pre-heating impulses, flashing time, upset current, time and platen travel during flashing and shall be capable of testing the welds during production using the ultrasonic testing method or the dry powder method of magnetic particle inspection.

B. The Vendor shall maintain welding equipment in good working order at all times.

3.03 RAIL BENDING AND STRAIGHTENING

A. Straightened rail sections shall achieve the alignment tolerance as specified in AREMA Manual, Chapter 4.

B. Any rail sections that cannot be straightened shall be cut back a sufficient distance to achieve the specified tolerances.

C. If straightened rail does not meet specification tolerance in two passes through the straightener, it will be cut out of the string.
3.04 RAIL CUTTING AND END PREPARATION

A. Rails used for electric-flash butt welds shall have their ends saw-cut or abrasive disc-cut clean and square by means of accepted equipment.

B. Torch cutting of rail is prohibited.

C. The head and base of the rail for a length of approximately six inches from welding end shall have mill scale removed down to bright metal.

D. All burrs shall be removed from the area where the welding current carrying electrodes contact on the head and base of the rail.

G. Holes will not be permitted in the rail, except as approved by SCRRA.

3.05 ELECTRIC FLASH BUTT WELDING

A. CWR strings shall be fabricated so that all of the branding appears on one side of the string.

B. Alignment of rail in the welding machine shall:
   1. Be done on the head of the rail.
   2. Vertical alignment shall provide for a flat running surface. Any difference in height of the rails shall be in the base.

C. Horizontal alignment shall be done in such a manner that any difference in the widths of heads of rails shall be divided equally on both sides of the head.

D. All electric flash butt welds shall be forged to point of refusal to further plastic deformation and have a minimum upset of 0.5 inches with 0.625 inches as standard.

E. The upset cylinder shall not bottom out during the upset portion of the weld cycle.

F. Post weld straightening may be permitted if performed before the surface temperature of the weld falls below 500 degrees Fahrenheit.

G. Quenching the weld metal shall not be permitted on standard rail. Quenching of premium rail weld is permitted and shall be per the standard industry practice as accepted by class I railroad.

3.06 FINISHING AND ALIGNMENT

A. Jagged, notched or badly mismatched end faces shall be preflashed to an even or mated condition before setting up rails for preheating and final flashing to assure that the entire surfaces of rail ends are uniformly flashing immediately preceding upsetting.
B. All heavy grinding used in the finishing process shall be performed on the hot metal immediately following welding, to prevent metallurgical damage.

C. Finishing shall eliminate cracks visible to the unaided eye. Notches created by offset conditions shall be eliminated by grinding to blend the variations.

D. All notches created by offset conditions or twisted rails shall be eliminated by grinding to blend the variations.

E. All fins on the weld due to grinding drag shall be removed prior to final inspection.

3.07 TOLERANCES IN ELECTRIC FLASH BUTT WELDS

A. Trimming and grinding of rail welds shall result in the weld being within the tolerances set forth in the AREMA Manual, Chapter 4, Part 2, Section "Specifications for Fabrication of Continuous Welded Rail."

3.08 RECORDS FOR ELECTRIC FLASH BUTT WELDING

A. On a bi-weekly basis a record shall be submitted to SCRRA documenting the production of each string of CWR. Included shall be the following:

1. The CWR string designation number and station location in the field.

2. The heat numbers of the first and last pieces of rail in the string.

3. The heat numbers on each side of any weld which has been cut out and rewelded.

4. A small sketch or graph indicating the current flow during the production of each weld.

3.09 CWR STRING MARKINGS

A. Mark each completed string with the appropriate CWR string designation indicated in the schedule of CWR strings.

3.10 CWR STRING HANDLING

A. Handling of CWR shall be in accordance with submitted procedures for transport and handling.

B. As welding is completed on each CWR string, the string shall be transported from the welding line by the Vendor to the track location or a suitable stockpile location.

C. The stockpile location shall be approved by SCRRA if it lies within the right-of-way.
3.11 VISUAL INSPECTION
   A. Production welds shall be visually inspected for surface cracks.
   B. Welds with surface cracks visible to the eye will not be accepted.

3.12 REPLACEMENT OF DEFECTIVE WELDS
   A. Flash butt production welds giving fault indication in magnetic particle inspection during production shall be cut, rewelded and retested and shall not be left for field welding.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT
   A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT
   A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
SECTION SS 34 11 15
OTHER TRACK MATERIALS (OTM)

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for Other Track Materials (OTM) to be furnished in accordance with Contract Documents or required by the Engineer.

B. OTM materials shall include rail fastening systems, screw spikes, track bolts, nuts, spring washers, tie plates, tie plugs, rail anchors, standard toeless joint bars, compromise joint bars, and insulated joints.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):
   1. Manual for Railway Engineering
   2. Portfolio of Trackwork Plans
   3. Specifications for Special Trackwork

B. American Welding Society (AWS):
   1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
   2. AWS D1.1: Structural Welding Code

C. American National Standards Institute, Inc. (ANSI)
   1. ANSI B1.1: Unified Inch Screw Threads
   2. ANSI B1.3M: Screw Threads Gaging System for Dimensional Acceptability
   3. ANSI B18.22.1: Plain Washers

D. American Society for Testing of Materials (ASTM)
   1. ASTM A36: Standard Specifications for Carbon Structural Steel
   3. ASTM A325: Standard Specifications for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
4. ASTM D257: Test Methods for D-C Resistance or Conductance of Insulated Materials

5. ASTM D1002: Test Methods for Apparent Shear Strength of Single-Lap-Joint Adhesive Bonded Metal Specimens by Tension Loading (Metal to Metal)

E. Association of American Railroads (AAR)
   1. AAR: Manual of Standards and Rec. Practices
   2. AAR Section J: Quality Assurance M-1003
   3. AAR: Assembly and Test of Insulated Track Part 16, Signal Section
   4. AAR: Signal Manual Assembly and Testing of Insulated Fittings, Part 14.5.1

F. SCRRA: Engineering Standards.

1.03 DEFINITIONS

A. Compromise Rail – A relatively short rail, the two ends of which are different sections, corresponding with the sections of the rail to which they are to be joined

B. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

C. Fasteners – Joint bars, bolts, clips and spikes

D. Joint Bar – A steel member used in pairs for the purpose of joining rail ends together, and holding them accurately, evenly and firmly in position

E. Insulated Joint – A rail joint designed to arrest the flow of electric current from rail to rail by means of insulation placed so as to separate the rail ends and other metal parts connecting them

F. OTM – A general term referring to all miscellaneous materials other than rail and ties

G. Tie Plug – Rectangular sections of wood for filling unused spike holes in wood ties

H. Switch – A track structure to divert rolling stock from one track to another

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the OTM have been placed in service.
B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. The Vendor shall submit OTM packaging, loading, shipping, and handling method.

D. The Vendor shall submit for SCRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality OTM included in the Schedule of Quantities and Prices.

E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing OTM to Class 1 Freight, passenger or commuter railroads.

F. The Vendor shall include installation instructions. The Vendor shall include, at a minimum, the Care and storage of materials; Date of glue manufacture; Glue shelf life; Rail end preparation; Weather and temperature restrictions; Mixing and application of glue; Installation of insulated joint bar and pin bolts; Curing restrictions; Detection of glue bond failures

G. Submit Certificates of Compliance for all OTM. Include material qualification test reports for materials, components, and assemblies.

H. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA’s Standard Specifications Section 01 25 00, “Substitution Procedures”. The specifications are available on SCRRA’s website at www.metrolinktrains.com.

1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.

B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. OTM delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA’s delivery and storage locations within 30 calendar days.

C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.
B. The material will be supplied to the SCRRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRRA representative. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

C. All materials delivered will be colored coded and have bar coded control tags using bar code # 128 system or as approved by SCRRRA on all parts/hardware for easy assembly by field personnel.

D. Steel tie plates shall be palletized, with each standard non-returnable pallet holding not more than 6,000 pounds. Binding for the palletized tie plates shall be of sufficient strength to facilitate multiple loading, unloading and handling with cranes and/or forklifts.

E. Resilient fasteners shall be packaged in burlap bags or other suitable container, with the weight of each package not exceeding 125 pounds. The bag or container shall be of sufficient strength to facilitate multiple loading, unloading and handling and storage.

PART 2 - PRODUCTS

2.01 GENERAL

A. OTM shall be new and conform to SCRRRA Engineering Standards.

B. OTM ordered to the Engineering Standards shall be produced in conformance to these specifications and AREMA Specifications for Special Trackwork.

2.02 TIE PLATES

A. Tie plates shall conform to AREMA Volume 1, Chapter 5, Section 1.1, Tie Plates - “Specifications for Steel Tie Plates” and appropriate SCRRRA Engineering Standard.

B. Tie plate dimensions for resilient fastening systems for 5½" base shall conform to SCRRRA Engineering Standard ES2453, “Rolled Steel Tie Plate to Suit 5½” Base AREMA Rail and Pandrol Rail Clips E2055”. Tie plate dimensions for resilient fastening systems shall conform to SCRRRA Engineering Standard ES2454, “Rolled Steel Tie Plate to Suit 132 LB. RE – 141 LB. RE Rail and Pandrol Rail Clips E2055”.

C. Tie plate dimensions for standard fastening systems for 5½" base shall conform to SCRRRA Engineering Standard ES2451, “Standard 13” Tie Plate for 5½” Base Rail”. Tie plate dimensions for standard fastening systems for 6” base shall conform to SCRRRA Engineering Standard ES2452, “14” Tie Plate for 6” Base Rail”.

2.03 TRACK SPIKES


B. Cut spikes shall be 5/8 inches by 6 11/16 inches and conform to all other dimensions specified in the AREMA Manual, Chapter 5, Part 2, Section 2.2, “Design of Cut Track Spike”.

C. Screw spikes shall be 15/16 inch by 6 inches straight shank screw spikes with a minimum tensile strength of 73,000 psi. Head shall be hot forged and centered relative to the shank in accordance with SCRRA Engineering Standards ES2355.

D. Stamp screw spikes with manufacturer’s identification and date of manufacture (month and year) in accordance with SCRRA Engineering Standard ES2355.

2.04 RAIL ANCHORS

A. Rail anchors shall be Channeloc-type rail anchors manufactured by Chemtron True Temper or equal.

B. Material for rail anchors to be high carbon steel. Material to be heat treated to Rc 34-47.

C. Rail anchors shall be sized to conform to the rail section used. Rail anchors shall have sufficient bearing area and depth to minimize the possibility of the anchor damaging or becoming embedded in the tie.

D. Rail anchors shall conform to the AREMA Manual, Chapter 5, Part 7, Section 7.1, “Specifications for Rail Anchors”. Rail Anchors shall be one-piece conforming to the requirements of AREMA Manual and of standard weight.

2.05 TRACK BOLTS, NUTS AND SPRING WASHERS

A. Track bolts and nuts shall conform to the dimensions specified in the AREMA Manual, Chapter 4, Part 3, Section 3.3, “Rail Drilling, Bar Punching, and Track Bolts”. Track bolts, nuts and washers shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.5, Specifications for Heat-Treated Carbon-Steel Track Bolts, and Carbon-Steel Nuts.

B. Spring Washers shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.6, Specifications for Spring Washers.

2.06 RESILIENT FASTENING SYSTEM

A. Resilient fastening system for wood ties shall be a Pandrol rail fastening system per relevant SCRRRA Engineering Standards, “Pandrol Rail Clip – Type “e” 2055”, consisting of elastic fastener "E-Clip" galvanized, type elastic clips, screw spikes, and elastic fastener tie plates or approved equal or as otherwise indicated in the Contract Drawings.
B. Resilient fastening system for concrete ties shall be a Pandrol Rail fastening system consisting of “Fast-Clip” type elastic fasteners pre-installed in the “off” position on concrete ties, or approved equal, unless indicated otherwise on the Contract Drawings.

C. Rail seat pads shall be “3-part” with steel interior plate.

D. Resilient fasteners for Insulated Joints shall be type specified in SCRRA Engineering Standards for the type of resilient fasteners to be used.
   1. The Contractor must provide suitable fasteners in accordance Relevant Engineering Standards requirements.

2.07 JOINT BARS

A. Joint bars shall conform to AREMA Volume 1, Chapter 4, Part 3, Section 3.2, “Joint Bars and Assemblies”; Section 3.3, “Rail Drillings, Bar Punchings and Bolts”; and Section 3.4, “Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars”.

B. Bar dimension and details shall conform to SCRRA ES2502, “Rail and Joint Assembly for 136 lbs. RE Rail”.

C. Joint bars used to temporarily connect rails that will be field welded in the final configuration shall be bolted with the rails ends drilled in the outer four holes only.

2.08 COMPROMISE JOINT BARS

D. Compromise Joints or connections to other rail weights on SCRRA mainline track (track used in passenger revenue service will be considered mainline track for purposes of this section) will be made through the use of transition rails as specified in SCRRA ES2372 or ES2373 as appropriate.
   1. Other rail weight connections or those connections necessary for “Industry Track” or “Other than main line” will be made using Compromise Bars.
   2. Compromise Bars shall be 6-hole conforming to AREMA Volume 1, Chapter 4, Part 3, Section 3.4, “Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars” and conform to the requirements of SCRRA ES2503, “Compromise Joints for Various Weights of Rail”.
   3. Final configuration of the track shall utilize field welds to join transition rails wherever applicable in mainline track.
   4. Compromise joint bars may be used for interim phases of construction on mainline track provided interim phase duration is expected to be six (6) months or less.
5. Temporary Compromise joint bars as noted above shall use track bolts in the outer four holes only.

2.09 INSULATED RAIL JOINTS

A. Bonded insulated rail joints shall conform to the current requirements of the SCRRA Engineering Standards ES2504 and AREMA Manual, Chapter 4, Part 3, Section 3.8, “Specifications for Bonded Insulation Rail Joints”.

B. Insulated rail joints shall be of the epoxy-bonded type as manufactured by Allegheny Rail Products, Co., or equal.

C. Insulated rail joints shall be complete with bars, end posts, bushing, washers, pin bolts, collars, washers and adhesives.

D. Straight bars shall be new and smooth and will be providing full face contact, conforming to the applicable rail section, and fabricated from material which meets or exceeds the mechanical properties and workmanship requirements of the current AREMA Volume 1, Chapter 4, Part 3, Section 3.4, “Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars”. The toe of the joint bar shall properly fit against the web of the rail. When elastically fastened, the joint bar shall provide adequate clearance to maintain electrical isolation.

E. Pin bolts shall be of ASTM A325 structural steel furnished with the appropriate collar.

F. Flat circular shall be hardened steel washers in accordance with ASTM F436.

G. Bolt hole size shall be in accordance with the bonded insulated joint Vendor's recommendation. If bolt hole diameter is larger than 1-3/16 inches, place ASTM A325 hardened washers between the joint bars and the nut.

H. The bolt hole locations shall be as specified in AREMA, Chapter 4, Part 3, Section 3.3, Rail for a 36-inch joint bar. Insulated joint bar lengths for main track installations shall be 36 inches.

I. Insulated material shall be high pressure, laminated design, impervious to oil, grease, and water, and having electrical characteristics equal to or greater than fiber insulation meeting requirements of the AAR Manual, Part 14.5.1, and electrical resistance tested as specified.

J. Each plug shall be Megohmmeter electrical resistance tested as per AREMA Manual.

2.10 TIE PLUGS

A. Tie hole plugging material shall be SpikeFast as supplied by Willamette Valley Company of Eugene, Oregon, or equal.
2.11 SUPERELEVATION TAGS

A. Furnish metal superelevation tags manufactured from 16-gauge aluminum in accordance with SCRRA Engineering Standard ES2206. Stamp tags in 1/4-inch increments from zero to maximum superelevation.


2. Adhesive for Securing Tags to Concrete Ties must be approved by SCRRA.

2.12 DERAIALS

A. Derails shall be as manufactured by Western Cullen Hayes or approved equal. Sliding derail shall meet the requirements shown in UPRR Standard Drawing 2007E or Norfolk Southern Railway Corporation. The sliding and hinged derails shall be painted yellow.

2.13 SOURCE QUALITY CONTROL

A. During OTM fabrication, perform the tests and inspections specified in the AREMA Specifications.

B. The bonded insulated rail joints shall meet electrical resistance test as specified in AREMA Chapter 4, Section 3.8.7.3.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRA’s Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.
4.02  PAYMENT

A.  Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION SS 34 11 23
SPECIAL TRACKWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for the Special Trackwork to be furnished in accordance with Contract Documents or required by the Engineer.

B. Special Trackwork materials furnished under this IFB shall include rail, switches, frogs, insulated joints, derails, compromise/transition rail, stick rail, and bumping posts and individual turnout components to be used as replacement parts. All materials furnished shall be entirely new materials.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

1. Manual for Railway Engineering
2. Portfolio of Trackwork Plans
3. Specifications for Special Trackwork

B. American Welding Society (AWS):

1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
2. AWS D1.1: Structural Welding Code

C. American National Standards Institute, Inc. (ANSI)

1. ANSI B1.1: Unified Inch Screw Threads
2. ANSI B1.3M: Screw Threads Gaging System for Dimensional Acceptability
3. ANSI B18.22.1: Plain Washers

D. American Society for Testing of Materials (ASTM)

1. ASTM A307: Carbon Steel Externally Threaded Standard Fasteners
2. ASTM D257: Test Methods for D-C Resistance or Conductance of Insulating Materials
3. ASTM E325: Requirements for a Testing and Inspection Laboratory

E. Association of American Railroads (AAR)
   1. AAR: Manual of Standards and Rec. Practices
   2. AAR Section J: Quality Assurance M-1003

F. SCRRA: Engineering Standards.

G. BNSF: BNSF Railway applicable specifications and standards

H. UP RR: Union Pacific Railroad applicable specifications and standards

1.03 DEFINITIONS

A. Closure Rails – The rails between the parts of any Special Trackwork layout, such as the rails between the switch and the frog in a turnout

B. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

C. Fasteners – Joint bars, bolts, clips and spikes

D. Frog – A track structure used at the intersection of two running rails to provide support for wheels and passageways for the flanges, thus permitting wheels on either rail to cross the other

E. Guard Rail – A rail or other structure laid parallel with the running rails of a track – used to hold wheels in correct alignment to prevent their flanges from striking the end of switch points of frog points

F. Point Rail – Switch rail or switch point – the tapered rail of a switch used to divert traffic along either route of a turnout

G. Railbound Manganese Steel Frog- A frog consisting essentially of a manganese steel body casting fitted into and between rolled rails and held together with bolts, known as RBM

H. Running Rail – The rail that carries a wheel as differentiated from a guard rail or flange rail which carry no weight

I. Spring Frog – A frog having a movable wing rail which is normally held against the point rail by springs thus making an unbroken sunning surface for wheels using the track. The flanges of wheels on the other track force the movable wing rail away from the point rail to provide a passageway

J. Stock Rail – A running rail against which the switch points operate

K. Switch – A track structure to divert rolling stock from one track to another
1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.

B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. The Vendor shall submit Special Trackwork packaging, loading, shipping, and handling method.

D. The Vendor shall submit for SCRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality Special Trackwork Materials included in the list of Special Trackwork items as provided in the Schedule of Quantities and Prices.

E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Special Trackwork material to Class 1 Freight, passenger or commuter railroads.

F. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA’s Standard Specifications Section 01 25 00, “Substitution Procedures”. The specifications are available on SCRRA’s website at www.metrolinktrains.com.

1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program. Comply with AREMA Portfolio of Trackwork Plans.

B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Special Trackwork materials delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA’s delivery and storage locations within 30 calendar days.

C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

D. Insulated gauge plates and switch rods shall be tested in accordance with AAR Manual, Part 116, Signal Section, Assembly and Test of Insulated Track Fittings.
1.06 DELIVERY, STORAGE AND HANDLING

A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

B. Band all switch points and stock rails together in one package for each turnout unit.

C. Package all frog as a single unit per turnout, and identify to indicate the turnout number.

D. Band guard rails together, and identify as to which turnout it is to accompany.

E. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

F. All materials delivered will be colored coded and have bar coded control tags using bar code # 128 system or as approved by SCRRA on all parts/hardware for easy assembly by field personnel.

PART 2 - PRODUCTS

2.01 GENERAL

A. Use SCRRA Standard Specifications and Engineering Standards for all turnouts and crossovers and related replacement and spare parts.

B. Rails, castings, forging, rolled shapes, washers, and fastening used in Special Trackwork ordered to the Engineering Standards shall be produced in conformance to these Specifications and AREMA Specifications for Special Trackwork.

2.02 RAIL

A. All steel rail used in the manufacturing of switches, turnouts and crossovers shall be new Low Alloy, Head Hardened, High Strength Grade HH or LH 136 RE (10 inch radius) conforming to AREMA Chapter 4, Part 2, Section 2.1, “Specifications for Steel Rail” and shall meet or exceed 370 HB or new BNSF Specification HH 370 Rail or an equivalent “Premium Type Head Hardened” Rail. If the Bidder is providing rail from a BNSF or UP specification that meets or exceeds these specifications and the AREMA standard – the Special Trackwork Manufacturer shall supply a copy of the applicable UPRR or BNSF standard for the rail being furnished.
2.03 SWITCHES

A. All switch point rails and stock rails shall be Samson type construction in accordance with SCRRA Engineering Standards.

B. Switch rails shall be fully heat-treated per specifications for heat-treated rails for Special Trackwork, Plan No. 100-92 Specifications in the AREMA Portfolio of Trackwork Plans.

C. Switch rod assemblies shall conform to AREMA Specifications for Special Trackwork, rolled mild steel.

2.04 FROGS

A. Spring frogs shall conform to SCRRA Engineering Standards or approved equal. Castings shall be 3-shot explosion-hardened. Rail shall be deep head hardened rail. Furnish frogs without plates for turnouts and crossovers on concrete ties. Bolts shall be 1-3/8 inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500 foot pounds.

B. Railbound Manganese (RBM) frogs with elastic fastening system shall conform to SCRRA Engineering Standards or approved equal. Manganese castings shall be 3-shot explosion-hardened in accordance with AREMA Specifications. Heel of the frog shall incorporate a 30-degree cut. Frog plates shall be with one inch round holes except as otherwise indicated on the SCRRA Engineering Standards. Bolts shall be 1-3/8 inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500 foot pounds.

C. Casting for frog inserts manganese steel shall be in accordance with AREMA Specifications for Special Trackwork, Article M2.

D. Frog guard rails may be machined initially and subsequently heat treated to achieve the requirements of high strength rail as specified in AREMA Specifications.

E. Tie plates shall conform to AREMA Volume 1, Chapter 5, Section 1.1, Tie Plates - "Specifications for Steel Tie Plates" and appropriate SCRRA Engineering Standard.

2.05 INSULATED JOINTS

A. Bonded insulated rail joints shall conform to the current requirements of the SCRRA Engineering Standards ES2504 and AREMA Manual, Chapter 4, Part 3, Section 3.8, “Specifications for Bonded Insulation Rail Joints”.

B. Insulated rail joints shall be of the epoxy-bonded type as manufactured by Allegheny Rail Products, Co., or equal.

C. Insulated rail joints shall be complete with bars, end posts, bushing, washers, pin
bolts, collars, washers and adhesives.

D. Straight bars shall be new and smooth and will be providing full face contact, conforming to the applicable rail section, and fabricated from material which meets or exceeds the mechanical properties and workmanship requirements of the current AREMA Volume 1, Chapter 4, Part 3, Section 3.4, “Specifications for Quenched Carbon-Steel Joint Bars, Micro-alloyed Joint Bars and Forged Compromise Joint Bars”. The toe of the joint bar shall properly fit against the web of the rail. When elastically fastened, the joint bar shall provide adequate clearance to maintain electrical isolation.

E. Pin bolts shall be of ASTM A325 structural steel furnished with the appropriate collar.

F. Flat circular shall be hardened steel washers in accordance with ASTM F436.

G. Bolt hole size shall be in accordance with the bonded insulated joint Vendor’s recommendation. If bolt hole diameter is larger than 1-3/16 inches, place ASTM A325 hardened washers between the joint bars and the nut.

H. The bolt hole locations shall be as specified in AREMA, Chapter 4, Part 3, Section 3.3, Rail for a 36-inch joint bar. Insulated joint bar lengths for main track installations shall be 36 inches.

I. Insulated material shall be high pressure, laminated design, impervious to oil, grease, and water, and having electrical characteristics equal to or greater than fiber insulation meeting requirements of the AAR Manual, Part 14.5.1, and electrical resistance tested as specified.

J. Each plug shall be Megohmmeter electrical resistance tested as per AREMA Manual.

2.06 DERAILS

A. Bi-directional Power Sliding Derail 136RE shall be Hayes model HBXS or approved equal. Derail package shall include all rods, hardware and wood switch timbers, dual powered Electric/Hand operated machine, target and fasteners. Timber to conform No. 8 Turnout Standards above. Derail to be compatible with 136 lb. rail.

B. Bi-directional Sliding Derail 136RE shall be Hayes model HBXS or approved equal. Derail package shall include all rods, hardware and wood switch timbers, low profile switch stand, target and fasteners. Derail shall be compatible for use with or without electric lock. Timber to conform No. 8 Turnout Standards above. Derail to be compatible with 136 lb. rail.

C. Switch Point Derail 136RE or Double Switch Point Derail with wood switch timbers shall meet the requirements of SCRRA Engineering Standard drawing ES2601, ES2602 and ES2604. 16"-6" switch points, Pandrol plates, and galvanized e-clips fasteners with all rods, connection hardware, and target shall be included for use with Union Switch and Signal M23E USS model machine. Timber to conform No. 8 Turnout Standards above. Derail to be compatible with 136 lb. rail.
D. Rail Mounted Flop-over Derail shall be bi-directional with flag, 136RE or 115RE as listed in the Schedule of Quantities and Prices, all hardware and mounting kit included.

2.07 COMPROMISE/TRANSITION RAIL

A. Forged transition rail shall be 136RE to 115RE. Use UPRR or BNSF standard for fabricating this rail section. Length of forged rail section to be 25 feet plus or minus one inch.

2.08 STICK RAIL

A. Furnish 80'-00" long rail with blank ends.

2.09 BUMPING POST

A. Bumping Post shall be as manufactured by Western Cullen Hayes Model “WAC” Bumping Post or equal. Western Cullen Hayes “Hayco Cushion Head” or equivalent that matches with the WAC bumping Post. Bumping post to be compatible for stopping Passenger Cars.

2.10 SWITCH STANDS

A. Hand throw switch stands shall be Racor 36-EH switch stand or approved equal furnished with a 14-inch red target with reflective material such as Scotchlite or equal on both sides.

B. Hand throw switch stand for crossovers shall be Racor 36-E switch stand, or approved equal, furnished with a 40 1/2 inch straight handle providing maximum clearance between tracks and an 8-inch red target with reflective material such as Scotchlite or equal on both sides.

C. Hand throw switch stand for double point split switch derail shall be Racor 36-EH switch stand, or approved equal, in accordance with SCRRA Engineering Standards furnished with a 14-inch round “D” target with yellow reflective material such as Scotchlite or equal on both sides.

2.11 SOURCE QUALITY CONTROL

A. During Special Trackwork fabrication, perform the tests and inspections specified in the AREMA Specifications.

B. Examine each forging and weld by the dry powder method of magnetic particle inspection in accordance with ASTM E709.

C. Perform ultrasonic testing on all forging and welds in accordance with ASTM E164.

D. All frog points shall be Brinell hardness tested on the head and along the side wearing surface in accordance with ASTM E10.
E. The bonded insulated rail joints shall meet electrical resistance test as specified in AREMA Chapter 4, Section 3.8.7.3.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRA’s Material Management Supervisor, 48 hours prior to the date of delivery.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for ballast to be furnished in accordance with Contract Documents or required by the Engineer.

B. Ballast shall consist of crushed stone which is angular fragments resulting from crushing by mechanical means the following types of rocks quarried from undisturbed, consolidated deposits: granite and similar phanero-crystalline igneous rocks, extrusive igneous rocks, or massive metamorphic quartzite or similar rocks. No crushed gravel shall be allowed.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):
   1. Manual for Railway Engineering
   2. Portfolio of Trackwork Plans
   3. Specifications for Special Trackwork

B. ASTM International (ASTM):


C. SCRRA: Engineering Standards, and Track Maintenance and Engineering Instructions, particularly but not limited to SCRRA ES2007-02.

1.03 DEFINITIONS

A. Fine Graded Aggregates – Mineral aggregates which will pass a No. 4 mesh screen and be retained on No. 200 screen

B. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

C. Fine Screening – Material below No. 4 mesh screen

D. Gravel – A rock fragment whose diameter range from 2 to 64 mm

E. Hardness of Minerals – A scale of hardness used as an aid in identifying minerals and based on a scale of one to ten with talc having a value of one and diamond a value often

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.

B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. Representative samples of ballast, of not less than 150 pounds for gradation and other required tests shall be taken from each source of ballast and tested as specified herein. Samples will be delivered to Authority within 20 days of award. Each shipment of ballast shall be accompanied by a certification as specified.

D. The Vendor shall submit for SCRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, "six sigma"
or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality ballast included in the list of ballast items as provided in the Schedule of Quantities and Prices.

E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Special Trackwork material to Class 1 Freight, passenger or commuter railroads.

1.05 QUALITY ASSURANCE

A. Testing shall be performed by Vendor’s independent certified testing laboratory approved by SCRRRA.

B. The Vendor shall provide laboratory certification that ballast Material meets the Specifications of this Section.

C. If the Vendor observes ballast material not suitable for work, or not in compliance with this part, SCRRRA must be notified within three (3) hours of discovery of condition.

D. The product delivered shall be from the same source from which samples were tested and found to conform to the Specification and shall be of the same type and quality of that which was tested.

1.06 DELIVERY, STORAGE AND HANDLING

A. Prepared ballast shall be handled in such a manner that it is kept clean and free from segregation, and when delivered, the ballast shall be clean and free from rubbish or any substance, which might foul the ballast.

B. Blending, stockpiling, and other production and handling operations must be managed by the Vendor to minimize segregation of finished product.

C. Stockpiling operations shall minimize breakage or excessive fall in stockpiling operations.

D. The movement of wheeled or tracked machines over stockpiled or installed Materials shall be limited.

E. The material will be supplied in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRRA release document. The material is to be delivered to the six-county Los Angeles area at a place designated by the SCRRRA representative. The delivery must be coordinated with SCRRRA representative prior to shipping and loading.
F. In the event of an emergency, the Vendor shall use its best efforts to provide 200 tons of products within 6 hours of notice, 400 tons within 24 hours’ notice, and 800 tons within 48 hours. The emergency status shall be determined by the Engineer. The Vendor is entitled to a surcharge to the unit price for emergency deliveries. If an emergency delivery occurs outside regular operating hours (The Vendor will be required to advise Authority, in writing, of operating hours or changes thereof) the Vendor will be entitled to a 10% surcharge to the unit price. Vendor must identify on each invoice which delivery is subject to the surcharge and identify the Authority representative who ordered the product under the emergency status.

G. Vendor shall be responsible for unloading ballast under the direction of the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL

A. Use SCRRA Engineering Standards ES2007 for all ballast and sub-ballast supply.

2.02 MATERIAL GRADING REQUIREMENTS

A. Ballast gradation shall conform to SCRRA ES2007-02 and AREMA Volume 1, Chapter 1, Section 2.4.4, Table 1-2-2, Standard No. 4A ballast unless otherwise noted. Gradation test shall be determined in accordance to ASTM C136, utilizing square opening sieves conforming to ASTM E11. The percentage passing each sieve shall fall within the following limits:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>SIEVE OPENING</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1/2</td>
<td>2.50”</td>
<td>100</td>
</tr>
<tr>
<td>2”</td>
<td>2.0”</td>
<td>90-100</td>
</tr>
<tr>
<td>1 1/2”</td>
<td>1.50”</td>
<td>60-90</td>
</tr>
<tr>
<td>1”</td>
<td>1.0”</td>
<td>10-35</td>
</tr>
<tr>
<td>3/4”</td>
<td>0.75”</td>
<td>0-10</td>
</tr>
<tr>
<td>1/2”</td>
<td>0.50”</td>
<td>-</td>
</tr>
<tr>
<td>3/8”</td>
<td>0.375”</td>
<td>0-3</td>
</tr>
<tr>
<td>No. 4</td>
<td>0.187”</td>
<td>-</td>
</tr>
</tbody>
</table>

B. Walkway rock or yard ballast gradation shall conform to SCRRA ES2007-02 and AREMA Volume 1, Chapter 1, Section 2.4.4, Table 1-2-2, Standard No. 5 ballast unless otherwise noted. The percent passing each sieve shall fall within the following limits:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>SIEVE OPENING</th>
<th>PERCENT PASSING BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1/2”</td>
<td>2.50”</td>
<td>100</td>
</tr>
</tbody>
</table>
2.03 MATERIAL QUALITY REQUIREMENTS

A. Ballast shall consist of crushed stone which is comprised of angular fragments resulting from crushing, by mechanical means, the following types of rocks quarried from undisturbed, consolidated deposits:

1. Granite and similar, phanero-crystalline igneous rock, extrusive igneous rock, or massive metamorphic quartzite or similar rock.

2. No crushed limestone, dolomites, or gravels shall be allowed.

3. Furnish prepared ballast that is hard, strong, angular, durable particles of crushed rock containing no carbonates or slag and free from injurious amounts of deleterious substances and conforming to the following requirements of these Specifications.

B. Material qualities shall be as follows:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>MINIMUM</th>
<th>MAXIMUM</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent material passing No. 200</td>
<td>--</td>
<td>1.0 percent</td>
<td>ASTM C 136</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ASTM C 117</td>
</tr>
<tr>
<td>Bulk specific Gravity – Rock</td>
<td>2.60</td>
<td>--</td>
<td>ASTM C 127</td>
</tr>
<tr>
<td>Absorption - Rock</td>
<td>--</td>
<td>1.0 percent</td>
<td>ASTM C 127</td>
</tr>
<tr>
<td>Clay lumps and friable particles</td>
<td>--</td>
<td>0.5 percent</td>
<td>ASTM C 142</td>
</tr>
<tr>
<td>Degradation</td>
<td>--</td>
<td>As Noted for Material Type</td>
<td>ASTM C 535 or ASTM C 131</td>
</tr>
</tbody>
</table>
2.04 SOURCE QUALITY CONTROL

A. Vendor’s testing laboratory shall take and perform gradation and other tests on representative samples of ballast, of not less than 150 lbs, from each source of ballast.

1. Perform tests to ensure compliance with these Specifications.

2. Each shipment of ballast shall be accompanied by a certification as specified.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with the SCRRRA Engineering Standards and Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.
3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRAs’s Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION SS 34 11 27

SUB-BALLAST AND AGGREGATE BASE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for roadway and pathway aggregate base to be furnished in accordance with Contract Documents or required by the Engineer.

1.02 REFERENCES


C. Caltrans Specifications: Section 26 – Aggregate Bases.

1.03 SUBMITTALS

A. Samples: As required by the Engineer samples of not less than 150 lbs. Samples shall be furnished by the Vendor or may be obtained independently by the Engineer’s representative for testing to determine whether the material delivered to the site is in compliance with the Specifications.

B. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.

C. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

1.04 QUALITY ASSURANCE

A. Testing shall be performed by Vendor’s independent certified testing laboratory approved by SCRRA.

B. The Vendor shall provide laboratory certification that ballast Material meets the Specifications of this Section.

C. If the Vendor observes material not suitable for work, or not in compliance with this part, SCRRA must be notified within three (3) hours of discovery of condition.
D. The product delivered shall be from the same source from which samples were tested and found to conform to the Specification and shall be of the same type and quality of that which was tested.

1.05 DELIVERY, STORAGE AND HANDLING

A. Prepared sub-ballast and aggregate base shall be handled in such a manner that it is kept clean and free from segregation, and when delivered, the sub-ballast and aggregate base shall be clean and free from rubbish or any substance, which might foul the ballast.

B. Blending, stockpiling, and other production and handling operations must be managed by the Vendor to minimize segregation of finished product.

C. Stockpiling operations shall minimize breakage or excessive fall in stockpiling operations.

D. The movement of wheeled or tracked machines over stockpiled or installed Materials shall be limited.

E. The material will be supplied to the SCRRRA in accordance with the delivery requirements, FOB Destination. The material when purchased is to be delivered to the six-county Los Angeles area at a place designated by the SCRRRA representative. The delivery must be coordinated with SCRRRA representative prior to shipping and loading. Orders can be combined and shipped on or before the delivery scheduled with approval by SCRRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

F. Vendor shall be responsible for unloading sub-ballast and aggregate base under the direction of Authority or authorized representative.

PART 2 - PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. Sub-ballast shall conform to the gradation and quality requirements for SCRRRA ES2007-02 and Caltrans Specifications Section 26-1.02A, Class 2 Crushed Aggregate Base, 3/4” Maximum. In addition, the aggregate shall consist entirely of crushed rock with a minimum of 75 percent of the material having at least two fractured faces. No reclaimed asphalt or concrete shall be included in this material.

B. Aggregate base shall be the same material as sub-ballast.
PART 3 - EXECUTION

3.01 GENERAL

A. Comply with the SCRRRA Engineering Standards and Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRRA’s Material Management Supervisor, 48 hours prior to the date of delivery.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Vendor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION SS 34 11 33
CONCRETE RAILROAD TIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for production and inspection of monoblock, pretensioned, prestressed concrete ties for standard gage track (4’ – 8 1/2”) to be furnished in accordance with the specifications and SCRRA Engineering Standards ES2402, ES2403, ES2406 or ES2407 as appropriate.

B. Work included in this Section encompasses work necessary for the manufacturing and production of concrete crossties and guardrail concrete cross ties both with or without neoprene pads.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 34 72 00 - Trackwork.
   4. Section 34 72 20 - Track Shifting, Relocation, and Resurfacing.

1.02 REFERENCES

A. SCRRA Engineering Standards:
   1. ES2402, ES2403, ES2406 or ES2407 as appropriate.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. T-26, Standard Method of Test for Quality of Water to Be Used in Concrete.

C. American Concrete Institute (ACI):
   1. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   2. 214, Standard Practice for Evaluation of Strength Test Results of Concrete.
   3. 301, Specifications for Structural Concrete.
   4. 318, Building Code Requirements for Structural Concrete.
D. American Railway Engineering and Maintenance of Way Association (AREMA):

1. Manual for Railway Engineering, Volume 1, Chapter 30, Part 4.2.3 Duggan Concrete Expansion Test.

E. ASTM International (ASTM):

3. A881, Specification for Steel Wire, Deformed, Stress-relieved or Low-relaxation for Prestressed Concrete Railroad Ties.
5. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
12. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.


25. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.


F. Precast/Prestressed Concrete Institute (PCI):

1. MNL 116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.03 DEFINITIONS

A. The word "Inspector" in this Specification shall mean the duly authorized representative of SCRRA.

B. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

C. The word "manufacturer" in this Specification shall mean the manufacturer of concrete ties.

D. The word "supplier" in this Specification shall mean a supplier of materials or components for use in the concrete ties.

E. The word "source" in this Specification shall mean a plant where a material or component used in the concrete ties, is produced. For aggregates, the word "source" shall mean the strata or quarry face from which the aggregate is obtained.
F. The word "bed" in this Specification shall mean a prestressing bed with forms placed end to end. Each bed is only one form wide.

G. The word "form" in this Specification shall mean a battery form, one tie long, with 5 to 8 cavities in which ties are cast upside down.

H. The word "line" in this Specification shall mean a series of ties end to end on a prestressing bed. Each line is only one tie wide.

I. The words "long line process" in this Specification shall mean ties being, made on a bed with at least ten forms end to end and on which the prestressing wires are tensioned between fixed abutments, independent of the forms, and prior to placing concrete.

J. The words "outside testing laboratory" in this Specification shall mean a testing laboratory, independent of the manufacturer, which conforms to ASTM E994 and is approved by the Engineer.

1.04 SUBMITTALS

A. Submit under the provisions of Division 01:

1. Compliance: Manufacturer's certification that the materials delivered are in compliance with the specification.

   a. Certification that the proposed concrete tie and shoulder inserts will satisfy all test requirements as specified herein.

   b. Certification shall include qualified laboratory test results, calculations and performance reports from a proven fastener design with five (5) years of operational service.

2. Tests:

   a. Certified test results, as required to demonstrate compliance of materials specified herein shall be submitted to the Engineer. The test results for the following items shall be supplied:

      1) Cement.
      2) Aggregates.
      3) Water.
      4) Concrete.
      5) Rail Seat Pads.
      6) Fasteners.
      7) Electrical Properties.
8) Tie Testing.

3. Design Analysis:
   a. A complete design analysis of the proposed tie and associated hardware, verifying the tie's capability to pass the test requirements contained in the Specifications and verifying the adequacy of the materials for their intended use.
   b. Design submission shall include:
      1) Structural detail Drawing(s) of the proposed tie and fastening assembly.
         a) The Drawing shall include tie configuration, prestressed strand size and location, and details of the shoulders with their fabrication tolerances.
      2) All structural calculations shall be based upon current industry standards for prestressed concrete design and the ACI standard requirements applied as follows:
         a) Calculations shall include moment analysis for the tie under no-cracking conditions and shall consider all long-term permanent prestress losses.
      3) Concrete batch compositions:
         a) Submission shall include physical and chemical composition of the batch; including, type and source of cement admixtures used, source and gradation of aggregates, source and quality assurance of water, curing, procedure, including concrete strength at prestress transfer, and separation of the tie from the form.
         b) It is the Vendors responsibility to ensure that the concrete composition and quality is suitable for its intended purpose.
      4) Specifications for pretensioning tendons:
         a) Documentation confirming the quality of material used in these elements.
      5) Cure time:
         a) The length of cure time necessary for the tie to reach 7,000 psi strength prior to delivery for placement in track.
4. Submit Shop Drawings prepared by the manufacturer for the standard “Fastclip” concrete ties and the guardrail equipped “Fastclip” concrete ties both with and without neoprene pads, if required.

5. Submit to the Engineer Shop Drawings prepared by the manufacturer for the forms and for the gages.
   a. Forms and gages shall not be used until the Plans have been approved by the Engineer.

6. Before production commences, submit a Quality Control Manual prepared by the manufacturers for approval by the Engineer.
   a. This Manual shall include the following details:
      1) Management organization.
      2) Responsibilities of production and quality control personnel.
      3) Plant Standards.
      4) Checks to be carried out by production personnel.
      5) Inspection and testing to be carried out by quality control personnel.
      6) Procedures for approving sources of materials and for order in materials.
      7) Procedures to insure that only materials complying with these Specifications are used.
      8) Procedures to insure all measuring equipment is properly calibrated.
      9) Procedures to insure that ties are not shipped until acceptance load testing is complete and that rejected ties are clearly marked and segregated from good ties.
     10) Quality Audit procedures.
   b. The Manual shall be revised or amended whenever there are changes in personnel, responsibilities, or other items contained in it.

7. Submit the Quality Control Program and the Production Program specified under “Quality Assurance and Quality Control” herein.

8. Submit written reports to the Engineer prepared by the manufacturer documenting strict adherence to the Quality Control Program and the Production Program.
1.05 QUALITY ASSURANCE

A. Qualification of the Manufacturer:

1. The manufacturer shall have a minimum of 5 years experience, in a fixed location, of the large-scale manufacture of pretensioned prestressed concrete railroad crossties by the long line process.

   a. The manufacturer's existing plants in the USA shall have been certified under the PCI Plant Certification Program.

   b. If the manufacturer's existing plants are outside the USA, they shall have been certified by the equivalent National Certification Organization for that country.

2. The manufacturer shall show to the satisfaction of the Engineer that he has, or can obtain, the necessary and proper equipment, tools, facilities and means, and that he has the experience, ability and financial resources to perform the work within the time specified and to the quality standards required.

3. Ties shall be manufactured by the long line process with 5 to 8 lines per bed.

4. If the manufacturer produces the ties in a new plant, that plant shall be certified under the PCI Plant Certification Program within 6 months from the start of production.

5. The requirements of ACI 301 and PCI MNL 116 shall apply except where other requirements are stated in these Specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Concrete ties shall be shipped in open-top cars or flat bed truck trailers.

1. Ties shall be securely braced for transportation to prevent any movement that will cause damage.

2. Ties shall be shipped in a horizontal position and braced with spacer blocks in such a manner that the top surface or cast-in-place hardware does not contact ties loaded above.

3. Ties shall not be loaded higher than the top of the cars and not more than six layers deep.
B. Ties must be delivered, unloaded, and neatly stockpiled as necessary on the project site by the Vendor.

1. When handling ties in the plant, yard or at the delivery site, ties must not be dropped or otherwise damaged.

2. Ties must be stacked on firm level ground, not more than 10 ties high and supported on dunnage at the rail seats only.

PART 2 - PRODUCTS

2.01 GENERAL - MATERIALS

A. The manufacturer shall only use materials from sources approved by the Engineer.

1. For cement, the source of clinker and the source of the ground cement will be approved by the Engineer.

2. All tests for cement and aggregate shall be completed in accordance with this Specification before approval of materials is requested from the Engineer.

B. Adequate time shall be allowed for the Engineer to approve new sources.

1. Trial concrete mixes shall be cast at least 90 days prior to approval being requested.

C. For aggregates to be supplied from a new source that has not been previously tested, a minimum period of 224 days shall be required for testing to ASTM C227 prior to approval being requested.

1. Alternatively, 70 days shall be allowed for the Osmotic Cell Test. SCRRA will accept previous test results on these aggregates from a qualified laboratory performing these tests as required to the standards of the appropriate ASTM which has been supervised, signed and sealed by a California Registered PE or Geologist.

2.02 CONCRETE

A. The minimum 28-day-design compressive strength of concrete used for concrete ties shall be 7000 psi as determined in accordance with ASTM C39.

1. The test cylinders shall be made and stored as specified in ASTM C31.

B. Batching and Mixing:

1. Aggregates and cement shall be measured by weight.

a. The weight of aggregate shall be based on a saturated surface dry condition corrected for free moisture.
2. Water shall be measured by weight or volume and admixtures shall be measured by volume.

3. Each batch of concrete shall be mixed separately in a pan mixer or approved horizontal drum mixer located at the site of the concrete tie manufacturing process.

4. No water shall be added to concrete after discharge from the mixer.

5. The quantity of each material used in each batch of concrete shall be automatically recorded.

C. Proportioning:

1. Mix proportions shall be developed using the method in ACI 301, Section 3.9. The cement content shall be not less than 600 lbs/cy.

D. Temperature: The temperature of freshly mixed concrete shall not exceed 90° F.

E. Curing:

1. Immediately after placing and consolidating, the concrete, the exposed surface shall be protected from rapid evaporation.

2. Concrete shall not be placed in forms whose temperature is less than 40 DegF and the concrete temperature shall not be allowed to fall below 50 DegF between casting, and transfer of prestress.

3. If heat curing is used, the forms may be preheated to avoid cooling of the concrete after placing but the temperature of concrete shall not exceed 90 DegF during the first three (3) hours and 105 DegF during the first four (4) hours (ASTM C403).

4. The rate of temperature rise in the concrete shall not exceed 35° F per hour and the maximum concrete temperature shall not exceed 158° F.

   a. Transfer of prestress shall not be carried out at a concrete temperature above 135° F.

   b. The heating method used shall be such that all ties in a bed are at a similar temperature.

5. During curing, the temperature at the center of the rail seat cross section of one tie in each bed shall be automatically recorded.

F. Testing Fresh Concrete:

1. The first batch on any bed shall be tested in accordance with this Specification and if this requires no adjustment to the mix, a further test shall be made after approximately 25 cubic yard has been poured.
a. If the first batch requires adjustment to the mix each subsequent batch shall be tested until no further adjustment is necessary and then a further batch shall be tested after approximately 25 cubic yard has been poured.

2. Slump:
   a. When measured in accordance with ASTM C143, the slump shall not exceed 2 inches when concrete is placed in the forms.
   b. A minimum of two measurements of slump shall be made, on separate batches of concrete, for each bed cast or each 50 cubic yard concrete whichever is less volume of concrete.

3. Air Content: Air entrainment of the concrete shall comply with the following table:

<table>
<thead>
<tr>
<th>PERCENT AIR ENTRAINMENT STAGE</th>
<th>AIR CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Concrete</td>
<td>4.5% ±0.7%</td>
</tr>
<tr>
<td>Cured Concrete</td>
<td>3.5% ±0.5%</td>
</tr>
</tbody>
</table>

G. Testing Hardened Concrete:

1. Compressive Strength:
   a. When measured on 4” x 8” cylinders capped in accordance with ASTM C617 and tested in accordance with ASTM C39, the minimum compressive strength shall be:
      1) At transfer of prestress: 4500 psi.
      2) At 28 days: 7000 psi.
   b. The minimum number of test cylinders per bed shall be:
      1) For transfer strength: 4.
      2) For 28 day strength: 3.
   c. The cylinders shall all be made from one batch of concrete and the slump and air content shall also be measured on the same batch.
   d. The cylinders shall be cured with the ties until transfer of prestress, in such a way that the temperature of the cylinders is with +0° -15° F of the temperature of the ties.
   e. After transfer of prestress, the 28-day cylinders shall be cured in accordance with ASTM C192.
2. As an alternative to cylinders 4 inches cubes may be used to measure the compressive strength at transfer of prestress.

3. Two cylinders shall be tested for transfer strength.
   a. If either result is less than 4500 psi, curing shall be continued for at least a further one (1) hour.
   b. No bed shall be detensioned until at least two cylinders achieve a strength of 4500 psi.
   c. If all transfer cylinders are tested without conforming to this requirement the bed may be detensioned if at least one cylinder achieves 4500 psi.
   d. An additional set of ties from one form shall then be acceptance load tested.
   e. If no transfer cylinders achieve 4500 psi, the bed may be detensioned providing, all ties are acceptance load tested.

4. The strength at 28 days shall be satisfactory if the average of three cylinders is not less than 7000 psi and no individual result is less than 6500 psi.

H. Durability:

1. One tie shall be selected at the start of production and thereafter every three months, for air void content and durability factor tests by an outside testing laboratory.

2. The air void content shall be measured in accordance with ASTM C457 on the top, center and bottom of a cross section slice cut from the rail seat of a tie.
   a. The measured air void content shall be not less than 3.0 percent and the air void spacing factor shall not exceed 0.008 inch.

3. The durability factor shall be measured in accordance with ASTM C666 on a minimum of 4 prisms of concrete taken adjacent to the samples used for the durability tests as required by this Specification.
   a. The durability factor shall not be less than 90 percent.

4. The frequency of testing, for durability shall be increased at the Engineer's request if there is evidence that not all ties satisfy the requirements of this Specification.
I. Chloride:

1. The water-soluble chloride content of the concrete shall not exceed 0.06 percent expressed as chloride ion by weight of cement.

   a. This shall be measured by an outside testing laboratory on fresh concrete or on individual materials in the mix when mix proportions are developed in accordance with Paragraph entitled “Proportioning” in the Article “Concrete” of this Specification and thereafter, by tests at three monthly intervals which include materials from all sources in use.

J. Alkali-Silica Reactivity:

1. The composition of the cement, fine aggregate shall be analyzed and tested in accordance with ASTM C33, ASTM C227, and the "Duggan" Concrete Expansion Test so as to ensure that the resulting combination does not produce a concrete subject to deleterious expansion resulting from an alkali-silica reaction.

   a. These tests are to be repeated every 6 months, from each source, unless otherwise defined in this Specification.

   b. In addition, whenever a component or source is changed, new tests will be performed on these components or sources.

2.03 CEMENT

A. Cement shall conform to ASTM C150, and low alkali.

1. Cement alkali content of Na₂O equivalent (Na₂O + 0.658 K₂O) shall be as low as possible and not greater than 0.6 percent.

2. The false set penetration, when tested in accordance with ASTM C359, shall be not less than 50 mm at intermediate times and 40 mm after remix.

B. Separate random samples of cement shall be taken each day to represent the cement used on each bed.

1. Each sample shall be not less than 1 gallon and shall be clearly identified with the date and bed number.

2. Each sample shall be kept in air-tight container until the corresponding 28-day cylinder tests have been carried out and results accepted by the Engineer.

C. Not more than two sources of clinker or ground cement shall be used by the manufacturer during any one-month.

1. Cement from each source shall be clearly identified and stored in separate weather tight silos.
2. If two sources of cement are used on one bed, the tests in Paragraph 2.02E herein shall be performed on the first batch of concrete made with each cement and if no adjustment to either mix is required, testing shall continue as single design as required in Paragraph 2.02E. herein Strength tests as required in Paragraph 2.02.F.1 herein shall also be conducted on concrete made with each type of cement.

D. Cement mill certificates shall be provided weekly by each supplier and shall include the results of the following tests on cement delivered during that week.

1. Under no circumstances shall substitution of cement be permitted unless it has been pre-qualified through the tests listed in this Section.

   a. Fineness by air permeability (ASTM C204).
   
   b. False Set (ASTM C359) - Penetration at 3, 5, 8, and 11 minutes and remix.
   
   
   d. Compressive Strength (ASTM C109) at 1 day, 3 days, and 7 days.
   
   e. Chemical Analysis (ASTM C114) - INCLUDING SiO Al₂O₃, Fe₂O₃, CaO, MgO, SO₃, K₂O, Na₂O and calculated alkalis as N₂O equivalent, C₃S, C₂S, C₃S, C₄AF.
   
   f. Residue on 325-mesh sieve (ASTM C430).

E. At least once during every three months, a randomly chosen sample of cement from each source used shall be analyzed for alkali content in accordance with ASTM C114 by an outside testing laboratory.

### 2.04 AGGREGATES

A. Both fine and coarse aggregates shall meet the requirements of the AREMA Specifications for Aggregates, Part 1, Section 1.3, Chapter 8 of the AREMA Manual.

B. Aggregates shall be natural aggregates complying with ASTM C33 Class 4S. The maximum combined coarse aggregate percentage wear shall not exceed 39 percent.

C. The manufacturer shall provide evidence that concrete containing aggregate from the proposed source with a cement content and alkali burden similar to the job mix, has a satisfactory service history of at least 5 years. This evidence shall include structures requiring a Class 4S aggregate.

D. The maximum size of aggregate shall be ¾”. If the coarse or fine aggregate is supplied in more than one size, each size shall be stored separately.
E. Washed aggregate shall be allowed to drain, in stockpiles, before use. All aggregates shall be free from ice when used.

F. In addition to the requirements of ASTM C33, the following tests shall be conducted by an outside testing laboratory.

1. Petrographic examination to ASTM C295. Examination shall be repeated on aggregate from each new source.

2. Evaluation of potential alkali reactivity to ASTM C227 or ASTM C1293.
   a. A separate test shall be conducted with each job cement and the results shall conform with ASTM C33 at three and six months.
   b. This shall be repeated every 6 months for each source.
   c. When there is insufficient time for testing, to ASTM C227 or ASTM C1293, potential alkali reactivity may be evaluated by the Osmotic Cell Test* developed by PCA.
      1) The flow rate at 30 days shall not exceed 1.5 mm per day. Proceedings 6th International Conference on Alkalis in Cement, Danish in Concrete Institute, Copenhagen, 1983.

3. Evaluation of potential alkali carbonate reactivity:
   a. Aggregates containing carbonate shall be tested in accordance with ASTM C586.

2.05 WATER

A. Water in mixing concrete and washing aggregates shall be potable and free of injurious amounts of oil, acid, alkali, inorganic matter, or other deleterious substances, that may be harmful to concrete or steel as specified in AASHTO T-26.

1. In addition, the mixing water, including that portion of the mixing water contributed in the form of free moisture on the aggregates, shall not contain a chloride ion content greater than 400 ppm.

2.06 ADMIXTURES

A. Chemical admixtures for concrete shall conform to ASTM C494.

1. Admixtures containing chlorides, fluorides, sulfides, or aluminum powder shall not be used.

2. Only liquid admixtures shall be used.
3. Air-entraining, admixtures shall conform to ASTM C260 and contain neutralized Vinsol Resin or other approved natural resins as the active ingredient.

4. Water reducing admixtures shall only be used with the approval of the Engineer. They shall conform to ASTM C494, Types A, B, D, or E.

   a) Water-reducing admixtures, retarding admixtures, accelerating admixtures, water reducing and retarding admixtures, water-reducing and accelerating admixtures, and high range water reducing admixtures, when authorized by the Engineer, shall conform to ASTM C494 or ASTM C1017 in the case of superplasticizers.

5. Other mineral admixtures shall not be used, except for Class F Flyash as noted below, unless mix and quality control program are specifically approved by the Engineer.

6. Class F Flyash, if used, shall conform to ASTM C618. The properties shall not exceed the following:

   a. 1.5 percent available alkalis and 6 percent loss on ignition.

   b. Mill test certificates shall accompany each lot of Class F Flyash used in tie production in order to ensure consistency.

   c. The combined mix design with admixtures, if used, shall be tested using ASTM C1567 on the proposed job mix to verify alkali-silica reaction (ASR) potential.

### 2.07 PRESTRESSING TENDONS

#### A. General:

1. Prestressing shall be indented wire strand or stress relieved wire.

2. The wires shall comply with ASTM A881 or stress relieved wire complying with ASTM A421.

3. The minimum tensile strength of the wire shall be 225,000 psi.

4. Strands for pretensioning tendons shall conform to ASTM A886.

5. All tendons shall be thoroughly cleaned of drawing lubricants before shipment.

6. Tendons from one source only shall be used on each bed.

7. Tendons shall not be contaminated with mud, oil, grease, or chloride salts.

8. Loose rust shall be removed during stringing and tendons pitted due to corrosion shall not be used.
B. Pretensioning:

1. During stringing, tendons shall not become contaminated with form release agent.

2. Each tendon shall be individually tensioned with the same initial force of between 5 percent and 20 percent of the final force using, a hydraulic jack.
   a. The final force shall then be applied by multiple tensioning with hydraulic jacks.
   b. The force shall be measured by pressure cases located immediately adjacent to each jack and be measured by elongation.
   c. The forces measured by the two methods shall agree to within 5 percent.

C. Detensioning:

1. Stress transfer shall be performed in a controlled manner with hydraulic jacks.
   a. The forms shall be free to move and the stress in all tendons shall be transferred at the same time and the same rate.
   b. No tendon shall be cut until it is completely detensioned.

2. If any tendons break during, curing, all ties shall be load tested in Rail Seat Positive in accordance with Paragraph entitled “Acceptance Load Testing” in Article “Testing of Ties”, starting with the ties from the form adjacent to the abutment where the tendon broke and moving towards the other abutment, when a point on the bed is reached at which all ties from one form pass the test, the remaining ties shall be accepted without further load testing.

2.08 RAIL FASTENING COMPONENTS

A. Rail fastening system shall be resilient, thread-less and adjustable in three steps without dismantling the fastener. The three steps shall be:

1. Retracted: Permits installation or removal of rail.


3. Clamped: Provides full rail clamping force.

B. Fasteners shall be comprised of as few components as economically and technically feasible for ease of assembly, disassembly, and maintenance. The rail clips, rail seat pads, and insulators shall be furnished by rail clip manufacturer and shall be compatible with concrete tie shoulders.
C. Configure fasteners so that the rail clip can be installed or replaced in the field by one person using standard readily available track tools. Clips shall also be capable of being installed by commercially available automated equipment.

D. Configure fasteners so that when the rail clips are retracted, the rail may be lifted vertically until it is completely free of the fastener without disturbing the horizontal or vertical alignment of the fastener.

E. Fasteners shall have, on both sides of the rail base, a positive means of preventing more than 1/8 IN total lateral movement of the rail base relative to the fastener in case of failure or loosening of one or both rail clips. The positive means shall extend at least 3/8 IN above the base of rail in the installed position.

F. Fasteners shall be Pandrol “Fastclip” or approved equal. Rail clips, insulators and tie pads shall be pre-assembled on cross tie at manufacturer’s plant.

G. Rail Clips:

1. Rail clips shall not be dependent on elastomeric components in torsion. The clips shall be reusable after removal through repeated applications without any effect on the operating performance of the system.

2. The minimum vertical hold down force for spring clips shall be 2,500 LBS with total minimum force of 5,000 LBS per rail fastener assembly.

H. Insulators:

1. An insulator shall be used between the rail clip, shoulder insert and the rail to position rail to the proper gauge, provide electrical insulation, reduce abrasion, and transfer the rail loading to the rail clip and shoulder insert.

2. The insulator shall be capable of withstanding degradation from oxidation, water, alkali, petroleum oils, synthetic lubricants, and sunlight without having detrimental effect on the performance of the insulator.

3. Insulator dimensions shall be appropriate to provide standard gauge dimension.

4. Insulators for different uses (adaptive insulators) shall be of different colors or different appearance for ease in identification.

I. Rail Seat Pads:

1. Provide rail seat pads compatible with the rail fastening system with a shape which provides positive means of preventing movement of the pad parallel to the rail. Pads must comply with SCRRRA Engineering Standard ES2363.

2. Alternate designs of rail seat pads shall be considered, provided they have successful history of performance of at least three years service under comparable service conditions.
a. Any alternate design must be specifically approved by the Engineer.

b. Submit results of industry standard tests concerning the above properties.

J. Iron Shoulders:

1. Iron Shoulders shall be Pandrol cast shoulders for “fast clip” or approved equal, sized for 136 lbs., 6” IN base rail dimension, with adaptive insulators, pads, and clips.

2. Ductile iron shoulders shall be obtained by the manufacturer and shall conform to ASTM A536 Grade 60-40-18 or 65-45-12.

   a. They shall be marked with the part number, supplier's identification and pattern number.

   b. At least four Y block specimens shall be cast from each heat, or in continuous casting, from each four-hour period.

   c. All specimens shall be heat treated under the same conditions as the shoulders they represent.

   d. Tension test specimens with a cage length of 2 inch shall be machined from the Y blocks and one tension test shall be made for each heat or each four-hour pour period.

   e. If the elongation and tension test results do not conform to ASTM A536, a further specimen shall be tested and if this fails the cast shall be reheated or rejected.

   f. The shoulders and test specimens may not be reheated more than once.

      1) After reheating, two test specimens shall be tested.

      2) If either of these fails to conform to ASTM A536, the cast shall be rejected.

   g. The shoulders shall be free from burned-on sand, cracks, cavities, injurious blowholes and other defects.

      1) All fins shall be removed from the vertical faces of the head of each shoulder.

      2) Fins across the top of the head shall not exceed 1/32 inch and below the head, fins shall not exceed 1/16 inch.

      3) At gates, there shall be no cavity in the shoulder more than 1/8” below the general surface level.
h. Go and No Go inspection gages shall be used to check that tolerances conform to the Plans.

1) A sampling plan for Acceptable Quality Levels of 1 percent for major dimensions and 4 percent for minor dimensions shall be used.

2) The manufacturer shall decide which are major and minor dimensions in consultation with the Engineer (through the Vendor).

3. Iron shoulders shall be free of mud, oil, loose rust and other contamination when cast into ties. They shall be rigidly secured in the forms during casting and shall not move within the concrete when the securing device is released.

4. Location within the ties shall comply with the tolerances on the tie Plans.

5. Ductile iron shoulders shall conform to the dimensions on the Plans issued by the fastening clip suppliers.

K. Guard Rail Inserts: Inserts for guardrail concrete ties shall be as shown on SCRRRA Engineering Standards ES2406 or ES2407 or approved equal.

L. Neoprene Pads: Neoprene Pads cast into the bottom of the tie for use on bridge decks in certain applications as indicated in the Contract Documents shall be as shown on SCRRRA Engineering Standards ES2403 or ES2407.

2.09 TIE DIMENSIONS, CONFIGURATION AND WEIGHT

A. Dimensions, configuration and weight shall conform to the following:

1. Alternative designs of concrete ties will be considered if they have the same general profile, and length.

2. Alternative designs must have a successful history of performance of at least five years service under comparable service conditions.

3. Any alternative design must be specifically approved by the Engineer.

B. Dimensions:

1. General:

   a. Weight: Maximum weight shall be 750 lbs..
   
   
   c. Height, at rail seat: 8 inch (+3/16 inch -1/8 inch).

2. Cross Ties:
a. Length: 8 FT 3 inch (±1/8 inch).


c. The rail seat shall provide for a cant of 1 in 40 toward centerline of track.

3. Track Gauge shall be 4” – 8 1/2”.

2.10 FLEXURAL STRENGTH

A. Flexural strength performance and test requirements shall comply with Section 4.4, Chapter 30 of AREMA Manual.

1. Results per Section 4.9, Chapter 30 of the AREMA Manual shall be provided.

2. The minimum flexural performance requirements for the concrete ties shall be as follows:

   
   b. Negative rail seat moment of 146 inch-kips static
   
   c. Static center positive moment of 110 inch-kips.
   
   d. Static center negative moment of 162 inch-kips.

2.11 LONGITUDINAL AND LATERAL RAIL RESTRAINT

A. The concrete tie and elastic fastener shall provide longitudinal and lateral rail restraint as specified in Section 4.6 and Section 4.7, Chapter 30 of the AREMA Manual.

2.12 ELECTRICAL PROPERTIES

A. Each concrete tie, together with its elastic fastening, shall comply with Section 4.8, Chapter 30 of the AREMA Manual.

2.13 TESTING OF TIES

A. Prior to approval of the concrete tie design, tests specified in Section 4.9, Chapter 30 of the AREMA Manual, unless otherwise modified by this Section, shall be performed at testing facility approved by the Engineer and results provided to the Engineer.

1. Surface Finishes.

2. Every tie produced shall be visually inspected.
3. Two ties which, in the opinion of the Inspector, show the required bottom surface finish and two ties which in the opinion of the Inspector show the maximum allowable rail seat defects shall be set aside as comparison standards for acceptance of ties.

4. The bottom surface of each tie shall have a rough struck, leveled surface.
   a. Projections from and indentations into the general level of the surface shall not exceed 3/16 inch.
   b. The indent pattern shall be approved by the Engineer.

5. The surface of the rail seat shall have a smooth, formed finish not inferior to the comparison standards.
   a. No forms, seams or warpage in the rail seat will be allowed.
   b. The rail seat flatness shall not exceed a 1/32 inch difference across any part of the rail seat.
      1) When referring to voids and rail seat flatness in the rail seat area, the rail seat will be defined as “area between adjacent shoulders and edge of tie to edge of tie” and the area adjacent to the shoulder and 3/8 IN beyond the face of the front face of the shoulder.
      2) Grinding or shaving with a jig is acceptable.
      3) Freehand grinding is not acceptable, unless approved by the Engineer.
      4) Filling of rail seat voids with fillers is not acceptable.
      5) No rubbing, brushing or other treatment shall be used on the rail seat.

6. All ties will require a lateral resistance pattern to be placed on the side of the tie.
   a. The Engineer will review for approval the design, but not provide the design of this pattern.
   b. The tie shall provide a minimum lateral in a single tie push test of 5,000 lbs.
   c. The tested tie must be in track on a major heavy haul railroad with adequate ballast depth.
   d. Proof of the lateral resistance design will be through multiple single tie tests as performed by the AAR.
e. The tie manufacturer assumes all responsibility for maintenance and design of these forms and patterns.

f. The Engineer will not accept a tie without a proven pattern.

7. Other formed surfaces shall be smooth and holes shall not exceed 1/4 inch in depth and diameter.

a. Ties with a limited number of holes up to 3/8 inch diameter but not exceeding 1/4 inch in depth will be accepted providing that holes are filled with a mixture of 3 parts washed sand, 1 part cement and 1 part SBR latex measured by volume or other accepted material.

8. Holes in tie ends shall not exceed 3/8 inch diameter and 1/2 inch in depth or 1/4 inch diameter and 1 inch in depth below the general surface level of concrete.

9. Corner breakage at tie ends shall not exceed 1 inch in depth.

10. Ties with visible cracks shall be rejected.

11. Prestressing wire shall not protrude more than 1/8 IN beyond the tie end and shall not have ragged ends, which would be hazardous in handling.

12. The surfaces where fastening components bear on the iron shoulders shall be 100 percent free from concrete or other foreign materials.

B. Tie Dimension Inspection:

1. Approved Go and No Go gages shall be used to check the following:

a. Out to out shoulder spacing.

b. Adjacent shoulder spacing.

c. Shoulder height.

d. Rail seat cant.

e. Rail seat flatness.

f. Rail seat wind or warpage.

g. Wire location.

2. A "Go and No Go" gage is the basis for acceptance and rejection. No interpretation of a gage is acceptable.
3. The inspector may gage as often as is required or as the Engineer feels necessary to QC confidence. If a problem is found then it is the responsibility of the Manufacturer to provide inspection as directed by the Engineer (100 percent if necessary) until the extent of the problem has been determined or the rework has been properly confirmed.

4. When new forms, modified forms or repaired forms are used, the first tie cast in each cavity shall be checked with Go and No Go gages and normal measuring equipment to insure conformity with dimensional tolerances on the tie Plans.

5. All ties selected for routine acceptance load testing shall be checked as described in this Specification.

6. Wire pattern shall:
   b. Be placed accurately to prevent electrical short between embedded fasteners.
   c. Achieve flexural bending strength in Section 2.10.

7. Wire pattern for all ties on both ends shall be visually inspected every day.

C. Acceptance Load Testing:
   1. All acceptance load testing shall be carried out on the day that detensioning is performed. Vendor must provide sufficient notice to the Engineer so as to allow for SCRRRA Inspectors to be present during acceptance load testing.

   2. Production Start-up Testing: From the first bed cast under any contract, all the ties from one form, selected at random, shall be load tested as follows:
      a. Rail seat positive and bond development at one end.
      b. Rail seat negative at the other end.
      c. If the ties meet these test requirements, further beds may be cast.
      d. If any tie fails to meet the test requirements, two further ties shall be taken from the same line and, if either of these ties fails to meet the test requirements, each tie in the line shall be individually tested, excluding the bond development test.
         1) One further bed shall then be cast and the test procedure repeated.
2) When the test ties meet these requirements an additional four (4) ties shall be randomly selected from the bed already cast and tested as follows:

a) Two (2) ties tested for Tie Center Negative Moment Test.

b) Two (2) ties tested for Tie Center Positive Moment Test.

3) If any tie fails to meet test requirements, two further ties shall be taken from the same line.

a) If either of the ties fail, then the batch is rejected.

b) When the test ties meet all of the production startup testing requirements, further beds may be cast.

3. Routine Production Testing:

a. After initial production acceptance testing routine acceptance testing shall be carried out on all beds cast.

b. All ties from one form, selected at random from each bed cast, shall be load tested as follows:

1) Rail Seat Positive at one end.

c. Every sixth (6th) tie selected for test shall additionally be tested as follows:

1) Rail Seat Positive at one end to first crack.

2) Rail Seat Negative at other end to first crack.

d. If any tie fails to comply with the test requirements in Paragraphs 2.13 C. 3 b. and c. above, two (2) additional ties shall be taken from the same line and all tests repeated.

1) If either of these ties fails the test, each tie in the line shall be tested.

e. One tie per day shall be selected at random from ties subject to Rail Seat Positive test and additionally tested for bond development.

1) If the tie fails to conform to the requirements of this test, two further ties from the same line shall be tested.

a) If either of these fails the test, one tie shall be tested from each bed cast on the same day as the ties, which failed the test.
b) No ties from beds with test failure shall be shipped until a test program to identify ties with unsatisfactory bond is agreed with the Engineer and the tests completed.

f. One tie per day shall be selected at random from ties subject to Rail Seat Positive Test and additionally tested for Tie Center Negative Moment.

1) If the tie fails to conform to the requirements of this test, two further ties from the same line shall be tested. If either of these ties fails, each tie in the line shall be tested.

D. Rail Seat Positive Test:

1. The tie shall be supported in a hydraulic testing machine with loading points so arranged that the load is applied at right angles to the base of the tie midway between the supporting pads. Test configuration shall be in accordance with Chapter 30 of the AREMA Manual.

2. A test load of 52 kips shall be applied at a rate not exceeding 10 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.

3. A tie will be considered to have failed the test if at the 52 kips test load, it contains a structural crack when viewed under 5-power magnification. The illumination at the surface shall be not less than 125 FT candles.

4. When a tie is to be tested to first crack loading shall continue, after inspection at the 52 kip load until a crack 1 IN in vertical length is observed. The load shall then be recorded.

E. Rail Seat Negative Test:

1. The tie shall be supported in a hydraulic testing machine, in accordance with the test configuration in AREMA Manual, Chapter 30.

2. The testing procedure shall be in accordance with Chapter 30 of the AREMA Manual.

3. A test load of 29 kips shall be applied at a rate not exceeding 5 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.

F. Bond Development Test:

1. The tie shall be supported in a hydraulic testing machine, in accordance with the test configuration in AREMA Manual.
2. Dial gages reading, to 0.001 inch shall be attached to the tie at the end being tested, to measure any movement relative to the tie of the outermost wire in each of the bottom corners of the tie.

3. A test load of 78 kips shall be applied at a rate not exceeding, 5 kips per minute and maintained for a period of five minutes.
   a. The wire movement shall not exceed 0.001 inch
   b. If during this test, a structural crack more than 3 inch long occurs, the test tie shall be rejected after completion.

G. Tie Center Negative Moment Test:
   1. The tie shall be supported in a hydraulic testing, machine in accordance with the test configuration in the AREMA Manual.
   2. A test load of 12 kips shall be applied at a rate not to exceed 5 kips per minute and maintained for at least 3 minutes to permit proper inspection. Both sides of the tie shall be inspected.

H. Tie Center Positive Moment Test:
   1. The tie shall be supported in a hydraulic testing machine in accordance with the test configuration in the AREMA Manual.
   2. A test load of 8 kips shall be applied at a rate not to exceed 5 kips per minute and maintained for at least three minutes to permit proper inspection. Both sides of the tie shall be inspected.

I. Electrical Short:
   1. Each tie tested in accordance with Paragraph 2.13.C. herein shall be checked for shoulder to shoulder direct electrical shorts under 10 Vdc using an Ohm Meter.
      a. The resistance shall not be less than 100 ohms.
   2. If any tie fails this test, all ties from the same line shall be individually tested.

J. Test Reports:
   1. The Vendor must submit a monthly manufacturer’s test report to the Engineer. This shall include:
      a. Number of good ties cast.
      b. Number of reject ties cast and reasons for rejection.
      c. Concrete compressive strength test results at transfer and at 28 days.
d. Average and standard deviation of the 28-day compressive strength results.

e. Percentage probability of 28-day compressive strength results failing to meet the minimum specified strength and the actual number of failures.

f. Tie first structural crack loads, rail seat positive and rail seat negative.

g. Average and standard deviation of the first crack loads.

h. Percentage probability of the first crack loads failing to meet the minimum specified load and the number of failures.

i. The 28-day Compressive Strength results shall also be presented as frequency histogram.

j. The Average 28-Day Strength results, Average first Crack Loads and Percentage probability of failing figures shall also be plotted on graphs showing, the corresponding results for the previous 12 months or since production started, whichever is the shorter period.

2. The manufacturer shall retain for a period of 10 years all test certificates provided by suppliers and outside testing laboratories.

a. Results of all inspection and testing carried out by the manufacturer shall also be retained for 10 years.

2.14 INSPECTION

A. Inspectors shall have access, during any and all working hours, to all parts of the manufacturer’s plant involved in tie production and to those parts of suppliers plants engaged in producing materials or components for use in the ties.

B. Inspectors shall access to the results of all tests carried out by the manufacturer, suppliers and outside testing laboratories.

2.15 PLANT AND YARD HANDLING

A. When handling ties in the plant or yard, they shall not be dropped or otherwise damaged.

1. Ties shall be stacked on firm level ground, not more than 20 ties high and supported on dunnage at the rail seats only.
2.16 IDENTIFICATION

A. Each tie shall be marked with indented or raised letters or numerals to identify the manufacturer, SCAX designation, form designation and date/month/year of manufacture as detailed on the SCRRA Engineering Standard Plans ES2402, ES2403, ES2406 or ES2407 as appropriate.

PART 3 - EXECUTION

3.01 QUALITY CONTROL

A. Quality Control:

1. Testing and inspection shall conform to AREMA Manual, Volume 1, Chapter 30, unless otherwise modified by these Specifications. The cost for testing of materials to be performed by an outside agency shall be provided by the manufacturers and will be included in unit price in the schedule.

2. Ties may be inspected by the Engineer at suitable and convenient places either at points of shipment or destination.

3. The Engineer reserves the right to examine any equipment used for any manufacturing process at any stage of tie production.

4. Material not meeting the requirements of this Specification shall not be used in the work.

5. Quality Control Program:

a. Vendor must comply with the following Quality Control Program requirements.

1) A quality control program under which the manufacturer will perform sufficient inspection and tests of all items of work, including those by suppliers or subcontractors in order to ensure conformance to applicable standards, Specifications or Plans with respect to materials, workmanship, fabrication, and identification.

2) The control plan shall specifically provide for:

a) Manufacturer’s surveillance (e.g. but not limited to shoulder inserts, wire).

b) Drawing- control (changes).

c) Mold Certification.

d) Document control.
e) Inspection procedures - in process and final.

f) Production test requirements.

g) Segregation and disposition of defective material and products.

h) Material and process control in plant identifying critical control points.

i) Production equipment and instrumentation calibration, maintenance, and data recording.

j) Work procedures and instruction.

k) Failure reporting analysis and corrective action.

l) Sample plans and quality levels shall conform to Military Standard 105D, AQL Level H unless otherwise stated or approved.

m) Raw materials standards and controls.

n) Records of test and inspections.

o) Time and temperature control.

p) Strength testing.

q) Storage handling and shipment controls.

r) Procedures or tests for determining within 24 HRS that the conditions necessary to achieve the 28-day strength have been met, with a margin of safety.

s) Quality budget in percentage of contract price.

t) Assurance that the plant will meet and continue to meet PCI certification.

u) Quality control organization chart showing all QC personnel and their corresponding contact level at SCRRA. QC organization must report independently from Production to Project Manager level or above.

v) The person responsible for quality control shall be independent of production management and shall report functionally to the manufacturing, company's senior management.

6. Production Program:
Vendor must comply with the following Production Program requirements. A complete production program shall include:

1) Plant layout.
2) Form design with tolerances.
3) Raw material requirements.
4) Primary and alternate sources.
5) Material handling.
6) Material placement with tolerances.
7) Curing method.
8) Bond release method.
9) Method of vibration.
10) Pretensioning and detensioning method for strand or wire.
11) Daily production capability.
12) Finished tie inventory plan.
13) Plan for handling ties from finished product to assigned rail cars or alternate transportation arrangements.
14) Flow chart of production process indicating points of control for all significant operations.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Vendor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION SS 34 11 34
WOOD RAILROAD TIES

PART 1 – GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for the Wood Railroad Ties to be furnished in accordance with Contract Documents or required by the Engineer.

B. Work included in this Section encompasses work necessary for the manufacturing, production and handling of wood switch ties, crossties, and grade crossing ties.

1.02 REFERENCES

A. AWPA: American Wood Preserver's Association:
   1. C1 – Standard for All Timber Products – Preservative Treatment by Pressure Processes.
   2. C2 – Lumber, Timber, Bridge Ties and Mine Ties – Preservative Treatment by Pressure Processes.
   5. M4 – Standard for the Care of Preservative – Treated Wood Products.

B. American Railway Engineering and Maintenance of Way Association (AREMA):

C. RTA: Railway Tie Association – Specifications for Timber Crossties and Switch Ties.
D. SCRRRA: Southern California Regional Rail Authority (SCRRRA) Engineering Standards.

1.03 DEFINITIONS

A. Anti-Splitting Device – Any device applied to the end or near the end of a tie or timber such as anti-splitting iron, dowel or nail plate to reduce its splitting.

B. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

C. Boulton Drying Process – A process for drying wood by removing moisture from it by heating in preservatives under sufficient intensity of vacuum to evaporate water from the material at the temperature of the preservative used.

D. Creep – The time-dependent deformation of a material under load.

E. Empty Cell – A treatment in which the cell walls in the treated portion of the wood remain coated with preservative, the cell being empty or only partially filled.

F. Hardwood – One group of trees (deciduous) which have broad leaves. The term has no reference to the hardness of the wood.

G. Softwood – One of the group of trees (conifers) which have needle-like or scale-like leaves. The term has no reference to the softness of the wood.

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the wood railroad ties have been placed in service.

B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. The Vendor shall submit wood railroad ties packaging, loading, shipping, and handling method.

D. The Vendor shall submit for SCRRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality wood railroad ties included in the Schedule of Quantities and Prices.

E. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing wood railroad ties to Class 1 Freight, passenger or commuter railroads.

F. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRRA’s

G. Tests: Certified test results, as required to demonstrate compliance of materials specified herein shall be submitted to SCRRA before any wood ties are used.

1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program.

B. Testing and inspection of tie manufacture shall be performed by Vendor in conformance with AREMA Manual, RTA and AWPA.

C. Ties may be inspected by SCRRA, at suitable and convenient times and places including points of manufacture, shipment, or destination.

D. SCRRA reserves the right to examine any equipment used for any process or method of treatment at any stage of tie production.

E. Material not meeting the requirements of this Specification shall not be used in the Work.

F. SCRRA shall have access to Manufacturer’s plant during normal working hours and all Project related procurement and production records for inspection any time during the Contract period of performance.

1.06 DELIVERY, STORAGE AND HANDLING

A. Tie shall be delivered to any point along the lines of the SCRRA rail track, as specified in each shipping release. Ties in truckload quantities will be unloaded upon two working day’s notice by the Vendor. All unloading operations will take place in active railroad corridors. SCRRA will assist the Vendor in unloading the ties and will provide necessary equipment for the unloading. SCRRA will provide an Employee-In-Charge (EIC) for on-track safety for the unloading of the ties in the right-of-way. The EIC will provide job briefing and safety protection to assure the Vendor a safe work environment and all Vendor personnel will be required to attend the job briefing.

B. Banding of ties by length or grade for shipment shall be done by applying bands in a tight manner (2,500 pounds of tension) to prevent warping, splitting, and slipping during storage or shipment. Two steel bands per bundle (T = 5,450 pounds, 1¼"x0.029" or better) shall be applied within one foot of each end of cross ties or switch ties. Three bands shall be applied to bundles of switch ties. No more than 9 switch ties shall be bundled together. No more than 25 cross ties shall be bundled together.

C. No steel cables, steel rods, chains, or wooden strips, or any other sticker material shall be shipped in any bundle to SCRRA.
D. All rejects shall be marked with an “X” on the end. This is to preclude the accidental shipment of less than grade ties to SCRR. Treated ties not handled directly from tram to car shall be carefully and neatly stored. Different size classifications shall be kept separate, and all bundles or stacks shall be marked with SCRR, grade or length, and treatment date. Ties shall be stacked to ensure that tie straightness is not impaired during temporary storage. Treated stringers shall be placed underneath all stacks of treated ties. No loose windrows of SCRR treated ties shall be allowed. Shipments shall be made from the oldest stacks first. If any ties become excessively bleached during storage, they shall be retreated or replaced by the supplier. Yard drainage conditions shall provide rapid drainage of water from beneath stacks of treated ties. Storage areas shall be kept free of grass and weeds to aid free flow of air and to minimize the possibility of fire. The Vendor shall be liable for all fire damage. A minimum 10 foot weed-free zone shall be maintained around SCRR stored inventory at all times. Care shall be exercised in handling of SCRR ties for storage or shipment to prevent damage.

E. Ties shall be stored to avoid contamination of water and soil by the ties.

F. Long-term tie storage shall not be located within 250 feet of an open road crossing or residences.

G. Ties temporarily located within 250 feet of a public road crossing or residences shall be covered by an impervious sheet material to control odor and vapor emitted by the crossties by SCRR.

PART 2 - PRODUCTS

2.01 GENERAL

A. Wood railroad ties shall be new and conform to SCRR Engineering Standards.

B. Wood railroad ties ordered to the Engineering Standards shall be produced in conformance to these specifications and AREMA Specifications.

2.02 WOOD CROSS TIES AND SWITCHTIES

A. The following hardwood species can be used for cross ties, switch ties and grade crossing ties:


B. The following species are not acceptable:

1. Oak-Hickory Group: Live Oak and Blackjack Oak.

C. Oak and elm ties shall be of compact wood throughout the top fourth of the tie.

D. All cross ties shall be the full length specified; double end trimmed, and should have full body and full face.

1. Ties with greater than 1" of wane within the 20" and 40" rail-bearing sections, when measured from the center of the tie, are not acceptable.
   a. Thickness and width tolerance shall be not more than ¼" thinner or narrower than the specified size.

E. Vendor shall provide a maximum of 50 percent of the ties from oak-hickory species and the remaining 50 percent from mixed hardwoods from list of ties specified under Attachment A, Part E, Section 1 through 4.

1. Oak ties must be air seasoned unless otherwise directed by SCRRA and preapproved and specified in writing.

2. Mixed Hardwoods must be air seasoned unless otherwise directed by SCRRA and preapproved and specified in writing.

2.03 GENERAL TIE REQUIREMENTS

A. All wooden ties shall be made from sound, straight, live timber and shall be free from any defects that may impair their strength or durability, such as bark, splits, shakes, large or numerous holes or knots, pitch seams, pitch rings, slanting grain or other imperfections.

1. Decay and/or insect damage in any form is not acceptable.

B. All ties shall be well sawn on all four sides and cut square at the end to the full dimensions specified.

1. All ties shall be straight and opposite faces shall be true and parallel, and with all bark entirely removed.

C. All ties shall be straight.

1. A tie shall be considered straight when:
   a. Timber Cross Tie: When a straight line from a point on one end to a corresponding point on the other end is no more than 1-1/2" from surface at all points.
   b. Timber Switch Ties: When straight line from a point on one end to a corresponding point on the other end is no more than 2" from the surface at all points.

D. A tie is not well sawn when its surfaces are cut with score marks more than ½" deep, or when its surfaces are not even.
E. The top and bottom of a tie shall be considered parallel, if any difference in the thickness at the sides or ends does not exceed ½”.

F. For proper seating of nail plates, tie ends must be flat and will be considered square with a sloped end of up to ½”, which equals a 1 in 20 cant.

2.04 ANTI-SPLITTING DEVICES

A. Anti-splitting devices are required.

1. Anti-splitting devices (endplates) shall be multi-nail plates as specified in AREMA Manual, Volume1, Chapter30, Part3.1.6, Specifications for Devices to Control the Splitting of Wood Ties.

   a. Structural type, Grade “C”, 18 gauge galvanized steel, ASTM A653 or better with ultimate strength of 55,000 psi and yield strength of 40,000psi.

   b. Galvanizing per ASTM A653, G60 coating.

   c. 4-5 teeth per square inch.

   d. ½” to 9/16” length of tooth.

2. This application should enable the plate to hold both vertical and horizontal splits.

3. End plates shall be applied by a mechanical device capable of squeezing any splits; bringing the tie back to its original (cross section) dimensions prior to application.

4. End plates for 7”x9” ties are to measure 6” x 7” or 6-1/4” x 7”.

5. No part of the end plate is to be within ¼” of any side

6. All anti-split end plates shall have rounded corners and a smooth perimeter.

B. Embossed on all end plates will be “SCRRA” and manufacturer name followed by the year of manufacture and Treating Plant. End plates will be installed with the letters “SCRRA” upright with the tie oriented with heartwood down.

2.05 DIMENSIONS

A. All cross ties shall have a 7”x 9” cross-section and shall be double end trimmed, unless otherwise ordered.

B. Length of ties shall be as ordered in each shipping release.

1. Ties will be ordered as 9'-0”or in one (1) foot increments from 9'-0” to 24'-0”.
C. The length, thickness, and width specified are minimum.

1. Ties with thickness and width more than ¼" thinner or narrower than specified will be rejected. Ties over 1" longer shall be rejected.

2. Tie dimensions shall not be averaged.

2.06 PRESERVATIVE

A. The preservative shall consist of a mixture of 50 percent by volume of P-1 creosote oil conforming to AWPA Specifications (AWPA P3 and AWPA P4), and 50 percent by volume of an approved petroleum residuum oil.

1. The creosote and oil shall be thoroughly mixed in the working tank until the mixture is of uniform composition. (Note: use of treatment with P-2, 7lbs / cu ft is an approved equal).

B. The residuum oil shall be approved asphalt base petroleum residuum oil.

1. It shall be free from water and any foreign substance that might interfere with its penetrating qualities.

2. The flash point of the residuum oil shall not be less than 210˚F as determined in the Cleveland Open Cup.

3. The viscosity of the residuum oil shall be such that a blend of 50 percent residuum oil and 50 percent creosote shall have a viscosity exceeding 50 seconds Saybolt Universal 180˚F.

4. BS&W shall not exceed one (1) percent and the creosote oil mixture shall show no sludge formation upon standing. (Note: AWPA P4 is acceptable as an approved equal for residuum oil).

2.07 APPROVALS AND REJECTIONS

A. Ties with any type of decay will be rejected.

B. Rejection of ties for holes and knots. All such holes and knots as defined shall be allowed if they occur outside the sections of the tie between 20” and 40” from its middle.

1. A “large hole” is any hole more than ½” in diameter and 3” in depth within the rail bearing area, or more than 1” in diameter and 3” deep outside the sections of the tie between the 20” and 40” rail bearing area measured from the center of the tie.

2. “Numerous holes” are any number of holes equaling a large hole in damaging effect. Such holes, whether caused in manufacture or otherwise, will because for rejection.
3. A “large knot” within the rail bearing area is one whose average diameter is more than 1/3 the width of the surface on which it appears. “Numerous knots” are any number, which, in total, equal a large knot in damaging effect. A cluster of knots will be judged as if it were a large knot in damaging effect.

C. Ties with shake more than 1/3 the width of the tie, and nearer than 1” to any surface, will be rejected.
   1. Fire scar will be considered as bark seam and graded accordingly.

D. Except in woods with interlocking grain, ties with a slant grain in excess of 1 in 15 will be rejected.

E. Ties with continuous checks whose depth in a fully seasoned and/or treated tie is greater than ¼ the tie thickness and longer than ½ the length of tie will be rejected.

F. Any other imperfections that are within the limits of current AREMA and RTA Specifications will be allowed.

G. A split is a separation of the wood extending from one surface to an opposite or adjacent surface.
   1. A split 1/8” wide and 4” long in an unseasoned cross tie is acceptable.
   2. A split more than ¼” wide and/or 9” long on the face on which it occurs in a seasoned cross tie will be rejected.
   3. Do not count the end as a surface.

H. Bark seam or pocket is a patch of bark partially or wholly enclosed in the wood.
   1. Bark seams will be allowed outside the rail bearing area provided they are not more than 2” below the surface, ¼” wide, and not more than 5” long.

I. Ties with heart – checks that go into the tie plate area will be rejected if the check is more than a cumulative ½” wide or if the check causes the plate area to be concave or convex.

J. Holes:
   1. Ties having solid holes on any surface within the rail bearing areas greater than ½” diameter and greater than 3” deep will be rejected.
   2. Ties having solid holes on any surface outside the rail bearing areas greater than 1” in diameter or greater than 3” deep will be rejected.
   3. Stump pull will be graded the same as a split in the end of a tie.
   4. A stump pull that goes into the interior of the tie more than 5” will be rejected.
5. Numerous holes are defined as having any number equaling a large hole in damaging effect. Such holes may be caused in manufacture or otherwise.

6. Mechanically damaged ties shall be replaced by the party that damages the tie.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the SCRRA Engineering Standards unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRA’s Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

3.03 PLANT EQUIPMENT

A. Treating plant shall be equipped with the thermometers and gauges necessary to indicate and record accurately the condition of all stages of treatment, and all equipment shall be maintained in acceptable, proper working condition.

B. All green ties should be checked periodically for moisture content prior to going in the cylinder.

1. Twenty (20) borings per charge shall be taken from cross ties, so that the moisture content level can be measured, to determine the amount of water that is to be removed from the crossties.

C. Material shall be conditioned by air seasoning

D. All material, either under vacuum or at atmospheric pressure, should be handled in such a manner that will not cause degrading, checking, splitting, warping or render it unfit for the service intended.

3.04 AIR SEASONING

A. When air seasoning is used, material shall be treated before it begins to deteriorate. Air seasoned material must be given a preliminary heating in the preservative for not more than three (3) hours at a temperature of not more than 210°F, just before the regular treating operation.

1. All Oak/Hickory ties will be seasoned for approximately 10 months to obtain moisture content not to exceed 45 percent on 2” cores.
2. Mixed Hardwood ties will be seasoned for approximately five months to obtain a moisture content not to exceed 40 percent on 2” cores.

3.05 BOULTONIZING

A. Ties shall only be Boultonized as directed by the SCRRA Director of Engineering and Construction or a designated SCRRA representative. Cross ties and switch ties scheduled for Boultonizing shall be separated by size and species, incised, and forwarded to the tramming station for handling prior to initiation of the drying process. Hickory ties must be Boultonized with oaks. Each layer of ties on the tram shall be separated with one ¾” steel cable, steel rod, or ¼” Grade 30 steel chain placed on alternate ends as the layers are built. Switch ties will require two cables, rods, or chains per layer for 9’–12’, and three cables, rods, or chains per layer for 13’–16’ + lengths. All steel or wooden stickers must be removed prior to shipment to SCRRA.

B. When boultonizing, the oils shall cover the material in the cylinder.

   1. The temperature of the oil during the conditioning period shall not exceed 210˚F.

   2. When a vacuum is then drawn, it shall be of sufficient intensity to evaporate water from the material at the temperature of the oil.

   3. The intensity of the vacuum or the temperature of the oil, or both, shall be adjusted so as to regulate the evaporation of the waters.

   4. The conditioning shall continue until the materials are sufficiently heated and enough water removed from the cylinder before an empty-cell process is applied for pressure treatment.

   5. The Boultonized process used is to conform to AWPA section C1-00 Section 1.3.3, most recent version.

   6. Maximum moisture content is to be 50 percent for oak-hickory and 40 percent in mixed Hardwoods before press cycle begins.

3.06 MANNER OF TREATMENT

A. Following the conditioning period, material shall be treated by an empty-cell process to obtain as deep and uniform penetration as possible with the retention of preservative stipulated.

   1. The range of pressure, temperature and time duration shall be controlled so as to get the maximum penetration by the quantity of preservative injected.

3.07 EMPTY CELL PROCESS (LOWRY AND RUEPING)
A. Treatment shall be by the empty cell method with a creosote/coal tar solution or creosote/petroleum (50 percent-50 percent) solution in accordance with AWPA Standard P-2, P-3, and P-4. The preservative solution shall be tested monthly according to AWPA Standard A-1 with a copy of the results forwarded to the SCRRA representative. In no case shall treatment be less than that required for AWPA U1, UC4B.

B. Material shall be subjected to atmospheric air pressure or to higher initial air pressure of the necessary intensity and duration.

   1. The preservative shall be introduced until the cylinder is filled while the air pressure is being maintained during the filling operation.

C. The pressure shall be raised on not more than 210 lbs/sq inch.

   1. Material shall be held under pressure until there is adequate preservative injected to meet specified retention.

D. The temperature of the preservative during the entire pressure period shall not be more than 210°F but shall average at least 180°F.

E. After pressure is completed, the cylinder shall be emptied speedily of preservative, and a vacuum of not less than 22” at sea level created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative, or;

   1. After pressure is completed, and before removal of preservative from tie cylinder, the preservative surrounding the material may be preheated to a maximum of 215°F, either at an atmospheric pressure or under vacuum; the steam to be turned off the heating coils and the leader lines opened immediately after the minimum temperature is reached.

   2. The cylinder shall then be emptied speedily of preservative and a vacuum of not less than 22” at sea level created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative.

F. At the completion of treatment, material may be cleaned by final steaming (when authorized) at a temperature not more than 240°F for not more than 30 minutes.

3.08 RESULTS OF TREATMENT RETENTION

A. No charge shall contain less than 75 percent or more than 110 percent of the quantity of preservative specified for the class of material except when the character of the wood in any charge makes these requirements impracticable despite treatment to refusal.

   1. The amount of preservative retained shall be calculated from readings of working tank gages or scales or weights before and after treatment of loaded trams on suitable track scales, with the necessary corrections for changes in moisture content.

B. The column of oil preservatives shall be calculated on the basis of 100°F.
1. Calculations of volume or weight shall be made by the use of temperature of specific gravity factor contained in the Volume of Specific Gravity Correction Tables of the AWPA.

3.09 PENETRATION

A. Penetration of ties shall not be less than the following for at least 80 percent of the pieces bored in each charge.

<table>
<thead>
<tr>
<th>Thickness (inches)</th>
<th>Depth (Inches)</th>
<th>Percent of Sapwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and over</td>
<td>½</td>
<td>90</td>
</tr>
</tbody>
</table>

B. Penetration of ties shall be determined by boring not less than two (2) ties in each tram in each charge or more than 20 ties per charge.

C. Penetration of timber and ties shall be determined by boring approximately midway between ends and midway between top and bottom on 7" side of tie.

1. Only material meeting the penetration requirements shall be accepted.

D. Any charge not conforming to stipulated minimum requirements may be retreated and re-offered for acceptance.

E. Any holes, which may be bored, shall be filled with tight fitting treated plugs.

F. Process and preservative to be used on material and retention required shall be as follows, unless otherwise specified, for all ties.

<table>
<thead>
<tr>
<th>50 percent Oil Process</th>
<th>50 Percent Creosote Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardwood</td>
<td>7 ½ lbs or Ref. L&amp;R</td>
</tr>
<tr>
<td>Oak</td>
<td>7 ½ lbs or Ref. L&amp;R Bethel</td>
</tr>
</tbody>
</table>

G. Retention will be determined by gauge. The amount of preservative solution retained shall be determined from readings of working tank gauges or scales made before and after treatment. The retention of preservative will be calculated after correcting the volume of preservative solution to 100°F.

3.10 CARE OF TREATED WOOD

A. In handling treated material, extreme care shall be used to avoid damage to the edges of the timbers or breaking through the portions penetrated by the treatment and exposing untreated wood.

B. The use of peaveys, timber dogs, picaroons, log hooks, or other pointed tools shall be such as not to break through the treated portion of treated timber.

3.11 PLANT STORAGE
A. The storage yard for seasoning shall be in the open where the air current will circulate freely; shall not be in a low humid situation if it can be avoided; shall have good drainage; and shall be kept free from vegetation and debris, especially from scrap wood already infected with decay.

B. Treated materials shall be stored in a similar manner to untreated, but must not be piled in same area with untreated materials.

C. Unseasoned material must be stacked separately from seasoned or partly seasoned material.

3.12 STACKING

A. Sawn ties shall be stacked either 1 x 9 or 2 x 9 standard stacking method.

B. Alternate: If necessary to retard evaporation of moisture from the ties, they may be stacked parallel on edge, using cross ties as separators.

3.13 BARKING

A. Remove bark and inner skin before treatment.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
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SECTION SS 34 11 36
ELASTIC RAIL FASTENERS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section specifies the material requirements and performance criteria for Elastic Rail Fasteners to be furnished in accordance with Contract Documents or required by the Engineer.

1.02 REFERENCES
A. American Railway Engineering and Maintenance of Way Association (AREMA):
B. American Society for Testing of Materials (ASTM)
   1. ASTM A123, Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on iron and Steel Products;
   2. ASTM A689 - Standard Specification for Carbon and Alloy Steel Bars for Springs;
   3. ASTM E112 - 10 Standard Test Methods for Determining Average Grain Size;
   4. ASTM E18 - 08b Standard Test Methods for Rockwell Hardness of Metallic Materials
C. British Standards Institute
   1. BS EN 10089 - Hot rolled steels for quenched and tempered springs, grade 56SiCr7
D. International Organization for Standardization (ISO)
   1. ISO 9001 Quality Management Systems – Requirements;
   2. ISO 643:2003 Steels -- Micrographic Determination of the Apparent Grain Size
E. SCRRA: Engineering Standards.
F. Shepherd Fracture Grain Size Standards
1.03 DEFINITIONS

A. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

B. Closure Rails – The rails between the parts of any Elastic rail fasteners layout, such as the rails between the switch and the frog in a turnout.

C. Fasteners – Joint bars, bolts, clips and spikes

D. Shepherd Fracture Grain Size Standards:
   2. The set of Fracture Grain Size Standards consists of 10 fractured specimens (each 3/4" diameter) in an enclosed compact case. Each specimen is numbered consecutively from 1 (coarse grain) to 10 (fine) and are accurately spaced with equal increments of fracture differential through this range.
   4. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz. of zinc per square foot of metal (average specimens) unless noted otherwise or directed by the standard.

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the turnouts have been placed in service.

B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. The Vendor shall submit for SCRRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality Elastic rail fasteners Materials included in the list of Elastic rail fasteners items as provided in the Schedule of Quantities and Prices.

D. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing Elastic rail fasteners material to Class 1 Freight, passenger or commuter railroads.
E. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRA’s Standard Specifications Section 01 25 00, “Substitution Procedures”. The specifications are available on SCRRA’s website at www.metrolinktrains.com.

F. Qualifying Tests: The Vendor or supplier must submit the results of the following initial qualifying tests for equivalent fasteners:

1. AREMA Manual for Railway Engineering, Chapter 30, Part 2.6:
   a. Test 5A – Fastener Uplift,
   b. Test 5B – Fastener Longitudinal Restraint,
   c. Test 5C – Fastener Repeated Load,
   d. Test 5D – Fastener Lateral Load Restraint,
   e. Test 5E – Fastener Assembly Rotation.

G. Fatigue Tests:

1. The Vendor or supplier must submit the results of the fatigue tests used to determine final acceptance of the clips from each heat of steel.

H. Shepherd Fracture Grain Size Analysis: The Vendor must submit the results of the Shepherd Fracture Grain Size analysis.

I. Samples:

1. The Vendor or supplier must submit samples of the raw material used in the production of the clips for independent verification, by SCRRA, of the chemical, physical, and mechanical properties steel used in the production of the clips.

2. The Vendor or supplier must submit, upon request by SCRRA, up to 20 samples of finished clips without charge for fatigue testing by SCRRA.

J. Mill Test Reports:

1. The Vendor or supplier must submit mill test reports for each heat of steel used in the manufacture of the clips furnished on a given order.

1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRA approved equivalent quality control program.

B. Manufacture must be performed by companies certified to ISO 9001: 2000. Certification must be held by the plant producing the clips. Certification of a
distributor for a manufacturer is not sufficient to satisfy this requirement.

C. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Elastic rail fasteners materials delivered to SCRRA shall be either promptly modified to meet specifications or removed from SCRRA’s delivery and storage locations within 30 calendar days.

D. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

E. Final fatigue testing of the clips may be performed in the facility of a manufacturer, or a distributor, or an independent testing laboratory. However, all fatigue testing must be performed within the coterminous United States and subject to witness by representatives of SCRRA. Notice of testing must be provided to SCRRA a minimum of three weeks prior to the tests. A representative of SCRRA will select the samples to be tested.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

B. The material will be supplied to the SCRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

PART 2 - PRODUCTS

2.01 DESIGN

A. Clips must be Pandrol® brand type e-2055 (e-2056 for left hand application) elastic rail clips or an equivalent in shape, size, function, and performance as generally described in United States Patent No. 4,413,777, and as shown on SCRRA ES2361 and ES2362. The equivalence of any alternative design, including the chemical and physical characteristics of the material, must be established through qualification by successful performance the tests described in AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A – Fastener Uplift, Test 5B – Fastener Longitudinal Restraint, Test 5C – Fastener Repeated Load, Test 5D – Fastener Lateral Load Restraint, and Test 5E – Fastener Assembly Rotation. For the purpose of conducting Test 5A – Fastener Uplift, the load “P” must be not less than 5500 pounds for each pair of fasteners.

B. ‘Pandrol’ Brand Rail Clips form part of a ‘Pandrol’ Brand Rail Fastening System and hold the rail to the tie, baseplate or other track support.
C. A new qualification test must be performed for each change in dimension or shape of the clip, or a change in the chemical, physical, and mechanical properties of the raw material used in the manufacture of the clip.

D. In lieu of performing the acceptance tests SCRRA may, at its sole discretion, may accept a clip offered as an equivalent to the specified clip upon evidence of satisfactory in-track performance for 10 years or more on a North American main line carrying 40 MGT or more each year.

1. The supplier shall have a minimum of five years’ experience in supplying rail clips and other track materials.

2.02 PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES

A. The raw material must be a fine-grained chromium allow spring steel with a composition closely approximating SAE/AISI Grade 5160, or ASTM A689, or BS EN 10089. Modifications to the basic alloy by the Vendor of the steel are required to achieve the physical, mechanical, and performance requirements of this specification.

B. Shepherd fracture grain size of the raw material must be seven (7) or greater.

C. Finished clips must possess a Rockwell C surface hardness not less than 44 or more than 48 when tested in accordance with ASTM E18.

D. All pair of finished rail clips must produce a minimum resistance load of 5500 pounds before separation of the rail from the rail seat when tested in accordance with AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A Fastener Uplift.

2.03 MANUFACTURE

A. Rail clips must be formed from a round bar stock made from a fine-grained chromium allow spring steel. The steel must be quenched and tempered during manufacture to achieve the physical and mechanical characteristics specified, and meet the requirements of the qualification tests.

2.04 PERFORMANCE REQUIREMENTS

A. Five clips produced from each heat of raw steel material must be tested after manufacture for fatigue failure. In performing the test, a single clip must be fixed in the test machine and a 2750 pound load applied at the toe of the clip. The clip must then be raised 1mm above the neutral (2750 pound load point) and relaxed to a point 1 mm below the neutral (2750 pound load point) through three million (3,000,000) cycles (one cycle = neutral to raised position to lowered position to neutral position).

1. Rail fastening system shall be resilient, thread-less and adjustable in three steps without dismantling the fasterner. The three steps shall be:
a. Retracted: Permits installation or removal of rail intermediate;
b. Permits longitudinal rail movement clamped;
c. Provides full rail clamping force.

B. The Vendor may use a test procedure similar to that described in Chapter 30, Part 2.6, Test 5A, of the AREMA Manual for Railway Engineering, or the Vendor may use the test described in Appendix I of Australian Standard 1085.19, or the Vendor may use another test procedure provided that the clip moves through a distance of 2mm, under a load of 2750 pounds at the mid-point of the range of flexure.

C. From the 5 clips selected, if two clips in a row break, all clips manufactured from the heat of steel tested must be rejected. If two clips in a row pass, all clips from the heat of steel tested, may be accepted.

D. A failure is recorded when a tested clip exhibits a loss of elasticity, breaks, or the neutral position load drops below 2750 pounds during the test.

E. Table below lists the possible test combinations and the action to be taken:

<table>
<thead>
<tr>
<th>Test Number and Results</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Pass</td>
<td>Fail</td>
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<td>Fail</td>
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F. At the conclusion of the fatigue test above, the pair of clips that have passed the fatigue test must prevent separation of the rail from the rail seat when a minimum uplift load “P” of 5500 pounds in accordance with AREMA Manual for Railway Engineering, Chapter 30, Part 2.6, Test 5A - Fastener Uplift.
G. The clips must not break when applied or removed with a 8 lb to 12 lb sledge hammer provided that the clips are not over-driven.

2.05 TOLERANCES

A. The clips shall conform to the dimensions on SCRRA drawing and shall fit the relevant standard 'Pandrol' inspection gauges and/or direct measuring fixture.

B. Alternatively, a Vendor may provide its standard dimensional tolerances and the means used to measure each clip for conformance to the standard to SCRRA for review approval.

2.06 INSPECTION

A. All clips must be inspected for visual defects, incomplete formation, damage, or dimensional non-conformance.

2.07 NUMBER OF TESTS AND RETESTS

A. A minimum of five clips from each heat of steel used for Vendor of the clips must be tested. SCRRA may, at its expense, select additional clips from any order and submit them to the fatigue test described in this specification. SCRRA will provide the Vendor or supplier a minimum notice of three weeks in advance of the date on which the test will be performed. The Vendor or supplier may, at its expense, send a representative to witness the test.

B. The Vendor must replace without charge any unused portion of an order that does not pass the fatigue test administered by SCRRA with clips that conform to the requirements of this specification.

2.08 WORKMANSHIP, FINISH, AND APPEARANCE

A. The clips must be free from burrs which may be considered harmful when handled or affect efficient assembly of the clip. Marks caused by the forming tools shall be smooth and free from sharp indentations.

B. All clips must be Hot Dipped Galvanized in accordance with ASTM A123.

2.09 PRODUCT MARKING

A. Each clip must be stamped with a code indicating the date of manufacture, the manufacturer, and the plant in which the clips have been made. A mark indicating the heat of steel used must also be included if the above information is not sufficient to trace the clip to a specific heat of steel.

2.10 PACKAGING AND PACKAGE MARKING

A. Clips must be packaged in sacks containing 30 fasteners (approximately 50 lbs) unless otherwise specified or approved by SCRRA.
2.11 SOURCE QUALITY CONTROL

A. Vendor must be performed by companies certified to ISO 9001: 2000. Certification must be held by the plant producing the clips. Certification of a distributor for a Vendor is not sufficient to satisfy this requirement.

B. Final fatigue testing of the clips may be performed in the facility of a Vendor, or a distributor, or an independent testing laboratory. However, all fatigue testing must be performed within the coterminous United States and subject to witness by representatives of SCRRRA. Notice of testing must be provided to SCRRRA a minimum of three weeks prior to the tests. A representative of SCRRRA will select the samples to be tested.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the SCRRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRRA’s Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 72 00, Trackwork or Section 34 72 20, Track Shifting, Relocation, and Resurfacing and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION SS 34 11 40
PRECAST CONCRETE GRADE CROSSING PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the material requirements and performance criteria for the Precast Concrete Grade Crossing Panels to be furnished in accordance with Contract Documents or required by the Engineer.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):
   1. Manual for Railway Engineering
   2. Specifications for Special Trackwork

B. American Welding Society (AWS):
   1. AWS B2.1: Standards for Welding Procedures and Performance Qualifications
   2. AWS D1.1: Structural Welding Code

C. American Society for Testing of Materials (ASTM)
   1. A36: Standard Specifications for Carbon Structural Steel
   2. A123: Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products
   3. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   5. C666: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
12. D2137: Standard test Methods for Rubber Property- Brittleness Points of Flexible Polymers and Coated Fabrics

D. Association of American Railroads (AAR)

E. International Organization for Standardization (ISO)
   1. 9000: An International Consensus on Good Quality Management Practices

F. Prestressed Concrete Institute (PCI)
   1. MNL115: Fundamental of Prestressed Concrete Design
   2. MNL124: Design and Typical Details of Connection for precast and Prestressed Concrete
   3. MNL138: PCI Connections Manual for Precast and Prestressed Concrete Construction

G. SCRRA: Engineering Standards, especially ES2402.

1.03 DEFINITIONS

A. The word “Vendor” used in the Material Specifications (SS) shall mean the Contractor.

B. Field Side – End of tie plate designed to be located on the opposite side of the rail from the centerline of track

C. Gage Side – End of tie plate designed to be located closest to the centerline of track

D. OTM – A general term referring to all miscellaneous materials other than rail and ties
E. Shunt – A connection between two points in an electric circuit that forms an alternative path for a portion of the current

1.04 SUBMITTALS

A. The Vendor shall submit supporting information within 60 days of award documenting the past successful performance in furnishing the materials included in the Schedule of Quantities and Prices. Provide references and contact numbers at the railroads where the precast concrete grade crossing panels have been placed in service.

B. The Vendor shall submit certificate of compliance that the material delivered is in compliance with the specification within 60 days of approval of payment.

C. The Vendor shall submit for SCRRRA’s review and approval quality control and quality assurance plans and related certifications such as ISO 9001, “six sigma” or equivalent demonstrating that the Vendor has the processes, personnel and systems to produce high quality precast concrete grade crossing panels included in the Schedule of Quantities and Prices.

D. The Vendor shall submit data documenting past performance and projects within the last ten (10) years furnishing precast concrete grade crossing panels material to Class 1 Freight, passenger or commuter railroads.

E. The Vendor shall include installation instructions.

F. Submit Certificates of Compliance for all precast concrete grade crossing panels. Include material qualification test reports for materials, components, and assemblies.

G. Administrative and procedural requirements for proposed changes in product and materials from those required by these specifications shall be as per SCRRRA’s Standard Specifications Section 01 25 00, “Substitution Procedures”. The specifications are available on SCRRRA’s website at www.metrolinktrains.com.

1.05 QUALITY ASSURANCE

A. Vendor’s Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or SCRRRA approved equivalent quality control program.

B. Materials or partially or fully assembled products not meeting the specifications shall be rejected. Precast concrete grade crossing panels delivered to SCRRRA shall be either promptly modified to meet specifications or removed from SCRRRA’s delivery and storage locations within 30 calendar days.

C. Equipment used for the manufacturing materials shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment shall be certified and traceable to national standards such as the National Institute of Standards and Technology.
1.06 DELIVERY, STORAGE AND HANDLING

A. The Vendor shall load, transport, and handle the material in a manner which will prevent damage to the material.

B. The material will be supplied to the SCRRRA in accordance with the delivery requirements, FOB Destination. Quantity of each supply will be as requested by the SCRRRA release document. The material when purchased is to be delivered to the Los Angeles area at a place designated by the SCRRRA. A complete Bill of Material for each order will be submitted with modes, dates, contents, and destinations of shipments clearly indicated. A complete shipping list with reference to blanket purchase agreement, if applicable, will accompany all deliveries of materials.

1.07 WARRANTY

A. The Vendor shall warranty the precast concrete grade crossing panels for a minimum ten years against defects in materials and workmanship.

PART 2 - PRODUCTS

2.01 GENERAL

A. Precast concrete grade crossing panels shall be new and conform to SCRRRA Engineering Standards ES2402.

B. Precast concrete grade crossing panels ordered to the Engineering Standards shall be produced in conformance to these specifications.

2.02 CONCRETE PANELS

A. Precast concrete grade crossing panels shall be lag-down heavy duty panels.

B. Precast concrete grade crossing panels shall be designed for use on 10 feet wood track ties and ballast track.

C. Precast concrete grade crossing panels shall have flangeways not less than 2½” in width and be electrically isolated to prevent shunt currents.

D. Precast concrete grade crossing panels shall be sized such that when installed, the top of the panels is at the top of rail elevation.

F. Panels shall be of the type which fastens to the timber ties utilizing a lagging screw system which fastens from the top down. The lagging screws shall be mechanically galvanized with zinc coating in a room temperature process, without electricity and without heat.
G. Rubber flangeway filler shall be designed to match the precast concrete crossing panels and rail fastening system.

H. Grade crossing surface systems, including any flangeway (gage and field side) filler material components, must be electrically non-conductive so as not to interfere with train control or crossing signals.

I. Each gage panel shall incorporate a 3” UHMW shunt break to assure electrical isolation. End angle for gage panels shall have 3” minimum gap to improve shunt resistance.

I. Concrete Crossing Panels shall be by Omega Industries or approved equal for use on SCRRA.

2.03 CONCRETE

A. Concrete compressive strength shall be minimum 6000 psi. The compressive strength shall be 2500 psi before panel is removed from forms and 5,000 psi at 21 days.

B. Minimum cement content shall be seven sacks per cubic yards.

C. Maximum water/cement ration shall be 0.44. Slump shall not exceed three inches.

D. Concrete sealant shall be used to prevent cracks and ion migration. Sealant shall be applied to fresh concrete as an aid in curing, hardening, water proofing, acid proofing and oil proofing each panel.

2.04 STRUCTURAL STEEL

A. Reinforcing steel shall be grade 60.

B. Steel angles shall be ASTM grade 36. The exposed steel shall receive one primer coat.

2.05 RUBBER FLANEGWAY FILLER

A. Rubber flangeway filler shall be permanently attached to the concrete panels.

B. Rubber flangeway filler shall meet the following:
   1. Tensile strength – 850 psi
   2. Ultimate elongation – 400% minimum
   3. Tear strength at 25 degree Celsius – 150 ppi minimum
   4. Hardness – 75
   5. Compression set 100 degrees Celsius for 70 hours
6. Accelerated aging test – 70 hours
7. Ozone resistance test – 5- PPHM for 96 hours
8. Electric resistance – 10 mega ohms minimum

C. The pre-attached flangeway filler shall allow for the removal of panels for maintenance without damaging the flangeway filler or any other components designed to hold the panel together.

2.06 FINISHES

A. All recess and minor concrete spalls are to be filled and finished to the panel dimensions using the proper bonding agent and repair material. Surface of the repaired area is to match the color and texture of the surrounding area.

B. The driving surface is to have a light broom finish or as approved by SCRRA. The addition of water to the concrete surface finish during casting is not permitted.

2.07 MARKING

A. Each precast concrete grade crossing panel shall be marked with concrete imprint for size of rail, weight of panel, Manufacturer’s ID, month/day/year of manufacture and crossing type. End of each panel will be stenciled painted with size of rail, weight of panel and crossing type.

2.08 SOURCE QUALITY CONTROL

A. During precast concrete grade crossing panel fabrication, perform the tests and inspections specified in these Specifications.

B. Vendor shall submit (via an independent testing laboratory to SCRRA), the freeze/thaw, mortar bar method and total alkali burden (0.06%) tests on the mix design.

C. A representative sample of panels shall be checked for bottom flatness.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the SCRRA Engineering Standards Standard Specifications unless specifically noted or excepted within these specifications. Promptly notify SCRRA of any conflicts, omissions or needed clarifications arising from the use of the designated drawings, standards or specifications.

3.02 SCHEDULE

A. The Vendor providing the materials shall contact SCRRA’s Material Management Supervisor at phone number 909-468-9729, 48 hours prior to the date of delivery.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work associated with project item in Section 34 71 50, Highway-Rail Grade Crossings and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 00
GENERAL SIGNAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. The work in this Section includes, but is not limited to, general procedures and requirements and incidental to the planning, manufacturing, installation, removal, relocation, modification, testing, placing in service, and documentation of as-built conditions of the various signal systems.

B. General:

1. Provisions of this Section apply to all Sections of Division 34, Transportation, Subdivision 34 42, Railroad Signals.

2. Modify existing equipment and material as shown on the Contract Plans to interface with the existing and proposed signal system.

C. Related Specification Sections include but are not necessarily limited to:

1. Section 01 14 19 – Coordination with Utility Owners

2. Section 01 29 73 – Schedule of Values

3. Section 01 33 00 – Submittal Procedures

4. Section 01 35 15 – Maintenance and Protection of Railroad Traffic

5. Section 01 43 23 – Contractor Qualifications and Requirements

6. Section 01 56 37 – Worksite Security Requirements

7. Section 01 78 39 – Project Record Documents

8. Section 09 90 00 – Painting and Coatings

9. Section 09 96 23 – Graffiti Resistant Coating

10. Section 31 20 00 - Earthwork

1.02 REFERENCES

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; SCRRRA Design Standards, and any applicable local ordinances.

B. The following General Orders (G.O.) or the most current General Orders 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


5. G.O. 118: Construction, Reconstruction, and Maintenance of Walkways and Control of Vegetation


C. The following parts of the Code of Federal Regulations, Title 49, Transportation, shall apply:

1. Part 212: State Safety Participation Regulations

2. Part 219: Control of Alcohol and Drug Use

3. Part 218: Railroad Operating Practices

4. Part 228: Hours of Service of Railroad Employees

5. Part 234: Grade Crossing Signal System Safety

6. 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

7. Part 236: Rules, Standards, and Instructions for Railroad Signal System

8. 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.

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 Communication 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”, it shall be substituted with the word “shall”.

F. American Railway Engineering and Maintenance of Way Association (AREMA):


1.03 SYSTEM DESCRIPTION

A. Provide all materials and installation services required for complete working signal systems, as described herein, and as shown on the Contract Plans, including any equipment not designated as being relocated or designated as Owner-furnished or in these specifications.

B. 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 Plans and specified herein.

C. The Contract Plans 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.

D. Provide systems that are compliant with applicable rules and regulations of CFR 49, parts 234 and 236, and CPUC GO 75D. Refer to Design Submittals herein for Contractor’s responsibility to indicate any corrections or modifications to the Contract Plans final design that the Contractor may determine are required to conform to these rules and regulations.

E. Be present 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.

F. 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.
G. Provide continuous train control and highway grade crossing warning during all phases of rail construction. The work of the contractor must not delay to train operations, cause an unsafe signaling condition, or reduce the effectiveness or quality of the existing or new grade crossing warning systems. The Contractor shall submit, for approval by the Resident Engineer, its proposed plan for providing alternate methods of crossing warning whenever the existing automatic crossing warning devices are deactivated, altered, or modified in order to accommodate construction work. Alternate methods shall conform to CFR 49, Part 234, and all local ordinances.

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.

H. Provide rail bonding for all new, temporary and relocated turnouts as shown on the Contract Plans or as required by the Engineer. Provide rail bonding, as necessary, to maintain existing systems during construction of all work including other disciplines.

I. Protect existing signal cabling and, where necessary, relocate existing cabling in order to prevent damage during track installation and surfacing. In the event that the Contractor damages existing cabling, the Contractor shall be responsible for all repairs, testing and replacement, if necessary, to existing cabling. Provide all new signals, new foundations, new cabling, and other new equipment as shown on Plans. The Contractor shall remove and reuse existing signaling equipment as indicated on the Drawings and in these specifications.

J. Refer to Section 01 78 39, Project Record Documents, and additional requirements specified herein. Record the final As-Built conditions of the signal systems for each system.

K. Perform and document all tests and inspections in accordance with CFR 49 regulations, the AREMA C&S Manual, the “Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems”, and these Specifications.

L. Refer to Section 01 43 23, Contractor Qualifications and Requirements, 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.

M. 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.

N. Perform acceptance testing and commissioning of the signal system as a normal part of the work.
O. Contractor furnished software and components shall be new and manufacturer certified.

P. 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.

Q. Refer to Division 31 20 00, Earthwork, for provisions for excavation and requirements for shoring of excavation as specified in Section 31 23 50, Excavation Support Systems.

R. Refer to Sections 31, Earthwork and 01 14 49, Coordination with Utility Owners, for requirements in 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 Plans. Information regarding new conduit runs and pullbox installations appear elsewhere in the Contract Plans. Conduit runs and pullbox locations, as shown, are the preferred locations. In case of conflict between the signal Drawings and other Contract Plans, 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 Plans, as part of the Work. Deviations in excess of 10 feet may be subject to the changes provisions of General Conditions.

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

T. Any components or equipment proposed by the Contractor as an equal to those specified in these specification, which are not currently in use on the Metrolink system or that do not have spare maintenance parts in SCRRA stocks, will require that the Contractor furnish sufficient spare components equal to 10% of the quantity order or a minimum of two (2) additional units, whichever is greater. The Contractor shall also arrange for manufacturer provided training for Metrolink maintenance personnel. Spares and training are to be furnished by the Contractor at no additional expense to SCRRA.

U. Provide construction signal support and coordination of all work with other disciplines including but not limited to track installation and removal, bridge construction or reconstruction, rail and track renewal within crossings, installation or change of track switches, clearing and grubbing. Contractor shall coordinate all work with other disciplines that may affect the existing crossings and track circuits in order to prevent train delays or inconvenience to the public.
1.04 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.

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.

E. Fail-safe equipment proposed for vital signaling applications shall have been proven with five (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 SUBMITTALS

A. Do not begin any work without the prior submittal to and approval by the Resident Engineer of the relevant personnel, plans and procedures.

B. Submit résumés of the proposed Signal Engineer(s) and Signal Manager(s) within 14 calendar days after receiving Notice to Proceed.

C. Submit to the Engineer for approval, proposed design changes, plans, test and inspection procedures, data sheets of proposed material, installation details, Shop Drawings, mechanical Drawings, proofs of compliance with applicable standards, and any other pertinent data required to fully demonstrate the Contractor’s proposed plan for the manufacture, installation, testing, and maintenance of the various signaling systems. The Contractor shall provide submittals within 30 calendar days after receiving Notice to Proceed.

D. Submit to the Resident Engineer 4 sets of application, installation, operating, and maintenance manuals of all new equipment and systems utilized under this Contract a minimum of 30 calendar days prior to placing any system in service.

E. Submit a detailed test plan for all systems a minimum of 60 days in advance of placing any system in service. These test plans shall reflect the latest revisions and changes approved by the Resident Engineer and made as a result of field checks and conditions. The Contractor shall not proceed with the cutover or in-service testing until the Engineer approves the test plans. Plans shall include, but are not limited to:

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.

F. Prepare and submit a 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 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. Manufacturers’ warranties and guarantees furnished for materials used in the work, instruction sheets, and part lists supplied with materials shall be delivered to the Resident Engineer prior to acceptance of the project. All equipment, material warranties, and guarantees shall cover parts and labor for two years from the date of final “acceptance”.

H. After a location is placed in service and prior to final acceptance of the project, the Contractor shall submit as-built documentation as follows:

   1. Detailed circuit Drawings within 3 days.
   2. Submit four copies of all as-built documents to the Resident Engineer within 3 business days.
   3. Final application logic documentation within 3 business days.
   4. 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.

I. Resident Engineer or his/her representative may inspect the Contractor’s furnished materials and work procedures during all phases of construction. Materials and procedures that fail to meet the requirements of these specifications, or regulations, shall not be installed or placed in operation.

J. Ensure that equipment used in the testing of wayside signal and grade crossing warning systems and components shall be in proper calibration. Test meters and other test apparatus shall have been inspected by a recognized facility that performs calibrations for proper calibration a minimum of 6 months prior to performing required tests. A sticker, or other documentation, must be made available for inspection at the request of the Resident Engineer.

1.08 DELIVERABLES

A. Submit manufacturers’ warranties, instruction sheets, and part lists supplied with materials to the Engineer prior to Final Acceptance.

B. Operation and Maintenance Data: Refer to Section 01 33 00, Submittal Procedures, for Operations and Maintenance Data Manual requirements. 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.
1.09 QUALIFICATIONS AND DUTIES OF SIGNALING PERSONNEL

A. Refer to Section 01 43 23, Contractor Qualifications and Requirements. 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. Signal Electrician, as used herein, shall be understood to mean Contractor's electrician(s) used to perform wiring and installation of railroad signal and grade crossing warning system circuits, component, and control equipment and devices including their primary and backup power supply systems.

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 and roadway 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. The Signal Engineer shall obtain, review, and maintain documentation of the required minimum experience, a copy of the Electrician's license(s), and a record of wage rate paid for each Signal Electrician that performs Signal or Crossing Warning System work prior to that Electrician starting any Signal related work. This documentation shall be available for review by the Engineer at all times upon request.

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.

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, or commuter railroad comparable to SCRRA. 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 Metrolink commuter trains. Candidate shall have a similar level of experience. 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 or commuter railroad comparable to SCRRA. 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 Metrolink commuter trains. Candidates shall have a similar level of experience. 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 Metrolink 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, Signal Manager, or Signal Electrician 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. The Signal Electricians shall have a minimum 1,000 hours of experience in the wiring and installation of railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. Signal Electricians shall perform the wiring, labeling and connection/continuity/resistance testing, as appropriate, of all
railroad signal and grade crossing warning system circuits, components, control equipment and associated devices including their primary and backup power supply systems. All Signal Electricians shall be licensed: Journeyman or Inside Electricians or an approved equal. Signal Electricians shall be paid at the prevailing wage rate for the locality of the construction.

K. All Contractor field personnel shall receive safety training in accordance with Section 01 43 23, Contractor Qualifications and Requirements, 01 35 23, SCRRA Site Safety Requirements, and 01 56 37, Worksite Security Requirements.

1.10 AS-BUILT DOCUMENTATION

A. Refer to Section 01 78 39, Project Record Documents, for requirements preparation and submittal of Record Documents.

A. The following as-built documentation requirements augment requirements specified in Section 01 78 39, Project Record Documents. After a location is placed in service, submit as-built documentation as follows:

1. Detailed circuit Drawings within 3 days.

2. Submit four copies of as-built corrections to the Engineer within 3 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 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.

1.11 TRACK AVAILABILITY REQUIREMENTS

A. General: Refer to Sections 01 35 15, Maintenance and Protection of Railroad Traffic for track access and related provisions. Metrolink Commuter Service and any other passenger or 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, Metrolink, other railroad, as applicable, and the Operating Railroad of Record to keep train delays to a minimum.

1.12 BID ITEM LIST

A. Submit the Bid Item List for signal bid items as required under Section 01 29 73, Schedule of Values, and in accordance with the following additional requirements:

1. Bid Item List 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, all pretesting and removal of old equipment.

2. Organize Bid Item List 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.

1.13 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 North America 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 Signal Manual, except as modified in the Specifications and Contract Plans.

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, perform all necessary work to fit the alternate equipment to these specifications and to revise the Contract Plans.

### 2.02 ELECTRICAL AND ELECTRONIC COMPONENTS

A. All contractor provided electrical and electronic component materials furnished under this contract shall be new. 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. Loads shall be divided so that no normal operating current is more than 75 percent of the fuse rating.

7. Fusing shall be functionally oriented to minimize the equipment affected by a blown fuse (i.e., per track, switch control circuits, etc.)

8. 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 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 09 90 00, Paints and Coatings and 09 96 23 Graffiti Resistant Coating.

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 09 90 00, Paints and Coatings and 09 96 23 Graffiti Resistant Coating.

2.04 FIELD PAINT MATERIALS

A. Field finish as specified in Section 09 90 00, Paints and Coatings and 09 96 23, Graffiti Resistant Coating 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 Plans shall be in accordance with the SCRRA Engineering 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 09 90 00, Paints and Coatings and 09 96 23, Graffiti Resistant Coating 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. Touch-up signal manufacturer’s finishes after installation.

B. Touch-up signal manufacturer’s finishes after installation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. General Signal Requirements will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. All work and services included in Sections 34 42 10, Coordination with SCRRA Procurement Contractor; 34 42 38, Interlocking Controls; 34 42 40, Solid State Coded Track Circuits; and 34 42 56, Signal Grounding; will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

C. Demolition and Removal of Existing Equipment including retiring of CPs, Grade Crossings, Signals, Gates and Cabling will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. General Signal Requirements furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Demolition and Removal of Existing Equipment including retiring of CPs, Grade Crossings, Signals, Gates and Cabling completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 10
COORDINATION WITH SCRRA PROCUREMENT CONTRACTOR

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes requirements coordinating installation, inspection, and testing of new Owner furnished material with the Engineer and with the Owner's procurement contractor. Notify the Engineer in writing a minimum of 30 days prior to any installation, inspection and testing of such material.

B. Refer to Section 01 64 00, SCRRA Furnished Material and Equipment, in the paragraph “Materials furnished by the Authority”.

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 Conditions, Warranty 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 Conditions, Warranty 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

A. Not Applicable to this Section.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor,
materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 16
SIGNAL WIRE AND CABLE

PART 1 - GENERAL

1.01 SUMMARY

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

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 20 00 – Earthwork
   2. Section 34 42 58 – Signal System Testing
   3. Section 34 42 60 – Signal System Miscellaneous Products

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

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 mega ohm.

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. Product Sample: The Contractor shall submit one (1) foot of sample cable when requested by the Resident Engineer. Resident Engineer shall make request in writing prior to approval if deemed necessary to ensure the product data submittal meets the specification.

C. 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.

3. All signal wire and cable furnished under this Contract shall be provided as new, and shall not be installed under this Contract if the manufacture date of the cable exceeds 24 months prior to the Notice-To-Proceed date.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping, storage, and handling shall be in accordance with 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 Plans.

B. Internal wire and cable shall conform to AREMA C&S Manual, Part 10.3.14, and the following requirements:


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 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 Plans.

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. Twisted track wire shall be Okonite-Okolene (EP-PE) manufactured by Okonite Co., or approved equal.

2. Track wire shall meet the requirements of AREMA C&S Manual, Part 10.3.15.

C. Signal, Switch, and Express Cable

1. Wire and cable used for signals, switches and express cable shall be Okonite (EP) Armored Underground Signal Cable manufactured by Okonite Co., or approved equal.

2. Conductors number six (#6AWG) and smaller shall be solid. Conductors number 4 (#4AWG) and larger shall be stranded.

3. Armored cable 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.


D. AC Power Cable

1. AC power shall be Okonite-FMR (EP) Okolon(CSPE) Type TC Cable manufactured by Okonite Co., or an approved equal.

2. Cable shall meet the requirements 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 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 mega ohms 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 production. The Engineer shall have the right to make inspections and tests, as necessary, to determine if the wire or cable meets the requirements of this Specification. The Engineer shall have the right to reject wire or cable that is defective in any respect.

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 in conduit in accordance with the Metrolink Standard Plans, and as called for in the Contract Plans.

3. The signaling cables shall be separated 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 a minimum of three reterminations of the conductor, due to broken eyelets without re-servicing or re-potheading 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 acceptance.

9. Identify individual cable conductors at each cable termination with plastic tags, as specified in Section 34 42 60, 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 emerged from the end of a conduit or pipe. Seal and plug all spare conduits. Seal around conduits where conduit(s) enter enclosure(s) to prevent entry of vermin and insects.

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 Scotch 88 plastic electrical tape or approved equal.

12. Terminate all cable conductors in number 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. When crossing underneath tracks, bury conduit(s) to a uniform minimum depth of 36 inches as measured from bottom of tie to top of conduit(s). When paralleling the tracks, bury conduit(s) a minimum depth of 36 inches as measured from the finished grade to top of conduit(s). Provide backfill and compaction as specified in these Specifications. Install cable within four-inch PVC schedule 80 conduit when passing under tracks or crossing a roadway. Install cable within four-inch PVC Schedule 80 conduit(s) when paralleling the tracks.

2. Upon written request from the Contractor and only under extreme circumstances because of installation hardship will installation of conduit(s) be allowed to a depth of less than 36 inches, and is subject to the Resident Engineer’s approval. The Contractor shall protect the conduit(s) and cable(s) in a manner acceptable to the Resident Engineer.

3. Ensure that whenever any signal conduit(s) is to pass under pavement or roadway, and if conduit is not provided by others, the Contractor shall
provide and install cable(s) in 4-inch PVC Schedule 80 conduit and extend schedule 80 conduit(s) a minimum of 2 feet beyond the edge of the curb and gutter and/or sidewalk, where applicable. Installation of conduit(s) and pull box(es) shall be in accordance with SCRRA C&S Engineering Standards. Restore pavement and roadway to its original condition including striping and markers, subject to local municipal requirements and the Resident Engineer's acceptance.

4. Whenever any signal cable is to pass under the hot-mix asphalt concrete (HMAC) underlay installed on the project, provide and install cable(s) in conduit(s) with pull boxes in accordance with the SCRRA Standard Plans.

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 underground cables enter a concrete foundation, junction box, shelter or case, leave sufficient slack in each cable in the nearest pull box to allow a minimum of an additional one foot of cable to be pulled into the shelter or junction box.

7. Ensure that the pot heading of underground 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. The Contractor shall ensure that cable(s), track wire, and conduit(s) shall be installed per Contract Plans and Section 31 20 00, Earthwork.

9. 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.

10. All cables except final connection of flex wires to rail shall be installed in a conduit system as shown on the Contract Plans.

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. Provide and install AC power cable dedicated conduit from the service meters to the signal shelters and between signal shelters.

E. CABLE PULLING
1. Provide cable pulling as specified within the conduits installed by the Contractor.

2. Do not use poly rope for any mechanical means of pulling cable. Poly rope stretches when subjected to high tension and can create a hazard. Manual pulling (by hand) using poly rope is allowed. When using a mechanical means to complete a pull, a Samson rope or equivalent, flat line, shall be used, as it does not stretch in the same way that poly rope does, and presents less of a hazard.

3. Provide two-way voice communication and adequate resources at both feeding and pulling ends of the run and at any interim location (e.g. 4 X 4 pull boxes). Apply cable pulling lubricant liberally during the cable pull. To minimize back reel tension accelerate slowly and smoothly from rest to a constant pulling speed. Avoid stopping the pull midway through the installation; the drag due to friction is greatly increased when pulling is restarted.

4. The cable that cannot be pulled in manually shall be installed by means of a cable puller, an electric winch or a winch on a radial boom derrick. In each case, the machine operator shall have access to a means of determining the pulling tensions on the cable (e.g. gauges which indicate direct line pressure or gauges which indicate hydraulic pressure which can be converted to line tension via a conversion table or a dynamometer). Do not exceed the manufactures pulling tension for any cable installation. Cable pulling with trucks, backhoes, crane/boom or any other method whereby the amount of pulling tension is not measurable, is unacceptable.

5. Establish the direction of the pull based on safe pulling tensions, sidewall bearing pressure calculations and minimum bending radius for a specific cable to be installed. Do not exceed the minimum bending radius at any time. Follow the manufacturer’s instructions for the safe pulling tension and determine if the cable pull requires a basket grip or a pulling eye attached to the conductor. Basket grips or pulling eyes shall be attached to the pulling rope or cable by an appropriate sized swivel head. Rod each conduit with an appropriate size brush and mandrel to ensure conduits are properly fitted and they are clean and free of all dirt, stones, scale, water etc. For installation in conduit, place cable guides wherever necessary to avoid abrasion and/or damage to the cable e.g. when guiding the cable from the reel to the conduit mouth or trench, when passing through or exiting manholes, when exiting a conduit run. Cable guides shall be in the form of large diameter, smooth-surfaced free turning sheaves or rollers. They shall be designed to ensure that cable will not ride off the end of the roller or be pinched into a sheave contour. Guide tubes or chutes shall be used provided they have a smooth burr-free working surface, well flared entrances, largest possible bending radius and are securely fastened so that the cable passes smoothly over them. In any case, equipment shall be installed to ensure the minimum bending radius of the cable is not exceeded. Using suitable reel mounting equipment, locate and position the reels such that cable tension at the feeding end is minimized. Select pulling equipment, which can provide smooth speed control at the anticipated
tensions. Ensure the pull rope or flat line has the required tensile rating. Avoid the use of elastic materials.

6. Pre-lubricate conduit with cable manufacture’s recommended cable lubricant. Setup lubrication points along the conduit run (e.g. feed in point, 4 X 4 etc. to reduce pulling tension and abrasion to the cable jacket). For long heavy pulls, pre-lubrication of conduit and pull rope is essential to prevent abrasion at the bends, particularly PVC conduit bends, which can become softened due to frictional heating. In the case of long conduit lengths or excessive curvatures in the conduit the cable may have to be pulled in from two directions. Follow the recommendations of the cable manufacturer as to the amount of lubricant to be applied which is depended on the size and length of the conduit system into which the cable is being pulled.

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 34 42 58, Signal Systems Testing, and AREMA C&S Manual, Part 10.4.30.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Cables will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Case and house wiring will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Cables and Wires furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and
doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Field Case and House Wiring furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

D. The Contractor shall allow for 100 wiring changes not shown on the Contract Plans and requested by the Engineer at no additional cost. A wiring change shall consist of connecting or removing a wire. Thus moving a wire from one contact terminal to another contact terminal will consist of two wiring changes.

END OF SECTION
SECTION 34 42 18
CONDUIT AND PULL BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Furnishing conduit, pull boxes, handholes and associated materials as specified herein.

B. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. All pull boxes, handholes, PVC conduits, HDPE conduits, fittings, cement and other materials to be furnished shall be suitable for use in the environment to be encountered on a railroad signal system. HPDE conduits, handholes and associated miscellaneous materials Commission Standards and Specifications except conduits and pull boxes installed to accommodate fiber optic cable installation into new control points, existing control points and grade crossing instrument enclosures. Conduits shall be used in underground, encased or exposed applications in accordance with National Electrical Code, Article 347.

1.02 SUBMITTALS

A. Manufacturer's catalog cut sheets, material descriptions, and specifications for each type of conduit, type of handhole, fittings, type of pull box and other materials the Contractor proposes to provide.

1.03 QUALITY ASSURANCE

A. Conduit manufacturer’s qualifications shall be as follows:

1. Quality Assurance Program: the manufacturer of conduits, handholes and pull boxes in accordance with the requirements of the Specification shall be accomplished in compliance with a Quality Assurance Program that meets the intent of the ASQC Standard C1: general reinstatement provided for in the subparagraph shall apply only to the first replacement of repair of any such item an, in the case of failure of major importance, to the first extension of the said warranty to said affected items.

1.04 INSPECTION

A. The Commission shall have the right to make inspections and tests, as necessary, to determine if the materials meet the requirements of the Specification. The Resident Engineer shall have the right to reject material that is defective in any respect.
1.05 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall immediately replace any conduit or pull box that is damaged at any time, prior to acceptance of delivery by the Commission without additional cost to the commission.

PART 2 – PRODUCTS

2.01 MATERIALS

A. 4” schedule 40 PVC conduit, in 20 ft. lengths.
B. 4” schedule 40 PVC elbows, varying from 22 ½ degree curve to 90 degree curve and 24” in length
C. 4” rigid galvanized conduit, in 10 ft. lengths.
D. 2.375” schedule 40 HDPE conduit.
E. 12/10-mm HDPE mini duct and couplers
F. 6” burial caution tape
G. PVC Cement
H. 4’-0” x 4’-0” x 4’-0” Concrete Pull Box with Bolt Down Steel Cover
I. MCI Standard handhole, 2’-6” x 5’-0” x 2’-6” made from a fiberglass polymer reinforced plastic.

2.02 SCHEDULE 40 PVC CONDUIT AND FITTINGS

A. Conduit shall be rated for use with 90 degree C Conductors, shall be UL listed, and shall comply with National Electric Manufacturers Association (NEMA) Specification TC-2 (conduit) and TC-3 (fittings).
B. Conduit and fitting shall carry a UL label and shall be identified by type and manufacturer and shall be traceable to location of plant and date manufactured. Labels shall be legible and permanent.
C. The conduit shall be made from polyvinyl chloride compound which includes inter modifiers to improve weatherability and heat distortion.
D. Conduit shall be free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar cables or conductors.
E. Conduit and fittings shall be solvent cemented in applications in accordance with instructions from the manufacturer.
F. Precast concrete vaults and access doors shall be designed for H-20 highway
vehicle loading.

G. All exposed portions of the vault shall be non-electricity conductive.

H. The minimum inside dimensions measured just below the lid support lip shall be 48” wide x 48” long.

I. The depth when measured from the top of the lid shall be 48”.

J. Covers shall be two individual galvanized diamond plate steel pieces with hex bolts to fasten in place. Covers shall have a skid resistant surface on top and equipped with lifting eyes.

2.03 RIGID GALVANIZED CONDUIT

A. Conduit shall be rated for use with 90 degree C Conductors, shall be UL listed, and shall comply with ANSI Specification C80.1.

B. Conduit shall carry a UL label and shall be identified by type and manufacturer and shall be traceable to location of plant and date manufactured. Labels shall be legible and permanent.

C. Conduit shall be hot-dipped galvanized inside and out. Conduit shall be coated with an organic layer to inhibit white rust and increase corrosion resistance.

D. Conduit shall be threaded on both ends, with a threaded coupler attached on one end to allow joining of multiple conduits.

2.04 HIGH DENSITY POLYETHYLENE CONDUIT

Conduit shall be high density polyethylene (HDPE) suitable for direct burial and plowing installation with the ballast portion of the track structural section. Corrugated innerduct is not acceptable.

A. HDPE conduit supplied shall comply with ASTM D2447, schedule 80, 2.375” O.D., black with an orange stripe in color, ribbed interior and smooth exterior. Ribbed interior wall shall be lubricated to reduce friction when installing fiber cable.

B. Equivalent material shall meet the minimum requirements of SDR 11 – ASTM D303 or SIDR 9 – ASTM D2239

C. HDPE conduit shall be an extruded coilable tube supplied on reels at a minimum of 5000 ft. lengths.

D. HDPE conduit shall be capped at both ends prevent any undesirable contaminates from entering tubes.

E. HDPE conduit shall be supplied with factory installed pull lines.
2.05 HDPE MINI DUCT AND COUPLER

A. HDPE mini duct shall be Fiber-Guard/MD as manufactured by ARNCO Corporation, or approved equal.

B. HDPE mini duct conduit shall be supplied on reels of a minimum of 5000’ foot lengths.

C. HDPE mini duct conduit shall be capped at both ends with air tight blank plugs to prevent any undesirable contaminates from entering tubes.

D. HDPE mini duct conduit shall be 12/10-mm and shall be available in colors of blue, orange, yellow and green.

E. HDPE mini duct shall be factory pressure tested per the manufacturer’s recommendations. Mini duct shall hold 130 psi to ensure there are no leaks.

F. Coupler for mini duct shall be as manufactured by ARNCP Corporation P/N 1-905694, or approved equal.

2.06 DETECTABLE UNDERGROUND TAPE

A. Detectable underground tape shall conform to the following specifications:

1. NTSB-PSS-73-1

2. American Gas Association 72-D-56

3. OSHA 1926-956 (c) (1)

4. DOT Office of Pipeline Safety USAS B31.8

5. API RP 1109

6. APWA Uniform Color Code

B. Tape shall be easily located with an industrial grade non-ferrous metal detector, and shall have highly visible colors to assist in location when digging.

C. The label on underground tape shall read:

CAUTION
METROLINK COMMUNICATIONS
CABLE BURIED BELOW
2.07 PVC CEMENT
A. Contractor to provide medium-bodied, fast-setting solvent cement that shall have a strong, leak-tight seal.
B. PVC cement shall conform to NEMA and UL specifications.

2.08 PULL BOXES
A. Pull Boxes shall conform to SCRRA’s Engineering Standard ES8225.
B. Pull boxes shall be manufactured by Jensen or approved equal.

PART 3 - EXECUTION

3.01 GENERAL
A. General
   1. The installation of pull boxes, 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 in conduit in accordance with the Metrolink 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 Resident 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 re-potheading the cable.
   6. In certain types of installation, the cable cannot be constrained; therefore, ample cable slacks shall be provided for 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 Resident 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. 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.

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/communications shelters and shall float when terminated in signal field apparatus.

14. Any work performed by the Contractor that impacts or involves any MCI facilities shall be done by an MCI approved contractor, and shall be governed by MCI’s underground cable standards. Contractor accepts all liabilities and responsibilities when undertaking repairs, modifications and additions involving MCI ducts, handholes and cables.

B. Underground Buried Installation

1. Bury cable to a uniform 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 theses 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 Resident Engineer’s acceptance. Protect the cable in a manner acceptable to the Resident 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 pavement. Installation of conduits and pull boxes shall be in accordance with SCARRA C&S Engineering Standards (see drawings ####, for typical installations). Restore pavement or roadway to its original condition, subject to the Resident Engineer’s acceptance.

4. Whenever any signal cable is to pass under the hot-mix asphalt concrete (HMAC) underlay installed at interlocking, install cable in conduit with pull boxes in accordance with the SCARRA Standard Drawings.
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 pull box 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.

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 cables are unavoidable 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/communications shelters and between signal shelters.

E. Pull Boxes

1. All pull boxes to be abandoned shall be removed completely by the Contractor and the existing sidewalk, parkway and landscaping shall be repaired.

2. All pull boxes in dirt or parkway areas shall have concrete cap around the box.

3. Pull boxes shall not be installed in any part of a driveway, wheelchair ramp or other travelled way unless specified by the Engineer.

4. The Engineer will approve the final location of all pull boxes.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Conduit will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Pull Boxes will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Conduit or Pull Boxes furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This section includes requirements for installing, testing, and documenting vital microprocessor based interlocking controller racks, custom local control panels that and ATCS compliant data radio that provides the functionality shown on the Contract Plans and described here in.

B. Final application logic programs, including EPROMS will be furnished by the Engineer.

C. Related Specification Sections include but are not necessarily limited to:
   1. Section 34 42 40 – Solid-State Coded Track Circuits
   2. Section 34 42 58 – Signal Systems Testing

1.02 REFERENCES

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):

1.03 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 five (5) copies of all test reports and verification of tests as described herein under testing.

D. Submit five (5) copies of Shop Drawings for each CLCP faceplate design for approval of the Engineer.
E. “Rack test” the application software. “Rack testing” shall mean the software has been thoroughly tested and all possible conditions simulated utilizing VHLC hardware and executive software.

1.04 QUALITY ASSURANCE

A. Install, program, and test the interlocking controller and custom local control panel (LCP) so as to conform to and provide all applicable requirements of CFR 49, Part 236, and AREMA C&S Manual Part 2.2.10.

B. Perform operational testing of the equipment in accordance with the requirements specified in 34 42 58, Signal System Testing.

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 two (2) years from the first date of final “acceptance.”

PART 2 - PRODUCTS

2.01 MATERIALS

A. Solid State Microprocessor Interlocking Controller.

1. Controller shall be a Vital Logic Controller (VHLC) manufactured by GETS.

2. The interlocking controller shall be capable of operating 12 VDC vital and non-vital relays. A minimum of 8 vital inputs and eight (8) vital outputs shall be grouped on a single I/O module. Each module used exclusively for vital inputs shall accommodate a minimum of 16 inputs.

3. The vital lamp driver module provided to operate wayside signal lamps shall be capable of directly driving a minimum of 16 each 10 VDC, 18 watt or 25 watt lamps through isolated lamp driver outputs for on, off, and flashing. Flashing shall be at a nominal rate of 55 flashes per minute. Controller shall provide tumble - down indications based upon light out detection using both hot and cold filament checking.

4. Controller chassis shall be designed to house a minimum of 12 modules. Three slots shall be reserved for modules that control and process vital and non-vital application logic and communications. The remaining slots
shall be designed to house any user defined configuration of input/output, lamp driver, and operating modules.

5. Plug connectors shall be keyed for each module type to ensure only the proper module can be connected. Plug connector cables shall be color-coded. No color code shall be repeated in a single plug connector.

6. The interlocking controller shall have the capacity to directly connect, via a cable, to a chassis that will generate and receive Electro Code 4 and Electro Code 5 track codes without use of relay interfacing.

7. The interlocking controller must be capable passing vital data, via a serial connection, to existing VHLC units utilized on SCRRRA properties.

8. The software associated with assuring the vitality of the system shall be an inherent part of the basic controller system and shall not be accessible for modification by the user. Changes to the application logic installed in the system shall not require re-verification of the software associated with assuring system vitality. The application logic shall be protected so that it is user modifiable by authorized personnel only.

9. The program compiler used in developing the site-specific application logic software shall be designed to allow the user to construct individual equation logic equations utilizing “ladder-logic” display elements. Reports generated by the compiler shall provide the user with a complete and detailed description of the system configuration including, but not limited to, module location assignments, internal timer settings, auxiliary input/output assignments, vital lamp output assignments, CTC control and indication bit assignments, electronic track code circuit assignments, data recorder equation selection, remote input/output assignments, and module plug-connector pin assignments.

10. The interlocking controller shall provide event recording. The event recording shall be designed so that the correct time is maintained when the vital logic and/or code system equipment is reset or powered down. The event recording equipment shall have sufficient storage capacity to store a minimum of seventy-two (72) hours of events, without overwrite, at the interlocking, recording user selected status changes along with diagnostically important internal status changes.

11. The interlocking controller shall provide mitigation for "processor failure" via a fall back relay.

12. The interlocking controller shall interface with the solid-state track circuit detailed in Section 34 42 40, Solid-State Coded Track Circuits.

13. The failure of an output shall not cause loss of functions not associated with those of the failed module.
14. The interlocking controller shall operate from a standard 12 VDC signal battery supply. Any special power supply filtering devices required for reliable operation shall be provided as part of the system.

15. The interlocking controller shall, at a minimum, enable a user to generate the following reports:

a. Configuration report that, at a minimum, indicates controller location, revision history, controller/software identification (chassis identification), chassis slot assignments, application software identification (Eprom crc/checksum), each vital and non-vital input/output assignment and nomenclature, each lamp driver vital output assignment and nomenclature, track code input/output assignment and nomenclature, serial and remote input/output assignment and nomenclature, vital timer configuration and time settings, and equation data recorder logging assignments.

b. Logic equation report that displays all application logic equations in a ladder-logic format.

c. Cross-reference report that displays all status names used in each logic equation.

d. Revision history report.

e. Real-time data logging that displays, on a user furnished computer display, changes in logic equation status.

B. Custom Local Control Panel (CLCP)

1. Local Control Panel (LCP) shall be a Custom Local Control Panel (CLCP). CLCP shall be provided by SCRRA and installed by the Contractor after instrument enclosure(s) have been delivered to SCRRA.

**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 APPLICATION LOGIC**

A. The Engineer shall furnish the VHLC application logic programs 90 days prior to performing in-service tests. The Contractor’s Signal Engineer shall “rack test” the application logic at SCRRA office in Pomona, CA. The Engineer shall observe the testing and shall make any modifications required to ensure the integrity and functionality desired. All time spent by the Contractor’s Signal Engineer in “rack testing” or making modifications to the programs shall be at no additional cost to SCRRA. SCRRA shall not be responsible for any work delays that may result from
software modifications made during final in-service testing and commissioning by the Contractor.

3.03 INSTALLATION

A. Wire and install the microprocessor-interlocking controller and the LCP in accordance with rack layout provided in the Contract Plans.

B. Load all programmable and configurable modules with application software and perform any configuration necessary.

C. Conduct a complete breakdown and operating test on the units prior to shipment.

3.04 FIELD QUALITY CONTROL

A. Conduct tests as specified 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 34 42 58, Signal Systems Testing.

D. Install and perform applicable tests in accordance with 34 42 58, Signal System Testing, to ensure that the interlocking controller software and CLCP has been installed and made operational as part of the operating signal system. Verification of such tests shall be provided to the Resident Engineer.

E. The Contractor shall conduct all tests as recommended by manufacturer.

F. 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 Resident 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.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 40
SOLID-STATE CODED TRACK CIRCUITS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for furnishing, installing, testing, and documenting solid-state track circuit elements.

B. Final application logic programs will be furnished by the Engineer.

C. Related Specification Sections include but are not limited to:
   1. Section 34 42 58 – Signal Systems Testing

1.02 REFERENCES

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):

1.03 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.

D. The Contractor shall provide the Resident Engineer with five (5) printed copies of all test reports and certify that all applicable tests have been made in accordance with this Section and with Special Provision, Signal System 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 AREMA C&S Manual, Part 8.1.2.
B. Perform operational testing of the equipment in accordance with the requirements specified in Section 34 42 58, Signal Systems Testing.

C. The Resident Engineer or his/her representative shall have the right to make inspections and tests, as necessary, to determine if the equipment meets the requirements of this Specification.

D. The Signal Engineer shall demonstrate knowledge and experience in the operation, programming and maintenance of the solid-state coded track system.

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.

C. Each microprocessor unit and its associated components shall be clearly identified on the packing crate, referencing its intended location.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Electronic track circuits shall be compatible with highway grade crossing constant warning devices. Utilization of bi-directional, uni-directional, and auxiliary crossing control functions shall be provided per Contract Plans and manufacturer's specifications. Track filters shall be installed in track leads, as shown on the Contract Plans.

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 Plans. 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. Install Electro Code 5, with Alternating Code 5, manufactured by GETS.
F. Provide a solid-state electronic coded track signal system to determine block occupancy and to pass signal aspect information from one interlocking or signal location to the next. The system referenced herein is Electro Code 5 (EC-5).

G. The electronic coded track circuit shall be user programmable to provide application logic changes as needed. The application program shall be specified on the release. The Contractor shall furnish the program specified with each electronic coded track circuit system.

H. The electronic coded track circuit unit shall be configurable for transmission/reception of the track circuit and signal codes over track.

I. The coded track circuit unit shall have available a minimum of six (6) discrete code rates for vital signaling indication in addition to a code rate used for train detection. An additional code rate shall be available for reversal of the code transmission/reception signal orientation. Track circuit shall have two (2) codes used to convey non-vital block information. Electrocode IV code rates are presently used on Metrolink with Alternating Code 5. Coded Track Circuit must be able to communicate on the rails with existing Electrocode without requiring any interface equipment.

J. Event recorder modules for electronic track circuits shall be provided as shown on the Contract Plans.

K. Electronic coded track circuits shall conform to the requirements of the AREMA Signal Manual, Section 8.1.2, where these instructions and requisites are applicable and do not conflict with these Specifications.

L. Conduct an acceptance test on Owner-furnished units prior to loading at the warehouse.

M. Conduct acceptance testing of 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 upon demonstration of readiness for pretest. This application logic will provide the functionality as shown in the Contract Plans 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 Plans.

B. Install the solid-state track circuit equipment in signal instrument shelters or cases as shown on Contract Plans.
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 specified 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 34 42 58, Signal Systems Testing.

D. Testing, including pre-testing, shall include operating any hand throw 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.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 42
SIGNAL LAYOUTS, STRUCTURES AND FOUNDATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. The work of this 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 cantilevers, bridges, ground mounted masts, ladders, platforms, and all mounting hardware required to construct signals.

C. Contractor shall furnish and install signals as shown on the Contract Plans at existing and new signal locations.

D. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 30 00 – Structural Concrete
   2. Section 31 20 00 – Earthwork
   3. Section 34 42 58 – Signal System Testing
   4. Section 34 42 60 – Signal Systems Miscellaneous Products

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. LTS-4 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals

B. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1.03 DESIGN REQUIREMENTS

A. Signal Foundation Structure: Provide 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 AASHTO LTS-4. 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 color light LED signal and adjust the signal head for the maximum sighting range possible. Provide to 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 the Engineer for approval. 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 Installation Procedure for approval by the Engineer. 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 requirements 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 requirements of AREMA C&S Manual Parts 14.1.1.A through 14.4.36 inclusive, where requirements of the AREMA Specifications do not conflict with any requirements specified herein.

D. The Engineer reserves the right to make inspections and tests, as necessary, to determine if the equipment meets the requirements of this Specification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship LED's separately from the signal in which they will be used.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Furnish LED color light signals, as indicated in the Contract Documents. Signals shall be in accordance with SCRRRA Standard Plans.
B. Colorlight signal units shall be capable of displaying three aspects: green, yellow and red as shown on SCRRA ES8525-01.

C. Furnish signal masts, signal cantilevers and signal bridges, as applicable, in accordance with SCRRA Standard Plans.

D. Furnish mounting brackets for marker light assemblies, ladders, junction boxes, housings, backgrounds, hoods and any other nuts, bolts, and associated hardware.

E. Furnish foundations for signal masts, signal cantilevers and signal bridges, as applicable, in accordance with SCRRA Standard Plans.

F. Install blank-out cover plates in all unused lamp units.

2.02 SIGNALS

A. Signal mounting shall conform to the SCRRA Standard Plans.

B. Signal LEDs shall be products specified in the Contract Documents or an approved equal.

2.03 SIGNAL MASTS

A. Mast assemblies for ground mounting shall conform to the Contract Plans and SCRRA Standard Plans.

2.04 SIGNAL BRIDGES AND CANTILEVERS

A. Refer to the Contract Plans for Signal Bridge and Cantilever requirements.

B. The junction box shall have two terminals with insulated test links, as specified in Section 34 42 60, 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.

3. Use 5C #10 signal color coded cable for mast and jct. box wiring, type TC Okonite 202-10-35-05 or an approved equal.

2.05 SIGNAL FOUNDATIONS

A. Furnish galvanized steel foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Specifications Section 34 42 60, Signal Systems Miscellaneous Products, and AREMA Signal 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 03 30 00, Structural concrete, or precast concrete as manufactured by Dixie Precast or an approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION - SIGNALS

A. Contractor shall install signal layouts in locations as indicated on the Contract Plans and as shown on the accepted Shop Drawings. No part of any signal layout shall conflict with SCRRRA Design Standards, Code of Federal Regulations, Part 49, or CPUC rules and regulations.

B. Locate signals centered between insulated joint, except where physically not possible. In such instances, submit a recommendation to the Engineer for approval.

C. Center line of signal mast shall be 15 feet 0 inches from centerline of track unless a deviation from this is approved by the Engineer, as shown on the Contract Plans 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 SCRRRA Design Standards.
E. Install signal layouts in accordance with the applicable requirements of AREMA Signal Manual, Part 7.4.1 and the SCRRA Design 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 the SCRRA Design 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 Plans.

K. The underground cable shall be dressed, potheaded, tagged, and terminated in the signal junction box as specified in Section 34 42 60, Signal Systems Miscellaneous Products. The conductor size of the underground cables shall be at least as large as that shown in the Contract Plans.

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 Plans.

M. Install identification tags on each wire. These tags shall bear the nomenclature shown on the accepted Shop Drawings.

N. Set lamp voltage between 8.8 volts and 9.2 volts measured at the signal lamp.

3.02 INSTALLATION - SIGNAL BRIDGES AND CANTILEVERS

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

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 Plans. 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 Division 31 20 00, Earthwork, 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 Division 31 20 00, 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. 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.

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 34 42 58, Signal System Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Signal Layout, Structures and Foundation will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Signal Layout, Structures and Foundation furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 43
ELECTRIC SWITCH LOCK LAYOUTS

PART 1 - GENERAL

1.01 SUMMARY
A. This section includes requirements for Electric Switch Lock Layouts.
B. Refer to Division 34, Transportation, for track construction requirements.

1.02 REFERENCES
A. American Railway Engineering and Maintenance of Way Association (AREMA)

1.03 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.

1.04 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 approved grease to prevent corrosion. Suitable 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 Resident 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 Mechanisms and layouts, such as Alstom Model 9B or 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 34 42 36, 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 34 42 33, 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 34 42 37, 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 furnished by SCRRA

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 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 controlled 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 SCRRA Engineering Standards.

C. Dap and drill timber ties to meet 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 the 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 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 34 42 37, 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 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 Resident 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 Resident 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 Resident 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 Commission assumes responsibility for maintenance of the equipment.

K. Connect electric switch lock rod and switch circuit controller rods to the normally closed switch point.
L. Any switch assembly which is connected to the open point side, or which has a reverse switch indication shall be equipped with an insulated front rod.

3.03 SECURITY

A. Install SCRRA 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 Procedure as accepted by the Resident Engineer.

B. Conduct the final operational tests of switch circuit controllers as described in 18600, Signal Systems Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Electric Switch Lock will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Electric Switch Lock furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 44
RELABS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for relays. Unless indicated as relocated on the Contract Plans, relays shall be Contractor furnished and relays of each type shall be uniform in design and contact assembly.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 40 00 – Quality Requirements
2. Section 34 42 58 – Signal System Testing
3. Section 34 42 60 – Signal Systems Miscellaneous Products

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):


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 requirements 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 SCRRRA Standard Plans SCRRRA ES8110 and ES8120.

B. Factory testing of each relay shall be the manufacturer's standard.

C. Provide relay specifications including drop away, pick up and working values, any special mounting or supporting arrangements, and contact stacking arrangements, for all relay types to be furnished under this Contract. Include any arc suppression where arc suppression is required.
D. 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.

E. SCRRA ES indicates acceptable relays in use. If the Contractor proposes use of alternate relays not listed in the SCRRA ES, and those alternate relays have been approved by the Resident Engineer, the Contractor shall submit manuals with comprehensive descriptions and illustrations of each type of alternate relay provided. The Contractor shall provide four relay manuals, four copies of relay specifications, and calibration sheets for each type of alternate relay furnished.

F. The Contractor shall provide field test reports indicating each relay furnished has conformed to the manufacturer’s specifications and the relay conforms to CFR 49 Part 234 and Part 236 requirements. The use of type written characters shall be used to fill in all information requested on the form.

G. Submit sample relay identification tag, including method of mounting proposed.

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.

B. Ensure that all vital relays are safely stored and protected from damage during storage, handling and transporting.

1.06 SPARE PARTS AND SPECIAL TOOLS

A. The Contractor shall furnish one (1) e-post wrench for opening and closing the relay test terminals with each shelter where relays are installed. E-post wrench must be in each shelter for final acceptance.

B. The Contractor shall furnish two (2) insertion/extraction tools for each type of contact at each shelter where relays are installed. Insertion/extraction tools must be in each shelter for final acceptance.

C. Refer to Section 01 50 00, Temporary Facilities and Controls, and 01 40 00 for Quality Requirements for details regarding packaging and delivery of spare parts and special tools.

1.07 WARRANTY

A. The Contractor shall provide warranty from defects arising from defective parts and workmanship for 2 years from the first date of final “acceptance.”

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, Safetran Type "ST", or an approved equal. Contractor shall use the specific relays shown on the Contract Plans.

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

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

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

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

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

7. 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 Plans, 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 plug board.
2.03 SWITCH OPERATING RELAYS

A. Vital switch operating relays used for control of switch-and-lock movement shall meet the same requirements as specified for vital biased neutral relays except that a minimum of two front-back dependent contacts or two independent front contacts and two independent back contacts shall be required.

B. Each contact shall be equipped with a magnetic blow-out feature to effectively interrupt high currents and minimize contact wear. Switch operating relays to be furnished under this Contract shall be identical: one normal and one reverse switch-operating relay shall be provided for each switch-and-lock movement.

2.04 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 34 42 60, 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 Plans. Contractor shall refer to SCRRRA ES8110 and ES8120 for relay “tab” and coil wiring information.

D. Identify each relay with nametag(s) as approved by the Resident Engineer.

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 34 42 58, Signal System Testing.

C. Record test measurements on Test Report Form provided by the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Relays will be measured by the unit or fraction thereof furnished and completed...
in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Relays furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 46
SIGNAL EQUIPMENT HOUSES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for new factory-wired signal equipment houses and relocating existing signal equipment houses. The Contractor shall be the responsible for supplying the new house(s).

B. Installation and field modification of the new factory-wired signal equipment houses by the Contractor to meet the requirements of the contract Plans shall meet or exceed the requirements of this Section.

C. Signal Equipment Houses may be referred to as instrument enclosures, instrument houses, crossing houses, signal shelters in these Specifications.

D. Related Specification Sections include but are not necessarily limited to:
   1. Section 34 42 00 – General Signal Requirements
   2. Section 34 42 16 – Signal Wires and Cables
   3. Section 34 42 56 – Signal Grounding
   4. Section 34 42 58 – Signal System Testing
   5. Section 34 42 60 – Signal Systems Miscellaneous Products
   6. Section 34 42 62 – Service Meters

1.02 REFERENCES

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):

1.03 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 prior to transporting new signal equipment houses to the job site.

D. Submit four (4) copies of Shop Drawings showing the proposed size and equipment layout including rack, air conditioner, lighting, convenience outlet arrangement, and exhaust fan mounting and location.

E. Submit four (4) copies of Shop Plans of each instrument and entrance rack, showing the arrangement and description of the mounted equipment and wiring if different from those shown on Contract Plans.

F. Submit four (4) copies of Shop Drawings of the complete grounding arrangement.

G. Factory Test Procedures proposed.

H. Shop Drawings shall be submitted within thirty (30) days of NTP.

1.04 QUALITY ASSURANCE

A. Submit four copies of Shop Drawings of the complete grounding arrangement. The factory test of the houses, and the functioning of the equipment contained within each, shall be conducted in accordance with the Contractor's approved Factory Test Procedure.

B. The instrument enclosures shall be assembled and wired to conform to the Plans. Contractor shall ensure the enclosures are free from defects and that workmanship is of the highest quality.

C. Each house will be inspected after it has been installed and the Contractor shall correct any deficiencies. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Installation Inspection Procedure.

D. The Contractor shall provide documentation of acceptance “in good condition” before removing and transporting existing houses to the job site.

E. The Contractor shall provide documentation of Factory Acceptance Testing before transporting new houses to the job site.

F. Each house 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.

G. Resident Engineer reserves the right to make inspections and tests at the facility where the wiring services are to be performed to determine if the equipment and workmanship meets the requirements of this Specification.
1.05 DELIVERY, STORAGE, AND HANDLING

A. Properly fasten and brace equipment shipped within houses 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 house is set at its final location.

PART 2 – PRODUCTS

2.01 HOUSE GENERAL

A. Furnish and install factory-wired signal equipment houses, as described herein and as shown on the Contract Plans. These houses shall be complete with all the equipment shown on the Contract Plans. Wiring shall conform to the requirements of the AREMA C&S Manual, NEMA Standard ICS-70, or National Electrical Code (NEC), as applicable.

B. Signal equipment houses shall be products manufactured by PTMW, Inc., Safetran Systems, GETSGS, or an approved equal.

C. Signal equipment houses shall be the size and layout shown on the Contract Plans.

D. Signal equipment houses shall be rain-tight and dust-tight, National Electrical Manufacturers Association (NEMA) 3R, ventilated, and have hinged doors with three point catch and handle and have welded construction throughout. Welds shall be 1-1/2 inch minimum in length with spacing not to exceed 6-inches where panels meet floor and roof. Spacing on panel welds shall not exceed 18-inches.

E. Signal equipment houses shall be constructed of 12-gauge galvanneal steel for floors, walls, and doors. Roofs shall be no less than 14-gauge galvanneal steel with a minimum of 50 lb/ft² loading as shown on the Contract Plans.

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 signal equipment houses 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 house proposed. No ventilation opening shall be made in the roof of the house. Provide lift rings to facilitate the movement of the house.

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 Plans.

K. Provide thermostatically controlled exhaust fans, operated from 120 Vac and fused separately, in each house, as shown on the Contract Plans. 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 house 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 house 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 signal equipment houses with interior lighting and duplex 120 Vac power receptacles. Signal equipment houses 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. House 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 Signal Equipment Houses 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.

P. All access points in the enclosure shall be sealed for weather protection and against entry of rodents. All interior and exterior seams shall be caulked with RTV silicone.

Q. Enclosure foundations shall be the inner wall type and adjustable from the outside of the enclosure. The range of adjustment shall be from 36-inches to 52-inches in 1/2-inch increments. Located in the wall the foundations shall be galvanized steel, a minimum of 60-inches long, include all hardware, and a 12-inch x 12-inch x 1/4-inch footing pad. All galvanizing shall conform to the AREMA Signal Manual, Part 15.3.1

R. Permanent vendor name plate, or equivalent, complete with vendor name, address, model number, serial number, and date of manufacture or equivalent shall be located on front.
2.02 CASE GENERAL

A. Case shall have welded construction throughout. Welds shall be 1-1/2 inch minimum in length with spacing not to exceed 6-inches where panels meet floor and roof. Spacing on panel welds shall not exceed 18-inches.

B. Interior surfaces including top, sides, and shelves shall be finished with primer coat and two (2) coats of white latex enamel paint.

C. All paint shall be fire retardant.

D. Key slot channels shall be provided on each side and extend to the full inside heights of the case. Keyhole spacing shall be 2-1/2 inch centers. Key slot channels shall be flush with insulation.

E. Sides, top, and doors shall include 1-inch of fiberglass faced polyisocyanurate insulation. Floor shall include 1/8-inch bi-directional pyramat rubber matting.

F. Permanent vendor name plate, or equivalent, complete with vendor name, address, model number, serial number, and date of manufacture or equivalent shall be located on front.

G. Cases shall be equipped with a minimum of two (2) lifting/tie down lugs located at roofline on each side.

H. Cases shall include four- (4) knockouts with cover plates and gaskets on sides ‘A’ and ‘C’ in the upper corners. Internal insulation at entry locations shall be precut for ease of removal and equipment installation.

I. All access points in the case shall be sealed for weather protection and against entry of rodents. All interior and exterior seams shall be caulked with RTV silicone.

J. Exterior shell shall be constructed of 12-gauge galvanized steel.

K. Exterior surfaces, including bottom of floor, shall be powder coated with TGIC polyester, color light gray, nominal thickness of 4 mils but not less than 3 mils thick.

L. Shelving and backboard shall be constructed of 3/4-inch MDO two-sided plywood and finished on all sides, with primer coat and two - (2) coats of fire retardant white latex enamel paint, before mounting.

M. Shelving shall be adjustable vertically in 2-1/2 inch increments and conform to the keyhole Specifications.

N. Shelves shall be 12-inches wide and covered with 1/8-inch bi-directional pyramat rubber matting. The shelf length will be determined by case size or as shown on the Contract Plans.

O. All exposed edges on shelving, including rear edge, shall have a 1-inch facing constructed of 14-gauge sheet metal, designed for this purpose. Facing shall be
aluminum or steel with rust preventive paint or plating. Facing shall be attached with screws and be free of burrs or sharp edges.

P. Surface area of backboards and shelves shall be free of protrusions such as bolt heads. The bottom of the backboards shall be cut level as shown on the Contract Plans.

Q. The width of the backboard shall be determined by the size of the case or as shown on the Contract Plans.

R. Door gasket shall be compressed 1/2-inch free height when door is closed and locked. The gasket shall be coated with an approved lubricant to prevent sticking.

S. Three bolt on hinges, separate castings, with bronze hinge pins and grease-able, (3/16-inch zerk), fittings shall be installed with an anti-theft arrangement.

T. All doors shall be lubricated before leaving the factory.

U. Heavy-duty three point locking system shall be furnished with each door. Latch and locking system shall operate smoothly through complete opening and closing cycle. The door handle must accept a large bail padlock. (Polar Hardware brand #7011) or approved equivalent.

V. Doors shall be provided with rods to hold door open at 90 degrees and near 180 degrees. Door insulation shall be covered by an interior sheeting to protect the insulation and to add rigidity to door.

W. Louvers shall be provided in doors with adjustable cover plates for winter and summer usage. The door shall accommodate an adjustable air intake sized to accept a 1-inch x 10-inch x 20-inch replaceable filter.

X. A drip channel (or roof design) shall be incorporated into the design to direct water away from opening. Y.

Y. Case shall include six (6), 4-5/8” knockouts in the floor behind the backboard with cover plates. Four (4) cable risers 36 inches long, complete with male adapters, lock nuts, and bushings shall be included. The knockouts shall be equally spaced behind the backboard.

2.03 HOUSE GENERAL ELECTRICAL SPECIFICATIONS

A. All vendor installed electrical products shall be UL listed. All electrical work shall conform to the National Electrical Code (NEC) standards and accepted practices.

B. Conduit and device box sizes shall conform to NEC Article 370.

C. The typical Breaker box shall be Square ‘D’ 100 AMP; Model QO12M100. The breaker box shall be furnished with the following breakers, one- (1) QO120 GFI, one- (1) QO230, one- (1) QO130, and seven- (7) QO120.
D. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrester shall be mounted on the top of the breaker box.

E. The Breaker box ground buss shall be bonded to the breaker box and the nearest keyway using an ERICO ‘VS’ welded connection designed for this purpose. The neutral buss shall not be bonded during manufacture. The field shall bond the neutral at the remote (main) disconnect when used.

F. The neutral bonding screw shall be packaged and shipped in the breaker box for installation in the field if necessary.

G. All conduits shall be installed above the wire chase and secured to enclosure structure. Flex conduit shall not be used except when used as a drop or attached to equipment that may be removed. All circuits must be routed in separate conduits. The fluorescent lamp fixtures shall not be used for a junction box, raceway or conduit for any circuit other than the one intended for lamp operation.

H. One (1) separate 20 AMP plug circuit shall be provided on the ‘A’ and ‘C’ walls as shown on the Contract Plans. The end plugs shall be 8-inches from the ‘D’ wall and 18-inches from the ‘B’ wall the remaining plug(s) shall be centered between them.

I. Separate 20 AMP circuits (equipment power drops) shall be provided on the ‘A’ and ‘C’ walls. The junction boxes shall be located, above the wire chase, as shown on the Contract Plans. The wires from the panel shall be terminated (wire nut and taped) in the junction box. One–(1) piece of aluminum flexible conduit, 48-inches long shall be supplied for each junction box and installed by the wiring shop. The conduit shall be coiled up and shipped along with other house material.

J. Bungalows to have provisions for connection of an auxiliary generator as shown on the Contract Plans. Provisions for this arrangement to include the following: 1ea. 125/250V 3-pole 4 wire flange male inlet plug NEMA Type L14-30P with exterior spring loaded weather proof outlet cover (Bryant #71430-MBWP). Main breakers to be 100 AMP (Square ‘D’ #QO2100) for bungalows with 2-pole 30 AMP breaker (Square ‘D’ #QO230) positioned adjacent to main breaker with mechanical interlock (Square ‘D’ # QO2DTI). DO NOT SUBSTITUTE.

K. General color code and wire specifications for all AC wiring are as follows. All wiring shall be THHN or THWN solid copper or as required by the NEC.

<table>
<thead>
<tr>
<th>Wiring Description</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFI Breaker to Receptacle/Thermostat</td>
<td>#10 Black</td>
</tr>
<tr>
<td>GFI Breaker to Receptacle</td>
<td>#10 White</td>
</tr>
<tr>
<td>GFI Receptacle Ground</td>
<td>#10 Green</td>
</tr>
<tr>
<td>Thermostat to Vent Fan</td>
<td>#10 Red</td>
</tr>
<tr>
<td>Fan Neutral</td>
<td>#14 White</td>
</tr>
<tr>
<td>Breaker to Light Switch</td>
<td>#10 Black</td>
</tr>
<tr>
<td>Light Switch to Light</td>
<td>#10 Red</td>
</tr>
<tr>
<td>Light Neutral</td>
<td>#10 White</td>
</tr>
</tbody>
</table>
Breaker to Receptacle A & C walls  | #10 Black  
Receptacle Neutral           | #10 White  
Receptacle Ground            | #10 Green

L. The service entrance shall be a 2-inch EMT conduit, entering the bottom of the breaker box. The conduit shall extend through the floor. Sufficient length shall be left to allow easy coupling. The open end shall be capped and protected while in transit.

M. One (1) 36-inch piece of 2-inch EMT conduit shall be included along with a compression coupling. The conduit and coupling shall be secured and shipped inside the enclosure.

N. A single or 3-way light circuit shall be provided based on house size and door arrangement. One (1) 115/120V-20 AMP duplex receptacle shall be mounted with each light switch, near the main enclosure entrance (D and/or B-wall). The fan thermostat control unit shall be mounted to the light switch/duplex receptacle handy box on ‘D’ wall.

O. A minimum of two (2) double tube, 4-foot fluorescent fixtures, 40 watts each and tube guards shall be installed in each enclosure. The actual quantity and location of lights shall be based on the enclosure size or as shown on the Contract Plans.

P. An air conditioner, sized for the structure, shall be supplied and located as shown on the typical Plans. A 30 AMP circuit, with a single 30-amp receptacle, shall be provided.

Q. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrester shall be mounted on the top of the breaker box.

2.04 CASE GENERAL ELECTRICAL SPECIFICATIONS

A. All vendor installed electrical products shall be UL listed. All electrical work shall conform to the National Electrical Code (NEC) standards and accepted practices.

B. The breaker box for cases shall typically be a Square ‘D’ 100 AMP; Model QO6-12L100S mounted as shown on the typical Drawings. Circuit breakers supplied with the case shall be Square ‘D’ QO series as follows, one- (1) QO120 GFI, two- (2) QO120.

C. Conduit and device box sizes shall conform to NEC Article 370.

D. Bushings shall be installed on all conduits entering or leaving the breaker or device boxes. An SDSA-1175 surge arrester shall be mounted on the top of the breaker box.

E. The breaker box ground buss shall be bonded to the breaker box and the enclosure frame using an ERICO ‘VS’ welded connection designed for this purpose. The neutral buss shall not be bonded during manufacture. The field shall bond the neutral at the remote (main) disconnect when used.
F. The neutral bonding screw shall be packaged and shipped in the breaker box for installation in the field if necessary.

G. General color code and wire specifications for all AC wiring are as follows. All wiring shall be THHN or THWN solid copper or as required by the NEC.

<table>
<thead>
<tr>
<th>Connection</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFI Breaker to Receptacle</td>
<td>#10 Black</td>
</tr>
<tr>
<td>GFI Breaker to Receptacle</td>
<td>#10 White</td>
</tr>
<tr>
<td>GFI Receptacle Ground</td>
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<tr>
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<td>#10 Black</td>
</tr>
<tr>
<td>Light Switch to Light</td>
<td>#10 Red</td>
</tr>
<tr>
<td>Light neutral</td>
<td>#10 White</td>
</tr>
</tbody>
</table>

H. The service entrance shall be a 2-inch EMT conduit, entering the bottom of the breaker box. The conduit shall extend through the floor. Sufficient length shall be left to allow easy coupling. The open end shall be capped and protected while in transit.

I. One (1) 36-inch piece of 2-inch EMT conduit shall be included along with a compression coupling. The conduit and coupling shall be secured and shipped inside the case.

J. Cases to have provisions for connection of an auxiliary generator as shown on the Contract Plans. Provisions for this arrangement to include the following: 1ea. 125/250V 3-pole 4 wire flange male inlet plug NEMA Type L14-30P with exterior spring loaded weather proof outlet cover (Bryant #71430-MBWP). Main breakers to be 60 AMP (Square ‘D’ #QO260) for signal cases with 2-pole 30 AMP breaker (Square ‘D’ #QO230) positioned adjacent to main breaker with mechanical interlock (Square ‘D’ # QO2DTI). DO NOT SUBSTITUTE.

K. 6-9 cases shall include one (1) switched incandescent light circuit. The fixture shall be complete with 100 watt equivalent lamp and metal lamp guard.

L. A GFI protected duplex plug and light switch shall be mounted inside on the end (C) wall as shown on the Contract Plans. The light with metal guard shall be mounted in the front at the top-center of the case.

2.05 SIGNAL EQUIPMENT MOUNTING

A. General:

1. Mount equipment as shown in the Contract Plans.

2. Mount all equipment in such a manner that a seismic event within the parameters of Section 34134 42 00, 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 6.2.2.

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.

2.06 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 34 42 60, 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 Plans and as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

E. Wire and cable conductor identification tags for terminal board mounting shall be as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

2.07 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 white with a fire retarding paint.

B. Cable Entrance Terminal Boards shall be located as shown on the Contract Plans.

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 Safetran or equal test links on all terminal pairs where conductors enter houses.

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 Plans.

G. Lightning arresters shall be as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

2.08 CABLE ENTRANCE PIPES

A. Supply Cable entrance pipes as specified in Section 34 42 60, Signal Systems Miscellaneous Products.

2.09 GROUNDING

A. House shall be fitted with four 48-inch long No. 2 ground wires cadwelded to floor frame of the house at each corner. Cadwelding shall take place prior to powder coating the structure. The pigtails shall be coiled and secured in a manner that prevents damage during construction and while in transit. Cases shall have two 48-inch long No. 2 ground wires cadwelded to floor frame of the house at each end.

B. Supply and install grounding material as specified in Section 34 42 56, Signal Grounding.

2.10 INTERNAL WIRING

A. Internal wiring shall be in accordance with Section 34 42 16, Signal Wires and Cables.

B. Minimum wire conductor sizes shall be as shown on the Contract Plans 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 34 42 60, 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 34 42 16, Signal Wires and Cables.

2.11 PAINTING - INSULATION

A. All instrument enclosures shall be furnished complete with a layer of rigid insulation on the walls, doors, and ceiling. Instrument houses 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. Apply typical legend for control point houses, highway grade crossing houses and cases as indicated on the SCRRA Standard Drawings. Consult with manufacturer of house prior to paint application.

### 2.12 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 Plans.

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 house. 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 34 42 00, General Signal Requirements.

### 2.13 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 house furnished under this Contract. Size panel board as shown on the Contract Plans. The capacity rating shall be in accordance with the Contractor's load calculations and the Contract Plans.

C. Service meters shall conform to local codes.

### 2.14 GALVANIZED HOUSE FOUNDATIONS

A. All houses shall be equipped with telescoping foundations as described in Part 2.01 Q of this Section complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Section 34 42 60, 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 houses 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 houses or cases.

B. Install cable entrance pipes through the cable knockout holes provided in the floor of the house behind the terminal board(s) as shown on Contract Plans. Fill pipes with a substance designed for the purpose that prevents entrance of debris, rodents, and other pests.

C. Ground houses as specified in Section 34 42 56, Signal Grounding.

D. Locate house as indicated on the Contract Plans. If conditions do not allow placement as shown on the Contract Plans, 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 shelter 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 SCRRRA 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 houses including Owner-furnished houses.

3.02 AC POWER

A. Wall mount load center as shown on the Contract Plans. Mounting height from floor, wire terminations, and clearances shall be in accordance with the NEC.

B. Install service meters as described in Section 34 42 62, Service Meters.
3.03 FIELD QUALITY CONTROL

A. Test the functioning of the equipment contained within the instrument house in accordance with the requirements of Section 34 42 58, Signal System Testing, CFR Title 49, Parts 234 and 236, and AREMA C&S Manual Part 2.4.1.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Signal Equipment House with Contractor-Owner furnished foundation (Includes ground rods and grounding) will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Signal Equipment House furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this Section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Work of this Section shall include the cost of furnishing and installing foundations for the house, ground rods and grounding, including the cost of excavation, shoring where necessary, potholing, fill and any other equipment necessary to install a foundation and a ground system including any mounting hardware.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This section includes requirements for dual control switch and lock movement for each interlocked track switch at new switch locations as shown on the Drawings. In addition, relocate existing switch machines where Drawings indicated on the Contract.

B. Refer to Division 34 72 00, Trackwork, for track construction requirements.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

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 power 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, 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. Install all new and complete dual control Power Switch and Lock Movement Layouts, including the switch targets where applicable. Power Switch and Lock Movement shall lock the switch points in power and hand operation. Power Switch and Lock Assembly shall be 110Vdc such as the US&S M23A configuration. The gear ratio shall be 360:1.

B. Contractor-furnished Junction Box shall be Model N349656 manufactured by U.S. & S. Co. or an approved equal.

C. Provide and install an insulated front rod per SCRRRA Standards as part of the power switch layout.

D. Miscellaneous Fittings: The Contractor shall provide all connectors such as threaded nipples, cable clamps, flex wire, tags, terminals and electrical fittings as required for each power switch and lock movement layout including 48-inch-long, 2-inch-diameter liquid tight flexible conduit and connectors from movement to junction box.

E. Switch targets shall be provided and installed by the Contractor within power switches that the Freight Carrier uses in hand operation during the construction of the project and shall be removed when the power switch is placed in service along with the control point.

2.02 SECURITY

A. Install SCRRRA furnished switch padlocks on trainman’s access side of hand-throw levers of power switch when switch has been determined necessary for Freight Carrier to access. Power Switch will be placed in an inoperative mode (all power removed from machine) and hand throw levers padlocked in hand throw position with SCRRRA provided switch locks.

B. At power switches under construction and not to be used by the Freight Carrier the Contractor shall place the power switch and lock movement in an inoperative mode (all power removed from machine and hand throw lever padlocked in hand position) and switch points secured using a padlock able switch point clamp with Contractor provided padlock. All locks shall be Contractor provided.

C. Furnish padlocks, with the exception of switches requiring Freight Carrier access, until all systems have been accepted. At final acceptance, the Contractor will remove their padlocks and SCRRRA maintenance will furnish replacement padlocks.

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 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. Provide and install all required components needed including but not limited to bolts, ties, gauge plates, universal plates, rods, switch point rollers and the power switch and lock movements at the locations shown on the Drawings in order to produce a complete power switch installation.

   1. Secure power switch and lock movement to the switch ties using galvanized or cadmium plated bolts of the proper diameter. Bolts are required to have a six sided or square head and a head bolt lock must be used on the underside of the wood tie. All thread threaded rod is unacceptable.

E. 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 (8) eight 7/8-inch bolts.

F. 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.

G. 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 requirements of AREMA C&S Manual Parts 12.2.1 and 2.4.1, and the SCRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems.

H. 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.

I. During storage and after installation, properly lubricate and maintain switch and lock movement layouts on a regular timed program until accepted by the Engineer.

J. 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.

K. 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.

L. Removal of switch targets, if applicable, shall be the responsibility of the Contractor after in-service testing has been completed and control point is placed in service.

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 34 42 58, Signal System Testing.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Power Switch and Lock Movement furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, shall be determined from the actual count in units as designated in the schedule of Quantities and Prices.

4.02 PAYMENT

A. Power Switch and Lock Movement furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 50
SWITCH CIRCUIT CONTROLLER

PART 1 - GENERAL

1.01 SUMMARY
   A. This Section includes requirements for switch circuit controllers.
   B. Switch circuit controller and layout shall be all new and include the controller unit, junction box, point lug, detector rod, shims, all required bolts, nuts, washers, pins, grease fittings, cotter keys, vent elbows, plates, adjusting brackets, and all hardware to mechanically couple the switch circuit controller to the track switch points as a stand alone or in conjunction with an electric switch lock and mount it on the ties.
   C. Refer to Section 34 72 00, Trackwork, for track construction requirements.

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.

1.03 REFERENCES
   A. American Railway Engineering and Maintenance of Way Association (AREMA):

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 Metrolink 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 as designated.

B. The Contractor provided Switch Circuit Controller and layout shall be Model U-5 with return spring, ventilators and wire outlet as manufactured by Ansaldo STS USA (formerly Union Switch and Signal) or approved equal. Switch Circuit Controller provided by Contractor shall be complete with offset crank, operating rod, switch point lug and associated hardware.

C. Contractor furnished Junction Box shall be Model 091 428-ABX manufactured by Safetran Systems or an 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 24-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 34 42 16, Signal Wires and Cables.

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 furnished by the Contractor until final “acceptance”.

B. At new switches under construction that are not to be used by the Freight Carrier the Contractor shall ensure that the switch points are secured using a padlock able switch point clamp with Contractor provided padlock. All locks shall be Contractor provided.

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
Metrolink 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 wood switch ties, by 3/4 inch by 10 1/2
inch bolts. Secure switch circuit controller to the switch tie using galvanized or
cadmium plated bolts. Bolts are required to have a six sided or square head and
a head bolt lock must be used on the underside of the wood tie. All thread
threaded rod is unacceptable.

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 34 42 16, Signal Wires and Cables. 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. In cases where the switch circuit controller is being used with a sliding derail with wheel crowder (hand-throw derail application), connect switch circuit controller to the lug provided with the derail.

M. Any switch assembly which is connected to the open point side, or which has a reverse switch indication shall be equipped with an insulated front rod.

3.03 SECURITY

A. Install Owner-furnished locks 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 34 42 58, Signal System Testing.

C. Test all functions of each switch and lock movement layout in accordance with Section 34 42 58, Signal System Testing.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Switch Circuit Controller will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Switch Circuit Controller furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 52
RECTIFIERS, BATTERIES AND BATTERY CHARGING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

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

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 34 42 58 – Signal Systems Testing

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

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 Plans 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. Exide ELM IRONCLAD Single Wet Cell low maintenance Lead Acid Batteries conforming to AREMA C & S manual parts 9.1.1 and 9.1.30 such as:
1. Model (ELM 240, 240AH)
2. Model (ELM 340, 340AH)
3. Model (ELM 425, 425AH)

B. NRS Battery Charger: Charger conforming to the requirements specified herein as manufactured by Exide Corp. or equal.
   1. Model ERBC 12/401C (12/40 1/20V, 40A)
   2. Model ERBC 12/201C (12/20 1/20V, 20A)

C. Battery Charger – manufactured by NEWMAR.
   1. Model SPS-12-20A

D. VMI Battery Charger – shall be all new and as manufactured by Quality Marine, or approved equal.

E. Battery Charger/Power Pack – manufactured by National Railway Supply, Inc.
   1. Model ELC 120/6

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 Vac to 130 Vac 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. Battery Cells shall be square tubular type design, flooded lead acid. Individual battery cells shall have handles incorporated into their design to facilitate lifting.

I. Batteries shall not release any gas, fumes, or any toxic substances when operated under normal conditions or when charged or discharged at a maximum recommended rate. Each battery cell shall be equipped with a dual action bayonet type flame-arresting vent plug, having an integral electrolyte level gage.

J. 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 2.30 volts per cell. Contractor shall warrant that all batteries supplied shall be free from any defective workmanship or faulty materials for a period equal to, or greater than, twenty (20) years, ten (10) full years of coverage plus ten (10) full years of pro-rata coverage. The Engineer reserves the right to reject any bid that fails to comply with these Specifications.

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 Plans.

3.02 TESTS

A. Perform tests specified in Section 34 42 58, Signal Systems Testing, ensuring system operation.

B. Test batteries and battery chargers in accordance with the manufacturer's standard when installed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Rectifiers, Batteries, and Battery Charging Equipment will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. Rectifiers, Batteries, and Battery Charging Equipment furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 54
RAIL BONDING

PART 1 - GENERAL

1.01 SUMMARY

A. This 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 SCRRRA Standards.

B. Rail track joints shall be bonded with welded railhead bonds per SCRRRA 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 the Engineer.

1.03 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 Plans.

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 Engineer.

D. Bond Strand: Bond strand for fouling wires shall be 3/16-inch single strand with 4/16-inch black PVC insulation.
E. Acceptable Manufacturers:

1. All electrical connections to rail shall be welded with the CADWELD® copper-based exothermic welding process as manufactured by ERICO Products or 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.

F. All welded bonds shall be installed per manufacturer's recommended installation procedure.

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. When there are multiple track connections to be applied at an insulated joint the wayside signal track connection shall be the nearest connection to the insulated joint with crossing detection circuits next and crossing shunts lastly installed in this order. The Contractor shall ensure that the insulating quality of the materials used to protect the splice meets FRA 234.241 requirements. The use of compression sleeves for track circuit connections is only acceptable when making a bond strand connection to underground cable inside of the trackside concrete pull box.

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 the SCRRA Engineering Standards.

D. Install all track circuit connections. Remove any found to be defective prior to acceptance, and install a new track circuit connection.

E. Provide and install bond strand retainer clips made of Electroplated Spring Steel on the rail base to hold terminated bond strand in place as specified in the Signal Standards and as recommended by the manufacturer.

F. Provide and secure the bond strand along the tie by use of PVC cable keeper for wood ties or “Snap-On” Style Stainless Steel Concrete Tie Clips for concrete ties.

3.03 TESTING

A. Shunt 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. Hardwire shunt usage for inspection and certification of wayside track circuits and constant warning devices is unacceptable.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Rail head bond and track connection will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Rail head bond and track connection furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

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 to the Resident Engineer upon completion of testing of a location.

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 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 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 sized appropriately for the connections involved.

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 Plans 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 an approved equal.

B. Ground wire as specified herein.

C. Cadweld connections: As manufactured by Erico Corp. or an 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 determination.

5. Ground wire/cable runs shall be as short and straight as possible and shall not be interrupted by any device, termination or splice.

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 Plans. 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, arrange to have the new ac power service inspected by state and local jurisdictional authority(s) as required.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Full compensation for all ground rods and grounding systems shall be considered as included in the contract prices paid for the various items of work involved, such as case and house installation, signal installation and AC Meter Service installation and no additional payment will be made therefore.

END OF SECTION
SECTION 34 42 58
SIGNAL SYSTEM TESTING

PART 1 - GENERAL

1.01 SUMMARY
A. This 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.

B. Related Specifications include but are not necessarily limited to:
   1. Section 34 42 56 – Signal Grounding

1.02 REFERENCES
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):

1.03 TEST SYSTEM DESCRIPTION
A. It shall be understood where this Section states “as authorized by the SCRRRA Signal Manager or SCRRRA Signal Engineer” or “submit to the SCRRRA Signal Manager or SCRRRA 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. Supply test equipment of proper type, capacity, range, and accuracy 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, make necessary corrections and retesting. Complete all tests and inspections 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 an 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. 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 SCRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems. Owner will provide three (3) copies of this Manual at the Pre-Construction meeting. Refer to Section 01 31 00, Project Management and Coordination, Contract Meetings. Request guidance from the Engineer where the test and inspection requirements written herein conflict with SCRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems. In the event that the test or inspection to
be provided by the Contractor is not provided in the SCRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems the Contractor shall request in writing to the Resident Engineer instructions of the testing required.

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 SCRRA Signal Manager or SCRRA 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 SCRRA Signal Manager or SCRRA 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 Resident Engineer for acceptance:

1. 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. Detailed 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 between the various individuals involved in the testing.

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, 60 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 subsystems.

C. Contractor's testing procedures and cut-over plan must pass the SCRRA Asst. Director or SCRRA Signal Engineer's and the Operating Railroads review. Allow 30 days for this approval process. In the event the Contractor's testing procedures and cutover plan is rejected in any manner, the Contractor shall not be entitled to any claim for delay or compensation from the Owner.

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 SCRRA 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 at listed locations.

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.

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, and 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 Plans 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. Provide confirmation 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 SCRRRA Signal Manager or SCRRRA 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 SCRRRA 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 Plans 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 34 42 56, Signal Grounding.
   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 SCRRA 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 SCRRA 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 SCRRA form.

3. These tests shall be performed at the shelter locations after the shelter has been set.

4. Record test results on the appropriate SCRRA 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 Plans.

3. Comparing wire gages with those called for on the Contract Plans. 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 Plans 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 from wayside instrument shelter.
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 SCRRRA 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.

3. Each line circuit will have a breakdown test performed between wayside instrument locations. Breakdown of the line circuit shall begin at the origination point of the circuit. The positive side of the circuit shall be opened to ensure appropriate relay or input is de-energized in the other instrument shelter. Close circuit and verify that the proper relay returns to its normal position. Repeat for the negative side of the circuit. If circuit breaks through relays within the instrument shelter where circuit originates, drop each relay one at a time, which breaks the circuit in order to verify that the appropriate relay or input is de-energized in the other instrument shelter. Restore relay and verify that the proper relay and/or input returns to its normal position in the other shelter. Each relay and/or input shall be tested to ensure that it follows all the proper breaks 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 both normal and reverse.
   b. Track circuit occupancy, all tracks.
   c. Signal clear indications, each signal.
   d. Power-off and alarm indications.
   e. Switch (es) out of correspondence.
   f. Auxiliary input indications if applicable.
   g. Signal at stop indications, each signal.
   h. Signal in time indication for each route.

3. All design changes found necessary to obtain proper operation shall be submitted to the SCRRA Signal Manager or SCRRA 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 SCRRA 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 one of the following insulated joint testers, the Harmon 1501A1JC, S&C Model 324 Track Circuit Short Finder, or 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 interlocking’s. 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. Record test results on the appropriate SCRRRA forms. Submit these completed forms to the Engineer in order to obtain acceptance of these test requirements.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Signal System Testing will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by
the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Signal System Testing furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this Section shall include the cost of all associated equipment, including meters, meggers, relay test units, shunt cords, communications equipment and testing.

END OF SECTION
SECTION 34 42 60
SIGNAL SYSTEMS MISCELLANEOUS PRODUCTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for miscellaneous components and products for signal systems that the Contractor shall provide and install. All materials provided by the Contractor shall be new unless designated on the railroad plans or approved by the Resident Engineer.

1.02 REFERENCES

A. American National Standards Institute (ANSI)
   1. C80.1 Electrical Rigid Steel Conduit

B. American Railway Engineering and Maintenance of Way Association (AREMA):

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 solder-less crimp-on type terminals be used in this Contract as well as samples of solder-less crimp-on type terminals from vendors performing house wiring.

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 requirements 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 requirements 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 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 Safetran, Inc., or an approved equal.

2.10 LIGHTNING ARRESTERS AND EQUALIZERS

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

2.11 SURGE PROTECTORS

A. Safetran SP-17, SP-18, SP-19, SP-20, or an approved equal. Surge Protectors shall be in accordance with AREMA C&S Manual Part 11.3.3.

2.12 TERMINALS FOR WIRES AND CABLES

A. Solderless terminals shall be in accordance with the 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 American Pamcor, Inc., under the trade name of “Pre-Insulated Flags” with translucent insulation similar to Catalog No. 322313, or an approved 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 an approved 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 an approved equal, shall be furnished for No. 8 studs and AMP Catalog No. 320571, or an approved 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 an approved 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 an 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 an 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 Plans. 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 40, herein referred to as PVC conduit, shall be installed as shown in the Contract Plans. 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 an approved 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 an 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.

C. Switch padlocks for the Freight Carrier’s use will be SCRRA furnished. Provide all other padlocks in order to provide security of signal and electrical equipment until such time as the equipment is placed in-service and approved through final “acceptance”.

D. Provide signal equipment padlocks until such time as the project is found to be acceptable and the Owner relieves the Contractor of maintenance responsibility. The Contractor and Owner or SCRRA will schedule a lock change out program directly related to the final “acceptance” of the project. The schedule shall be coordinated through the Resident Engineer. Present a list of equipment locks to be changed out by equipment and locations and the total number of locks that will be required to secure all the signal equipment.

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 40, 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 an approved 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 an approved 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 an 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 an approved equal.

2.24 AC GENERATORS

A. AC Generator shall be ACG-3 with 10-10 Modules manufactured by GETS Global Signaling or approved equal.
2.25 AUDIO FREQUENCY ISLAND TRACK CIRCUITS
A. Audio frequency island track circuits shall be AFTAC-II manufactured by GETS Global Signaling, PSO manufactured by Safetran systems, or an approved equal.

2.26 OVERLAY TRACK CIRCUITS
A. Provide and install Overlay track circuits EPIC III manufactured by GETS Global Signaling, or approved equal as designated in the railroad plans.

2.27 AC TRACK CIRCUITS
A. AC Track Circuits shall be steady energy such as the SE-3 manufactured by Safetran or an approved equal. Vane Relays shall not be used.

2.28 DATA RADIO
A. Data radio package shall be comprised of Safetran Systems Inc. WCP II Radio, PN A53412; DC/DC Converter, PN A53106; and Wayside Control Unit, PN A53105.

2.29 POWER OFF STROBE LIGHT
A. Power off strobe light and miscellaneous materials shall be packaged and shipped with each shelter to be installed as shown on the Contract Plans. Power off strobe light and miscellaneous materials shall be installed in the field by the installation contractor.

B. Each shelter requiring a power off strobe light and Miscellaneous materials will include the following:
   1. 1 ea. Power Off Indication Light – S&C Distribution Company p/n 120-10, or an approved equal.
   2. 1 ea. Protective Cage 5” x 5” x 5” – Fumio Fukaya Enterprises p/n UPRR0012, or an approved equal.
   3. 1 ea. Rubber Grommet 3/8” x 1/8” – Newark Electronics p/n 32F1353.
   4. 4 ea. Bolt, 1/4” – 20 x 2” Hex Head Cap Plated – McMaster Carr p/n 013194-002.
   6. 8 ea. Washer, 1/4” Flat Stainless Steel – Grainger Industrial Supply p/n 4P484.
   7. 1 ea. Silicone, RTV Sealant (Blue) – Grainger Industrial Supply p/n 5E220.
2.30 ENCLOSURE ALARM SYSTEM

A. Intrusion alarm system to be supplied and installed inside of enclosure as depicted on the Contract Plans. Intrusion alarm system supplied by “ADEMCO No. V20 Pack”, or equivalent system approved by the Engineer.

2.31 EXTRA MATERIALS

A. Furnish two gallons or equivalent volume of corrosion preventive compound, No-Ox-ID A-Special or approved equal. Compound shall be the same product as approved for use in the Work.

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.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Furnishing, installing and testing Miscellaneous Signal Equipment will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Furnishing, installing and testing Miscellaneous Signal Equipment in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 62
SERVICE METERS

PART 1 - GENERAL

1.01 SUMMARY

A. This 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 Local Power Company (LPC), in order to obtain the commercial metered power service at the locations shown on the Contract Plans and as required by the Engineer.

C. Related Specification Sections include but are not necessarily limited to:

1. Section 34 42 56 – Signal Grounding

1.02 REFERENCES

A. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit Meter Service Plans, 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.

D. Submit a copy of each service order to the Resident Engineer for approval and to verify that each meter service planned falls within the Owners property.

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 LPC.

C. Ground Rods and Ground Rod Clamps: Ground rods and ground rod clamps shall meet the requirements of Section 34 42 56, Signal Grounding, and those of the LPC.

D. Wood Poles: Shall meet the requirements of LPC.

E. Meter Pedestals and Bases: Shall provide and install meter pedestals and bases which meet the requirements of LPC.

PART 3 - EXECUTION

3.01 GENERAL

A. Make the necessary arrangements with LPC 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 LPC. Pay LPC charges for this service connection.

C. Where the Contract Documents specify that the Owner will make arrangements with the LPC, Contractor shall be responsible for installation and coordination with the LPC.

3.02 COORDINATION

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

B. Shall be responsible for Local Power Company monthly charges from all new meters installed until “The Commission” accepts full and final maintenance of the project. When final acceptance has been granted, the Contractor shall coordinate with SCRRA and the Local Power Company to transfer all new meter address to SCRRA at:
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 LPC's requirements and the NEC.

B. The requirements included within this Section shall cover all incidental installation work necessary to affect an integrated, tested, and operable signal power system for the Work as shown on the Contract Plans.

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. The Contractor, in cooperation with the Engineer, shall meet as necessary with LPC representatives to negotiate for the upgrade, relocation, or addition of required power services needed to complete system operation.

3.04 GROUNDING

A. Meter service grounding shall be in accordance with Section 34 42 56, Signal Grounding, the NEC, and the LPC's requirements. If there is a conflict between the above specifications, LPC's 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.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. AC Meter Service Panel will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. AC Meter Service Panel furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 64
HIGHWAY-RAIL GRADE CROSSING WARNING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for highway-rail crossing warning systems. These requirements shall also apply to pedestrian grade crossing warning systems, as applicable.

B. Where shown on the Contract Drawings or as required to accommodate associated other work of the Contract, make modifications to the existing highway-rail 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-rail crossing warning systems in preparation for, and during, track installation and rehabilitation work.

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA):

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-rail crossing warning during all phases of rail construction. Refer to Section 01 14 00, Work Restrictions. 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 34 42 00, 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 01 14 00, Work Restrictions. 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 within 3 days of testing.

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 01 50 00 Temporary Facilities and Controls, for general requirements for spare parts. Furnish for spare parts:

1. 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-rail 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 01 64 00, Authority Furnished Material and Equipment, 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 34 42 00, General Signaling Requirements.

2.03 CROSSING WARNING TRAIN DETECTION EQUIPMENT

A. Furnish and install 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 and install 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 in kHz are 10.0, 11.5, 13.2, and 15.2 or the Harmon (GETSGS) Random Signature Island frequency.

D. Each highway-rail 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 and install 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, Safetran GCP 3000-D2, GCP 4000 as shown on the Contract Drawings, or Approved Equal. 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 and install 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 30 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 and install an internal 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.

K. Furnish and install a separate solid state data recorder and crossing monitor, which shall be capable of being integrated into the Metrolink Railway Works crossing monitor and alarm system, and capable of remote interrogation. The North American Signal Micro Data Analyzer II with data radio (MDA II) as shown on the Contract Drawings or Approved Equal shall be used.

L. Furnish and install a Roof mounted VHF antenna and 7db YAGI antenna and associated antenna cables, on each shelter as shown on the Contract Drawings.

M. Program and install an all new solid-state microprocessor based control system for interface with the traffic signal system for preemption applications. This system shall utilize an isolated RS-422 serial link (two twisted wire pairs) to a separate traffic controller or traffic control communications interface device. The system shall utilize the industry-standard IEEE 1570-2002 communications protocol to establish a serial link with a compatible Advanced Transportation Controller (ATC). The system shall be user configurable via a touch screen LCD user interface panel. The system shall have an output for interface system health, and one for traffic controller health. The system shall be able to provide second train logic via an output to drive a vital relay. This relay may also be used to extend the warning time of the crossing when there is a failure of the traffic signal controller. The Safetran Systems I–SPI unit, or approved equal shall be
used.

### 2.04 CROSSING WARNING GATES AND FLASHING LIGHTS

A. Furnish and install each highway-rail 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 relevant sub-parts of the AREMA C&S Manual Part 3.2.

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 Metrolink signal standards and site conditions. Arms shall be of the aluminum with fiberglass extensions and fiberglass tip type. Gate arm lamps shall be LED conforming to the AREMA C&S Manual, Part 3.2.40. 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 AREMA C&S Manual, Part 3.2.60 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-rail crossings shall conform to CPUC required signage.

J. Exit Gates will default to the vertical position when energy is removed. At a grade
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Highway-Rail Grade Crossing Warning Systems

crossing, the entrance gates and the exit gates should be provided by the same manufacturer. The Safetran S-40 and S-40EXIT, or the US&S Model 95 Entrance Gate and Exit Gate are acceptable.

K. Exit Gate Systems shall incorporate dynamic vehicular detection utilizing preformed inductive loops with a modular processor assembly incorporating a minimum of 4 inputs and 8 outputs per module. Operating parameters shall be accessible and programmable from the front of the module such as the Reno A & E Model E-1400 or equal. Modules shall be capable of synchronous loop frequency scanning. Loop detector modules shall be integrated within the Exit Gate System.

L. Control of Exit Gate operation shall be by a solid state processing system which is user configurable with permission and password protection. The Exit Gate System shall be configurable to process gate position information for up to eight (8) individual gate mechanisms selectable to be either Entrance or Exit Gates. The Exit Gate System shall be configurable to process vehicular detection information for vehicle presence and detector health for up to sixteen (16) individual inductive loops. User configuration and event analysis must be by a front panel LCD touch screen panel. The front panel LCD shall provide a graphic display depicting collective positions of entrance and exit gates along with occupancy status of entrance, intermediate and exit vehicular loops for both traffic directions. Exit Gate controller shall have an event recording capability and the ability to serially connect with another Exit gate controller of the same manufacturer. The Railroad Controls Limited Exit Gate Management System or Approved Equal shall be used.

M. Control of Entrance Gates shall be by a solid state microprocessor system which contains a charging system and programmable gate delay. This controller may be a separate unit such as the Safetran SSICCIV or approved equal, or it may be an integrated modular component of the Constant Warning Time system such as the GCP4000 or Approved Equal.

2.05 FOUNDATIONS

A. Provide foundations for wayside equipment cases, highway-rail 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 03 30 00, Cast-in-Place Concrete, and 03 40 00, Precast Concrete.

C. Provide precast concrete foundations complete with anchor bolts, nuts, and washers in accordance with the AREMA C&S Manual, Part 14.4.
D. All galvanized steel foundations to be furnished and installed shall be complete with Section 34 42 60, Signal Systems Miscellaneous Products, and 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.


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 34 42 60, Signal Systems Miscellaneous Products.

2.07 CONDUIT

A. Conduit shall conform to the specifications in Section 34 42 60, 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
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 34 42 54, Rail Bonding, with the type of bonds specified in Section 34 42 54, Rail Bonding.

C. Make signal connection to rails using weld type track circuit connectors per Metrolink Design 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-rail crossing or signal systems.

3.05 TRACK CIRCUITS

A. Install and adjust all track circuits in accordance with the requirements of AREMA C&S Manual, Parts 8.6.1, CFR 49, Parts 234 and 236, 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-RAIL 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 the AREMA C&S Manual, Parts 3.3.1 and 3.3.5 and CFR 49 Part 234.
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. Furnish and install 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 Division 31 - 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 03 35 23, Exposed Finished Concrete, 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 31 11 50, 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 31 11 00, 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 34 42 58, Signal Systems Testing, including documentation requirements.

B. Prepare test procedures and perform and document tests on the highway-rail crossing components and systems as follows:

1. Include all tests herein specified, as specified in the appropriate sections of the AREMA C&S Manual, and the FRA Rules, Standards, Instructions for Railroad Signal Systems, CFR 49 Part 234 and 236.

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 34 42 58, 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 SCRRRA Instructions Governing Installation, Maintenance, Inspection and Testing of Signal Apparatus and Signal Systems, 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.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Pedestrian or Vehicular gates and Flashing Light Assemblies will be measured by the unit or fraction thereof furnished, assembled, and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Microprocessor based crossing equipment such as GCP, EGMS and I-SPI units shall be measured by the unit or fraction thereof furnished, assembled, and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Preformed inductive loops shall be measured by the unit or fraction thereof furnished, assembled, and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

D. Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC’s) will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices,
or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

### 4.02 PAYMENT

A. Pedestrian or Vehicular gates and Flashing Light Assemblies furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Microprocessor based crossing equipment such as GCP, EGMS and I-SPI unit assembly furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for programming, furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Preformed inductive loops shall be assemblies furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for programming, furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

D. Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC’s) furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

E. The Narrow Band Shunts, Wideband Shunts and Tuned Joint Couplers (NBS, WBS & TJC’s) shall include the cost of related enclosures, track wires and exothermic track connections and all associated equipment, conduits, mounting hardware, trenching and filling, adjustments and testing as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

F. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 42 66
DRAGGING EQUIPMENT DETECTOR SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. The work in this Section shall include providing detailed design, furnishing and installing a complete Dragging Equipment Detector as specified herein and as shown on the Contract Drawings.

1.02 QUALITY ASSURANCE

A. Dragging equipment detector and automatic equipment identification reader shall be tested to Manufacturer’s Standard when installed.

1.03 SUBMITTALS

A. Detailed design drawings of the installation in Bentley Microstation V8.

B. Field Engineering Survey of the proposed installation site validating conformance to manufacturer’s installation requirements, or detailing improvements required to the track structure, which will be performed by others.

C. (Two copies each of) Manufacturer’s Installation, Maintenance and Training manuals for each of the various systems composing the complete installation.

D. Manufacturer’s office software for each of the detector and monitoring systems.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Signal bungalow and any equipment therein shall be shipped, stored and handled as specified in Section 34 42 46, Signal Equipment Houses.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Double-track Dragging Equipment Detector system.

B. Bungalow to house detector monitoring devices.

C. Radio talker equipment.

D. Standby Battery sized sufficiently for the detector systems.
2.02 MATERIAL DETAILS

A. The Dragging Equipment Detector system shall utilize mechanical paddle detectors similar to the GETS Self Restoring Paddle that can be interconnected and output a female voice or an approved equivalent system.

B. Defect Detectors shall conform to all applicable parts in Section 5 “Defect Detector Systems” of the AREMA C&S Manual.

C. The Automatic Equipment Identification system shall consist of an antenna, a reader and a processor utilizing a radio frequency transceiver reading system capable of scanning standard AAR AT5110 equipment tags.

D. The defect detection system shall be an integrated system composed of all subsystems and capable of future integration of typical railroad defect detection systems such as hot bearing and hot wheel detectors. The AEI system shall be integrated into the defect detection system.

E. All battery, communication and detector monitoring equipment shall be housed in a standard Metrolink bungalow as described in Section 34 42 46, Signal Equipment Houses and shown on the Contract Drawings. Placement of equipment in bungalow shall allow for the future installation of equipment for a double-track hot bearing and hot wheel detector system.

F. A 5-watt radio system with a roof-mounted antenna shall be configurable to broadcast the status of all trains, or to only broadcast alarms from the various defect detection systems on the voice channel and to report health status to Metrolink via a separate data path. The digitized radio voice shall announce “Metrolink detector, milepost ###.#” on AAR channel ###/### when broadcasting.

G. The standby power and charging system shall be sized to provide 48 hours of continuous operation in the event of an AC power failure, and conform to the requirements of Section 34 42 52, Rectifiers, Batteries and Battery Charging Equipment.

H. The defect detection system shall be capable of communicating via a radio-based Ethernet data communication link.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Design, Furnish and Install a complete Defect Detector System consisting of a Dragging Equipment Detector system, including all transducers, audio frequency overlay track circuits and all other trackside equipment.

B. Design, Furnish and Install a radio system to communicate with nearest Control Point (CP) information from the Defect Detector System.
3.02 TESTS

A. Perform all tests to Manufacturer’s Standards and as specified in Section 34 42 58, Signal System Testing, ensuring system operation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Dragging Equipment Detector Systems will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Batteries and Chargers will not be measured and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.

C. Grading and site preparation required for the installation of Dragging Equipment Detector will not be measured and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.

4.02 PAYMENT

A. Dragging Equipment Detector Systems furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. No separate payment shall be made for any grading or site preparation required for the installation of Dragging Equipment Detector and shall be considered incidental to the installation of the Dragging Equipment Detector Systems.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. The Section includes the requirements for furnishing and installing wayside signal assemblies.

B. Wayside signal assemblies shall consist of ground-mounted masts, color-light signal heads with LED lamps, backgrounds, visors, number plates (for automatic signals), ladders, platforms, foundations, and all mounting hardware required to construct absolute (interlocking) and automatic signals.

C. Contractor shall furnish and install signals as specified herein and as shown on the Contract Drawings.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. LTS-4 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals

B. American Railway Engineering and Maintenance of Way Association (AREMA)

C. Code of Federal Regulations, Title 29, Occupational Safety and Health Administration (OSHA)
   1. Part 1910 Subpart D “Walking-Working Surfaces”

1.04 QUALITY ASSURANCE

A. Wayside signal assemblies shall meet the requirements of AREMA C&S Manual part 7 and applicable portions of Manual Part 3.2.5, where requirements of the AREMA Specifications do not conflict with requirements specified herein.

B. Inspect each signal assembly after it has been installed in the field. This inspection shall conform to the Contractor's Installation Procedure as accepted by the Engineer.

C. L.E.D. Lamp Units shall meet the requirements of AREMA C&S Manual Part 7.1.5.

D. 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 2000 feet. Where unobstructed sighting distance for a standard signal
arrangement is less than 2000 feet, provide to the Resident Engineer written notifications of sighting problems and locations.

E. Foundations shall meet all requirements of AREMA Signal Manual Part 14.1.1.A through 14.4.36 inclusive, where requirements of the AREMA Specifications do not conflict with requirements specified herein.

F. Resident Engineer reserves the right to make inspections and tests, as necessary, to determine if the equipment meets the requirements of these Specifications.

1.05 SUBMITTALS

A. Contractor shall submit shop drawings for each type of signal unit and each type of signal layout to the Resident Engineer for approval. 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 signals, and material specifications for all items to be furnished.

B. Submit shop drawings for structure foundations.

C. Submit Installation procedure for approval by the Resident Engineer. The procedure shall include a detailed description of installation activity and sufficient detail to allow the Resident Engineer to determine the validity of the installation procedure.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship lamp units separately from the signal head in which they will be used.

B. Contractor shall ensure that all wayside signal assemblies and signal lamp units are safely stored and protected from damage during storage, handling and transporting.

1.07 WARRANTY

A. Contractor shall provide warranty from defects arising from defective parts, workmanship, and lightning damage for 2 years from the first date of service.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Contractor shall furnish color-light signal heads as manufactured by Safetran, as specified herein, and as shown on SCRRA ES8525-01

B. Contractor shall furnish ground signal assemblies in accordance with these Specifications, and SCRRA ES8500-01 and ES8505-01, as appropriate for site-specific requirements.
2.02 SIGNAL HEADS

A. Signal head shall be furnished with L.E.D. lamp units, blank out cover plates (if applicable), hoods, background, mounting brackets, and U-bolts to fit 5-inch mast assemblies that Contractor proposes to furnish.

B. Signal head shall include mounting bracket for 5-inch mast and stainless steel fasteners.

C. Color-light signal units shall be capable of displaying three aspects: green, yellow and red as shown on SCRRA ES8525-01.

D. Install blank-out cover plates in all unused lamp units.

E. Signal head shall be designed to allow removal of lamp units from the rear with the exception of the Unilens dwarf signals.

F. Dwarf signals shall be of the Unilens type as manufactured by Safetran Systems or approved equal and must be able to display three aspects: green, yellow, and red as shown on SCRRA ES8525-01.

G. Signal access covers (doors) shall be provided with a means of securing in closed position.

2.03 GROUND SIGNAL ASSEMBLIES

A. Contractor shall furnish ground signal assemblies in accordance with SCRRA ES 8500-01, as appropriate for site-specific requirements.

B. Ground signal assemblies shall consist of an aluminum five-inch mast structure, junction box, liquid-tight flex conduit, platform(s), ladder, ladder foundation, grounding pigtail welded to the mast structure, and shall be equipped with all mounting hardware to accommodate the required arrangement of signal heads.

C. Each ground signal assembly must be fully compliant with the latest OSHA and CAL-OSHA fall protection requirements in effect at the advertisement of this Contract. Where a conflict exists between the requirements, the most stringent shall apply.

2.04 SIGNAL MASTS

A. Signal masts shall be predrilled for the placement of signal unit(s) by the manufacturer at the factory. Nominal signal mast height is between 21’-0” and 21’7”. A 5-inch cap for top of mast shall also be provided with each mast unit.

B. The base section shall be designed to accommodate a 5-inch mast. The dimensions of the foundation bolt hold centers in the base shall be as specified on SCRRA ES8500-01 and SCRRA ES8505-01.

C. Signal mast shall be fitted with one (1) 48-inch long No. 2 ground wire cad-welded to the mast as shown on SCRRA ES8500-01 and ES8505-01. The pigtail shall be...
coiled and secured in a manner that prevents during construction and while in transit.

D. Grounding for signal mast shall be as specified in Section 34 42 45, Signal Grounding.

2.05 LADDERS AND PLATFORMS

A. Platforms and ladder mounting brackets shall be constructed of galvanized steel, and shall be in accordance with AREMA Signal Manual Part 7.2 and SCRRA ES8500-01 and ES8505-01.

B. Ladders shall be constructed of aluminum having non-slip rungs and capable of supporting the weight of two people. Two hinged flat plates shall be fitted to the ladder to prevent unauthorized access to both sides of the ladder. The covers shall be locked in place by a signal padlock and hasp arrangement intended for this purpose.

C. Ladder platform cages shall extend a minimum of 42 inches above the top of landing.

2.06 JUNCTION BOXES

A. Junction box shall be in accordance with SCRRA ES8530-01

B. Junction box shall be mounted as shown in SCRRA ES8500-01 and ES8505-01. Junction box shall be securely fastened to the mast using 5-inch u-bolts. Junction box shall be furnished with a minimum of 28 AAR test (multi-unit) terminals in accordance SCRRA ES8330, and a 4-inch liquid tight flex conduit 8ft. length with liquid-tight flex conduit 8ft. in length with liquid-tight fitting.

2.07 FOUNDATIONS

A. Furnish foundations for ground signals in accordance with SCRRA ES8255.


C. 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.

PART 3 - EXECUTION

3.01 INSTALLATION - SIGNALS

A. Contractor shall furnish and 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 SCRRA Design Standards, Code of Federal
Regulations, Part 49, nor installed within the clearance envelope as defined in CPUC G.O. 26-D.

B. Locate signals centered between insulated joint, except where physically not possible. In such instances, submit a recommendation to the Resident Engineer for approval.

C. Center line of signal mast shall be 15 feet 0 inches from centerline of track unless a deviation from this is approved by the Resident 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 SCRRA Engineering Standards.

E. Install signal layouts in accordance with the applicable requirements of AREMA Signal Manual, Part 7.4.1 and SCRRA 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 Resident Engineer with written notification with any sighting problems.

I. Mount signal heads on an offset arm as shown in the SCRRA 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, pot-headed, tagged and terminated in the signal junction box as specified in Section 34 42 60, Signal Systems Miscellaneous Products. The number of conductors and conductor size of the underground cables shall be as shown in the contract drawings.

L. Wiring from the junction box base to the signal heads shall be No. 10 AWG copper stranded wire 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. Set lamp voltage between 8.8 volts and 9.2 volts measured at the signal lamp.

### 3.02 INSTALLATION – JUNCTION BOXES AND CABLING

A. The junction box shall have two terminals with insulated test links for each cable conductor, as specified in Section 34 42 60, Signal Systems Miscellaneous Products.
B. Junction box placement and cable entry to the junction box shall be as shown on SCRRRA ES8500-01 and ES8505-01.

C. The method of routing #10 flex wire from the junction box to each signal mounted on the structure shall be to route the wire within the tubular members of the structure. Pull wires entirely through the structure members, mast and signal mounting brackets, unless otherwise approved by the Resident Engineer.

D. Provide pull boxes located a maximum of 5 feet from each signal. Edges shall be smooth and rounded to accommodate cable installation.

### 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 SCRRRA ES8215-01. 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 01 14 24, Coordination with Utility Owners, for requirements for locating and protecting existing utilities. Advise the Resident Engineer immediately if any utility or cable interferes with foundation work. After locating interference, allow 72 hours for the Resident 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 31 20 00, 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 Resident Engineer, until the unit to be supported is installed.

E. After back filling excavation, the Contractor shall ensure that the foundation is plumb and level. Where ground signal foundations are installed, the top of the foundation shall be no higher than the nearest rail and no lower than the top of nearest tie. Under no circumstance shall the top of the foundation be more than 24 inches above final grade.

F. Foundations shall be installed to the lines, grades and dimensions required as determined by the Contractor and accepted by the Resident 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. The Contractor shall provide a means to prevent entry of rodents and insects at the bases of the vertical masts.

### 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 34 42 60, Signal Systems Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Wayside Signal Assemblies will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Wayside Signal Assemblies furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 34 71 50
HIGHWAY-RAIL GRADE CROSSINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Constructing new highway-rail grade crossings of SCRRA railroad tracks.
2. Removing and reconstructing existing highway-rail grade crossings.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
2. Section 03 31 00 – Structural Concrete.
4. Section 33 42 00 – Culvert and Drainage Pipe.
5. Section SS 34 11 10 – Continuous Welded Rail (CWR).
6. Section SS 34 11 23 - Other Track Materials (OTM).
7. Section SS 34 11 26 – Ballast.
8. Section SS 34 11 34 – Wood Railroad Tie.
9. Section SS 34 11 40 – Precast Concrete Grade Crossing Panels
10. Section 34 72 00 - Trackwork.
11. Section 34 72 20 – Track Shifting, Relocation and Resurfacing.
12. Section 34 72 30 – Field Welding Rail.
13. Section 34 80 33 – Hot Mix Asphalt (HMA) for Bridges.
14. Section 34 80 43 – Precast and Prestressed Concrete for Railroad Bridges.

1.02 REFERENCES

A. SCRRA: Engineering Standards, and Track Maintenance and Engineering Instructions.
B. ASTM International (ASTM):  
   1. D3776 Standard Test Methods for Mass per Unit Area (Weight) of Fabric.  


D. California Public Utilities Commission (CPUC): General Order(s) for road crossing(s) being newly constructed, removed or reset under the Project.  


H. Americans with Disabilities Act (ADA).  

I. Materials not meeting the requirements of this Specification shall not be used in the Work.  

1.03 SUBMITTALS  

A. General  
   1. Submittals shall be made in accordance with Division 01 requirements.  

B. Plans and Procedures:  
   1. Traffic Detour Plan signed by a Registered Professional Engineer using SCRRA Engineering Standards ES4301 as guidelines and incorporating provisions of the State of California MUTCD and the WATCH BOOK.  
   2. Site Specific Work Plan (SSWP) and Operating System Interface in accordance with Division 01 requirements.  

C. Certificates:  
   1. Material Test Reports for products purchased and used in the Project.  

D. Product Data and Shop Drawings:  
   1. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

c. Shop Drawings detailing dimensions, reinforcement and lifting apparatus for precast crossing panels.

1) Precast concrete mix design in accordance with Section 34 80 43.

2) Structural calculations.

3) Manufacturing and curing procedures.

E. Miscellaneous Submittals:

1. Submit quality control test results for testing performed for precast concrete panels and other material. Testing shall be performed by a certified test laboratory hired by the Contactor or fabricator and approved by the Engineer.

2. Verification documentation that Contractor requested DigAlert field location of underground utilities and SCRRRA clearance of underground railroad utilities prior to starting any excavation work in accordance with Division 01 requirements.

3. Contractor must submit qualifications and experience of installers of precast concrete grade crossings.

1.04 QUALITY ASSURANCE

A. Employ a skilled foreman for the Installation of grade crossings, having no less than 3 years experience in installation of the type of grade crossing panels used.

B. Track work shall be performed under the supervision of an FRA Part 213 Track Safety Qualified Foreman in accordance with requirements of Section 34 72 00.

C. The Engineer, will review test reports in accordance with the Specifications as applicable for the material item and may require additional testing to confirm requirements with the Specifications.

1.05 PROJECT SITE CONDITIONS

A. Prior to commencing Work, Contractor must examine the Contract Documents, inspect the site, obtain and review available Record Drawings of existing work and utilities and note conditions and limitations which may influence work required by this Section in accordance with Division 01 requirements.
B. Contractor must execute Work under this Specification in such a manner as to minimize impact to the daily operation of the railroad, vehicular and pedestrian traffic in accordance with Division 01 requirements and the approved Traffic Control Plans.

C. Contractor must maintain vehicular traffic and pedestrian walkways using barricades, warning signs and warning lights in accordance with Division 01 requirements.
   1. Warning lights shall be set so they do not shine into the eyes of locomotive engineers in on-coming trains.
   2. Temporary pedestrian walkways shall meet ADA standards.

1.06 ENVIRONMENTAL CONDITIONS

A. The Contractor must protect against erosion and uncontrolled run-off within and adjacent to right-of-way in accordance with the Project’s Storm Water Pollution Prevention Plan (SWPPP) and the approved NPDES Permit in accordance with Division 01 requirements.

B. The Contractor must obtain all required permits for dewatering and legally dispose of water from dewatering operations in accordance with Division 01 requirements.

C. Contractor must provide for site cleanliness, sweeping and dust control in accordance with Division 01 requirements.

D. Contractor must provide noise abatement as required by environmental permits or local agency requirements in accordance with Division 01 requirements.

1.07 REGULATORY REQUIREMENTS

A. Furnish any required excavation drawings or traffic control plans to Engineer for review and approval by SCRRA and jurisdictional authorities.
   1. Contractor to obtain permits for performing such work as required in accordance with Division 01 requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Precast Concrete highway-rail grade crossing Panels shall be new and conform to Section SS 34 11 40:

B. Wood Ties: Ties shall be new 10 feet long and conform to Section SS 34 11 34.

C. Ballast: Ballast shall be new and conform to Section SS 34 11 26.
D. Rail: Rail size shall be 136# CWR and shall conform to Section SS 34 72 00.

E. Rail Fastening: Rail fastenings shall be new and shall conform to Section SS 34 72 00.

F. Geotextile:

1. Geotextile filter fabric used for grade crossings shall be nonwoven fabric. The filaments shall be polypropylene, polyester, or polyethylene. The filaments must be dimensionally stable (i.e., filaments must maintain their relative position with respect to each other) and resistant to delaminating. The filaments must be free from any chemical treatment or coating that might significantly reduce porosity and permeability. Nonwoven fabric may be needle-punched, heat-bonded, resin-bonded, or combinations thereof.

2. The physical properties for Geotextile shall conform to the following:

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D3776</td>
<td>Minimum Weight (oz./sq. yd.)</td>
<td>3.5</td>
</tr>
<tr>
<td>ASTM D4632</td>
<td>Minimum Wet Grab Tensile Strength (lbs.)</td>
<td>100</td>
</tr>
<tr>
<td>ASTM D4632</td>
<td>Minimum Grab Elongation at Break (%)</td>
<td>20</td>
</tr>
<tr>
<td>ASTM D4751</td>
<td>Apparent Opening Size(US Sieve)</td>
<td>30</td>
</tr>
</tbody>
</table>

G. Asphalt Concrete:

1. Asphalt concrete for crossing underlayment shall conform to Section 34 80 33.

2. Asphalt concrete for roadway shall conform to Section 32 12 00, Hot Mix Asphalt Concrete. Asphalt concrete for roadway approach paving shall conform to Section 32 12 00, Hot-Mix Asphalt Concrete and the Greenbook Section 203 – Bituminous Materials as noted in SCRRA Engineering Standards ES4201 for permanent crossings or ES4302 for temporary crossings or Agency requirements as specified in the Plans or Project Special Provisions.

   a. Contractor must submit the proposed pavement design to the Engineer for review and acceptance. Roadway approach paving will be reviewed and accepted by SCRRRA and the local agency governing the crossing.

H. Cast-in-Place Concrete
1. Cast-in-Place concrete for new or replacement sidewalks, curbs, gutters and other concrete items shall conform to Section 03 31 00 or as shown in the Plans.
   a. Minimum 28-day compressive strength shall be 3250 psi (560-C-3250 –SSPWC) unless otherwise shown in the Plans.

I. Perforated Drain Pipe:

1. Perforated drain pipe shall be Schedule 80 PVC pipe in accordance with Section 33 46 00.

J. Signal Conduit:

1. Signal conduits shall be Schedule 80 PVC electrical conduit in accordance with Section 34 42 00.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate with SCRRA Signal Department forces in accordance with Division 01 requirements.

B. Demolish and dispose of existing grade crossing material including asphalt concrete pavement, sidewalks, curbs and gutters and other items as required in the Plans in accordance with Section 31 11 50.

C. Remove and salvage existing grade crossing panels or other crossing appliances as required in the Plans in accordance with Section 31 11 50.

D. Track subgrade, asphalt underlayment, and ballast shall be constructed to extend at each end, beyond the limits shown for each grade crossing in accordance with SCRRA Engineering Standards ES4201 or as shown in the Plans, whichever is greater.

3.02 SUBGRADE AND SITE PREPARATION

A. Prepare subgrade in accordance with the Contract Documents, Section 31 20 00 and SCRRA Engineering Standards ES4201.

B. Remove existing concrete foundations, curbs, sidewalks, storm drains, pavement and traffic striping as shown in the plans in conformance with Section 31 11 50.

C. Cut lines for asphalt and concrete shall be straight and neat in accordance with Section 31 11 50 and any damage to facilities to remain shall be repaired to the approval of the Engineer at no additional cost to SCRRA.
3.03 DRAINAGE AND SUBDRAINAGE

A. Drainage and subdrainage work including placement of geotextile wrap of perforated drainage pipe, shall be performed as specified in the Contract Documents and in accordance with SCRRA Standard Plans ES4201.

3.04 HOT MIX ASPHALT (HMA) CROSSING UNDERLAYMENT

A. Hot Mix Asphalt (HMA) pavement for crossing underlayment shall be placed as indicated in the Contract Documents Section 34 80 33 and as shown in SCRRA Engineering Standards ES4201.

B. Hot Mix Asphalt (HMA) pavement end ramps shall be provided at all concrete grade crossing panel installations in accordance with SCRRA Engineering Standards ES4201 if the preapproved crossing panel is used. End ramps shall be per the manufacturer’s recommendation if a substitute is approved, but shall not be less than 3 feet in length.

3.05 SIDEWALKS, CURBS, GUTTERS AND OTHER ROADWAY ITEMS

A. Place new sidewalks, curbs, gutters and other roadway items as shown in the plans, the identified standards of the public agency identified in the Plans responsible for the roadway and SCRRA Engineering Standards ES4001 through ES4021.

B. Highway-Railroad Grade Crossing Crossbuck signs, when called for, shall be installed in accordance with SCRRA Standard Drawing ES4310.

C. Private, Pedestrian and Bicycle Railroad Grade Crossing Sign, when called for, shall be installed in accordance with SCRRA Engineering Standards ES4311.

D. Temporary construction crossing signs, when called for, shall be installed in accordance with SCRRA Engineering Standards ES4302.

3.06 PRECAST CONCRETE HIGHWAY-RAIL GRADE CROSSING PANELS

A. Install precast concrete grade crossing panels to the position and location shown in the Plans in accordance with manufacturer’s recommendations, the approved procedures and SCRRA Engineering Standards ES4201.

1. Contractor must use SCRRA Engineering Standards ES4201 when using the preapproved crossing plank.

B. Contractor must clean dirt and debris from the flangeways before releasing the crossing for the passage of trains.

C. Re-used highway-rail grade crossing panels, when shown in the Plans, shall have hot mix asphalt (HMA) placed with proper compaction in the flangeway if a rubber filler does not exist in the flangeway.
3.07 BALLAST
   A. Place and spread ballast in accordance with the details indicated on the Contract Plans, SCARRA Engineering Standards ES4201 and Section 34 72 00.

3.08 TIES
   A. Grade crossing ties shall be spaced per crossing plank manufacturer’s recommendations if not the pre-approved crossing plank, and spacing per SCARRA Engineering Standards ES4201 if the pre-approved crossing plank. Other tie location and layout distances shall be per the SCARRA Engineering Standards ES4201.
   B. Tops of all ties within the crossing limits shall lie in the same plane. Any tie with an irregular surface dimension shall be adzed or replaced.

3.09 HIGHWAY-RAIL GRADE CROSSING TRACK CONSTRUCTION
   A. Construction and fastening of track through grade crossings shall be performed in accordance with details shown on the Contract Plans, SCARRA Engineering Standards ES4201 and Section 34 72 00.
   B. Rail joints or thermite welds are not permitted within the limits of the grade crossing trackwork unless approved by the Engineer.
   C. Rail joints consisting of field welds are permitted at the ends of rail strings placed for crossings. Welds shall conform to Section 34 72 30.
   D. Contractor must use a dynamic stabilizer after initial tamping and surfacing followed by a second surfacing pass in accordance with Section 34 72 20, prior to the final installation of the grade crossing panels.
   E. Every attempt needs to be made to close the roadway for the crossing construction so that the entire crossing can be completed continuously. If the roadway cannot be closed, extra efforts shall be utilized to ensure track surface profile is maintained during and after construction, including but not limited to an extra dynamic stabilizer pass.

3.10 FIELD QUALITY CONTROL/QUALITY ASSURANCE
   A. Compaction testing for subgrade, trench backfill and sub-ballast shall conform to Section 31 20 00.
   B. Compaction testing for asphalt concrete crossing underlayment shall conform to Section 34 80 33.
   C. Contractor must coordinate with and provide 24 hours advance notice of crossing work to SCARRA Signal Inspectors and verify that testing of all crossing signal work has been completed and accepted by SCARRA prior to opening crossing to vehicular traffic.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Highway-rail grade crossings will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. All material, work and services included in Sections SS 34 11 10, Continuous Welded Rail (CWR); SS 34 11 15, Other Track Materials (OTM); SS 34 11 26, Ballast; SS 34 11 27, Sub-Ballast and Aggregate Base; SS 34 11 34, Wood Railroad Ties; SS 34 11 36, Elastic Rail Fasteners; and 34 11 40, Precast Concrete Grade Crossing Panels will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

C. No separate measurement and payment will be made to the Contractor for removal of concrete panels.

4.02 PAYMENT

A. Highway-rail grade crossings furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. This price shall be full compensation for furnishing all labor, materials, tools, equipment, fees, supplies, supervision, and incidentals within the limits of highway-rail grade crossing work in accordance with SCRRRA Engineering Standards ES4201 necessary for any highway-rail grade crossings described by the Contract Documents.

END OF SECTION
SECTION 34 72 00
TRACKWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This Section consists of the Contractor, unless otherwise indicated, furnishing all labor, materials, equipment, tools, and incidentals necessary to remove, repair, modify, rehabilitate, or construct trackwork, turnouts, crossings and crossovers.

   1. Work includes ballast, walkways, ties, rail, fastening systems, other track material (OTM), turnouts and other special trackwork.

B. Related Specification Sections include but are not necessarily limited to:

   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section SS 34 11 10 – Continuous Welded Rail (CWR).
   4. Section SS 34 11 15 - Other Track Materials (OTM).
   5. Section SS 34 11 23 – Special Trackwork.
   6. Section SS 34 11 26 - Ballast.
   7. Section SS 34 11 27 - Sub-Ballast and Aggregate Base.
   8. Section SS 34 11 33 - Concrete Railroad Ties.
   9. Section SS 34 11 34 - Wood Railroad Tie.
   10. Section 34 71 50 – Highway-Rail Grade Crossings.
   11. Section 34 72 30 – Field Welding Rail.

1.02 REFERENCES

A. American Railroad Engineering and Maintenance of Way Association (AREMA):


C. SCRRRA: Engineering Standards.
D. SCRRA: Current Track Maintenance, Right-of-Way and Structures, Engineering Instructions.

1.03 SUBMITTALS

A. Submit, under the provisions of Division 01:

1. Materials: Submit individual certifications that all materials furnished by the Contractor conform to the specified requirements.

2. Shop Drawings:

   a. Submit Shop Drawing and product data for trackwork items not specifically defined by engineering standards.

   b. Shop Drawings for each size and direction of Turnout will be required.

   c. Shop Drawings shall also be submitted in electronic media Microstation Intergraph DGN V8 compatible format on compact discs and shall conform to SCRRA’s CADD Standards.

3. Equipment: Provide submittal for all construction equipment proposed to be used as identified in Division 01.


   a. Submit proposed construction and installation procedure for new trackwork as part of the Site Specific Work Plan (SSWP) submitted under Division 01, Coordination with SCRRA.

   b. Contractor may modify Installation procedure stated hereinafter, to produce the most efficient method for track construction, subject to approval by the Engineer.

5. Compliance Record: As-built compilation of actual track geometry produced in construction including curvature, length of reversing tangent, length of spirals, top of rail profile, and super elevation values.

6. Compliance Record: Rail temperature record taken during anchorage and de-stressing procedures as described in the Articles entitled “Procedures for Placement of CWR” and “Anchoring CWR” herein.

7. Compliance Record: Test results for insulated joints as described in Article entitled “Insulated Joints” in Part 3 of this Section.


10. Procedure: Submit procedure and field welding material technical data for field welding rail.

11. Procedure: De-stressing of Rail.


13. Procedure: Plan for the coordinating and scheduling of a signal track support crew to protect and maintain the operating signal system.

1.04 QUALITY ASSURANCE

A. Quality Assurance:

1. Perform track construction under the supervision of Qualified personnel, as defined in Division 01.

2. Corrections by Contractor: During the installation and testing period, Contractor must make available personnel, equipment, and Materials necessary to make required corrections to the track including such work as replacements, re-ballasting, resurfacing and realigning, or repair of constructed items, as the Engineer may require ensuring completion of the Work in accordance with the Contract.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Ties shall be lifted and supported during storage, transportation, and placing in such a manner as to prevent damage.

1. Ties shall not be dropped to the roadbed.

2. Wood ties shall be handled in accordance with AREMA Manual Volume 1, Chapter 30, Section 3.5 and Concrete Ties shall be handled in accordance with AREMA Manual Volume 1, Chapter 30, Section 4.11.

3. Refer to Sections 34 11 34 and Section 34 11 33 for on-site storage requirements.

B. Rail shall be unloaded and distributed in a manner that prevents damage to ties, rails and structures. Do not bump or strike rail.

PART 2 - PRODUCTS

2.01 CONSTRUCTION EQUIPMENT

A. If the Engineer determines that Contractor's equipment is not in good working condition or that the kind, size, capacity or quantity of equipment is incapable of contributing to the Work progress or to the requirements of the Contract Documents, Contractor must promptly replace the equipment with an improved kind, type, size, capacity, or quantity. Rejection of equipment shall not be considered justification for a delay Claim.
B. Track surfacing and alignment equipment shall be laser guided.
   1. Track surfacing equipment must have all tamping tools in good repair and working order.
   2. As a minimum at least 70 percent of the original surface area of the tamping tool pad must be available and these tools must closely match adjacent and opposite tamping tool pads in the amount of wear.

C. Equipment shall be compatible with and shall be operated within the clearances indicated in SCRRA Engineering Standards.

D. Wheel contours of all rail-mounted equipment shall conform to the Association of American Railroads (AAR) wheel standards or AREMA maintenance of way equipment wheel standards.

E. All construction loads borne by equipment shall be applied between gage lines of running rails on each track unless approved by the Engineer.

F. Vibratory compaction equipment for compaction of base ballast shall be specifically manufactured for compaction purposes.
   1. The self-propelled, pneumatic-tired roller shall have a gross weight of 10 to 15 tons, and the vibratory compactor shall have a weight of not less than 10 tons and shall be capable of applying a dynamic load of not less than 18,000 lbs. at 1300 to 1500 cycles per minute.
   2. The proposed compaction equipment is subject to approval by the Engineer.

G. Ballast Stabilizer for compacting ballast in crib and shoulder areas shall be approved by the Engineer.

2.02 TRACK TOOLS

A. Furnish tools and equipment necessary to construct the track.

B. Track gages, track levels, and other tools shall conform to the AREMA Volume 1, Chapter 5, Part 6, "Specifications and Plans for Tools."

C. Tools and equipment shall be maintained in such a condition as not to endanger personnel nor damage the Work and shall be subject to inspection by the Engineer.

D. Tools not conforming to standard shall be repaired to AREMA standards or shall be replaced.
   1. Substitution of tools other than AREMA standard will be permitted only with approval of the Engineer.
E. Track levels and gages shall be checked for accuracy at the start of every work shift and at any time the tool is dropped or struck.

1. Adjustments shall be performed anytime it is found to have more than 0.050 inches deviation from the nominal measurement value.

2.03 SUB-BALLAST

A. Sub-Ballast shall conform to the requirements of Section SS 34 11 27.

2.04 BALLAST AND WALKWAY ROCK

A. Ballast shall conform to the requirements of Section SS 34 11 26.

B. Walkway rock shall conform to the requirements of Section SS 34 11 26.

2.05 TIES

A. Wood ties shall conform to the requirements of Section SS 34 11 34.

1. Cross ties and switch ties shall be of the lengths detailed on the Contract Documents or the designated SCRRA Engineering Standard.

2. Ties shall be new unless indicated otherwise in the Contract Documents.

B. Concrete ties, shall conform to the requirements of Section 34 11 33 and SCRRA Engineering Standard Plan ES2402 for Pre-stressed Concrete Track Tie or ES2403 and ES2407 (for bridge deck locations requiring a neoprene pad). Ties shall be new unless indicated otherwise in the Contract Documents.

2.06 RAIL

A. Rail shall conform to the requirements of Section SS 34 11 10.

2.07 OTHER TRACK MATERIAL (OTM)

A. OTM shall be new and conform to requirements of Section SS 34 11 15 and SCRRA Engineering Standards.

2.08 TURNOUTS

A. Special Trackwork shall conform to the requirements of Section SS 34 11 23.

B. Turnouts shall be as indicated on the Contract Plans, fabricated with all new Material, and in conformance with SCRRA Engineering Standards.

C. Derails shall be of constructed using new Material and conform to SCRRA Engineering Standards with type (double switch point derail or sliding derail with crowder) as indicated in the Contract Documents.
2.09 GRADE CROSSING PANELS

A. Road Crossings shall be of new Material and conform to Section SS 34 11 40 and SCRRRA ES4201 and as indicated on the Contract Plans.

2.10 LUBRICANTS

A. Lubricant for special trackwork shall be Whitmore’s Railmaster Curve grease except that Dixon L-5550 graphite shall be used for switch plate lubricant. Approved equals shall be submitted for approval by the Engineer.

2.11 INSULATED JOINTS

A. Insulated Joints shall be new and conform to requirements of Section 34 11 15 and SCRRRA Engineering Standards.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Work shall be completed in accordance with SCRRRA Engineering Standard Plans, SCRRRA Track Maintenance and Engineering Instructions, AREMA Manual for Railway Engineering, and as specified herein.

1. Each fully completed segment of track, as approved in the SSWP, that is to be placed into operational service shall fully comply with the requirements of FRA 49 CFR 213 for the specific classification of train operation.

2. Track must have ballast section full to top of ties, have joints fully bolted or welded, have all anchors or elastic fasteners applied, and the rail shall be fully de-stressed.

B. Bottom of rail, fastener assemblies, and all bearing surfaces shall be broom cleaned before laying rail.

C. The low rail (inside rail of curves) on all superelevated track shall be designated as the profile rail.

D. Install track, OTM, turnouts, derails and road crossings in accordance with the Contract Plans, SCRRRA Engineering Standards, Track Maintenance and Engineering Instructions and California Public Utilities Commission requirements.

3.02 SUB-BALLAST

A. Sub-ballast construction shall conform to typical cross sections as depicted in SCRRRA Engineering Standards or as shown on Contract Plans and must also comply with the requirements of Specification Section SS 34 11 27.
3.03 CROSS TIES

A. Wood or concrete ties shall be used in special trackwork, grade crossings, turnouts, and crossing diamonds as shown on the Contract Plans.

1. Use of wood ties or concrete cross ties shall be designated on the Contract Plans for use in track construction as indicated.

B. Ties damaged as a result of improper handling or installation by Contractor and rejected by the Engineer must be removed and replaced with new ties at no additional cost to the SCRRA.

C. Installation and placement of wood ties shall be as follows:

1. Place wood Crossties on 19-1/2" centers for mainline track, except through grade crossings.

2. Space cross ties for grade crossings in accordance with the applicable SCRRRA Engineering Standard.

3. Space Crossties for turnouts in accordance with the applicable SCRRRA Engineering Standard and the Contract Plans.

4. Obtain approval for any deviation in crossties spacing from the Engineer prior to installation of spikes or hold down devices.

5. Place wood ties with heartwood face down and square to the rail, except as otherwise shown on the Contract Plans.

6. When handling or spacing ties, prevent damaging them with picks or spiking hammers. Tie tongs, lining bars, other suitable tools or tie spacing equipment shall be used.

7. Do not drive nails or spikes other than those called for into wood ties.

8. Do not re-spike new wood ties.

D. Place concrete Crossties as shown in the Contract Plans and SCRRRA Engineering Standards.

1. Ensure that the proper rail cant is established.

2. Concrete Crosstie spacing shall be 24 inches centers.

E. Transition ties shall be installed where concrete ties abut timber track in accordance with SCRRRA Track Maintenance and Engineering Instructions and SCRRRA ES2351-03.
F. Bridge decks with less than 12 inches of ballast under the tie will require use of a concrete tie with embedded neoprene pad (SCRRA ES2403 or ES2407). When calculating the depth of ballast under the tie, include any HMA underlayment as a part of the ballast depth for determining the requirement for use of the concrete tie with embedded neoprene pad. Bridge decks with 12 inches or more of ballast under the ties will utilize standard concrete ties (SCRRA ES2402 or ES2406).

3.04 TIE PLATES

A. Plates shall be positioned so that the rail will cant inward towards track centerline and the plate shall be centered on tie and applied as to obtain full proper bearing on both the tie and rail.

B. Tie plates shall be installed as shown on the SCRRRA Engineering Standards, in SCRRRA Track Maintenance and Engineering Standards, and on approved Shop Plans.

3.05 RAIL FASTENING

A. OTM shall be installed in accordance with SCRRRA Engineering Standards and where applicable, manufacturer’s recommendations.

B. Installation of screw spikes and specified resilient fasteners shall be in accordance with manufacturer's recommendations, and SCRRRA Engineering Standards and SCRRRA Track Maintenance and Engineering Instructions.

C. Spiking for standard cut spike fastening systems shall be performed using new cut spikes unless otherwise indicated in the Contract Plans and as follows:
   1. Spiking pattern shall conform to SCRRRA ES2460.
   2. Spikes shall be started vertically, square to the base of rail and driven straight.
   3. Shank of rail-holding spikes shall have full bearing against base of rail.
   4. Do not strike rail or fastenings when driving spikes.
   5. Bent spikes shall be removed and replaced with a new spike as approved by the Engineer.
   6. Spikes shall not be over-driven.

D. Holes for the screw spikes shall be pre-drilled and applied perpendicular to the plane of the base of tie plate.
   1. Sufficient torque shall be applied to bring the bearing face of the screw spike into flush bearing contact with the tie plate so no gap exists.
   2. Not more than 2 each cut spikes per plate may be used to hold the elastic fastening system plates until the screw spikes are installed.
3. Cut spikes used in this manner as temporary fasteners may be salvaged or used material.

4. Cut spikes used as temporary fasteners in this manner shall not be removed; however four (4) screw spikes per plate shall be provided if cut spikes are used in this manner.

### 3.06 RAIL ANCHOR INSTALLATION

**A.** Rail anchors shall be installed per SCRRA ES2351-01 through ES2351-04, as applicable.

1. In applying rail anchors, they shall be set with full bearing against the side of the tie.

2. Anchors shall not be over-driven.

3. Fractured or spread rail anchors will be rejected.

4. Rail anchors shall be applied prior to operation of trains.

5. If, in accordance with the Engineer-approved SSWP, a slow order will be required, the Contractor must submit proposed anchor pattern to the Engineer for approval prior to commencement of the rail anchor work.

6. Anchors shall be removed and re-applied at the time CWR is de-stressed.

**B.** Rail anchors shall be applied in accordance with manufacturer's recommendations.

### 3.07 INSTALLING TRACK

**A.** Installation, laying, raising, lining, tamping and dressing of track over ballast shall be performed as follows:

1. Ballast shall only be installed over sub-ballast, which has been prepared in accordance with Section 34 11 27 and approved by the Engineer.

2. Place base ballast in lifts not more than 6 inches in thickness before compaction.
   
   a. Layers shall extend beyond the edge of the ties as shown on the Contract Plans before compaction.
   
   b. Compact ballast thoroughly to form a stable section able to support the subsequent layers and loads.

3. Compaction of base ballast shall be by means of vibratory compaction equipment specified in Division 01.
3. Each lift of ballast within the initial layer shall be uniformly spread and compacted with not less than four passes of either a self-propelled, pneumatic-tired roller or vibratory compactor.

b. Ballast surface that exhibits ruts or crowns is not acceptable and shall be re-graded and re-compacted prior to the placement of the crossties.

4. Obtain the Engineer’s verification of the compacted ballast prior to the installation of track and appurtenant Work over the ballast.

5. The track shall be assembled on the compacted ballast to permit placement of additional ballast for subsequent raising and tamping and to provide the full depth under the ties.

6. The ballast shall be tamped with a 16 tool vibrating squeeze-type mechanical tamper specified in Division 01, making a minimum of one full tamping insertion per tie for each inch of raise.

7. The final track raise shall not exceed 1 inch.

8. The ballast in the crib areas shall be mechanically stabilized by a ballast stabilizer approved by the Engineer in accordance with Division 01.

9. The track shall be raised, aligned and tamped to within the specified tolerances.

10. Ballast shall be thoroughly tamped within a space from 15 inches inside either rail to the ends of the ties.

a. In tamping ties within the above-described limits, simultaneous tamping shall be performed under each rail.

b. Tamping is not permitted at the center of the tie except within limits of turnouts and crossings where the center of the ties shall be tamped unless prevented by trackwork components.

11. Pneumatic or electric tamping tools, either hand held or machine mounted shall be used to perform tamping at portions of turnouts not accessible to a production tamper. Hand tamping with shovels or picks will not be permitted unless authorized by the Engineer.

12. Two tamping tools shall always be used opposite each other on the same tie.

a. Tampers shall be started from a nearly vertical position and worked downward past the bottom of the tie, after which the tool should be slanted downward to force ballast under the tie.

b. Double tamp every joint tie.
13. Ballast shall be mechanically dressed to provide the section as shown on the SCRRRA Engineering Standards and the Contract Plans.

14. Excess ballast shall be removed.
   a. With the Engineer’s permission, excess ballast may be placed as directed by the Engineer.
   b. Payment will not be made for ballast in excess of dimensions shown on the Contract Plans.

15. Ballast damaged by overwork or excessive tamping or fouled by dirt or other deleterious material as determined by the Engineer must be removed and replaced at no additional cost to the SCRRRA.

16. Where new track joins existing track, the existing track shall be surfaced for a minimum distance of 500 feet on mainline or siding tracks, or 200 feet on industrial tracks, from the point of connection.
   a. Existing track surfacing may be longer as needed to meet FRA requirements, or as shown of the Contract Plans.

17. After the track has been raised to its final elevation and super-elevation, ballast consolidation of all tracks shall be performed before the track is placed in service.
   a. Each segment of track may be placed in full service, as approved in the SSWP, if that segment fully complies with FRA 49 CFR 213 for specific classification of train operation, has ballast section full to top of ties, has joints fully bolted or welded, has all anchors or elastic fasteners applied, and has the rail fully de-stressed and ballast compacted.

18. When raising track, a spot board or other approved device shall be used to maintain grade, and a level shall be used to keep track to proper crosslevel.
   a. Laser guided alignment is required, and horizontal alignment must be maintained during the raising operation.
   b. Use of automated controls on tampers will satisfy this requirement.

19. In addition to the other requirements specified herein, all newly constructed mainline and mainline siding tracks, upon completion of final surfacing operations, shall be mechanically stabilized using a Ballast Stabilizer as specified in Division 01.
3.08 INSTALLING TURNOUTS

A. Installation of frog plates, switch plates, and plates under the closure rails shall conform to SCRRRA Engineering Standards and AREMA trackwork standards.

1. Plates shall be secured by screw spikes except rehabilitation of existing turnouts with cut spikes, which shall be fully spiked.

B. Following the installation of turnouts on the initial layer of ballast, the turnouts shall be lifted, aligned and supported prior to placement of final ballast.

C. Ballast shall be uniformly placed and spread.

1. The turnout shall then be raised and the ballast tamped under both sides of each tie for the full length of the tie.

2. Tamp ballast thoroughly throughout the length of all ties in the turnout or other special trackwork.

3. Final top of ballast shall conform to the ballast section as indicated except in cribs wherein switch operating rods, locking rods or connecting rods are located and between point of switch and heel of switch where the crib ballast shall be 3 IN below the base of the rail.

D. When installing the various components of the turnout, particular attention shall be given to the following:

1. Check that alignment, gage, and surface meet Specifications.

2. Verify that bolts, nuts, cotter pins, and other fastenings are in place, in good condition, and properly tightened.

3. Verify that switch points are properly aligned and fit tightly against rail when switch is thrown in either position.

4. Verify that connecting rod and switch rod bolts are equipped with cotter pins properly applied.

5. Test-operate the switches for lost motion, difficult throw, or loose connections and adjust as necessary.

6. Examine the rod and fastenings that connect the switch point to the switch stand to see that they are in place and in good condition.

E. Joints within turnouts shall be welded.

F. Switch stands shall be so installed as to hold the switch point tightly against the stock rail when stand is in normal position, per the manufacturer’s instructions.

1. Switch rods shall be adjusted to hold the opposite point tightly against the rail when stand is in reverse position.
2. Switch stands, for both switches and derails, shall be mounted on two 16 feet ties.

G. Switch stands shall be kept securely fastened to the head block ties, use approved screw spike fasteners.

   1. The head block ties shall be set square with the track and kept firmly tamped.

   2. Correct any walkway deficiencies adjacent to the head block ties that would impact SCRRA employee or operating personnel access to the operating levers or controls for the switch stand.

H. Switch stand target colors shall conform to SCRRA ES2106 for Derail Switch Target or to SCRRA ES2703 for standard switch target.

I. At the time of Installation, sliding surfaces of special trackwork assemblies shall be lubricated with a dry film graphite lubricant in accordance with the manufacturer's recommendations.

J. Insulated joints for non-interlocked switches shall be installed as shown on the Contract Plans and in accordance with AREMA (Former AAR) Signal Manual.

   1. Install joint using manufacturer's recommended procedure.

K. Signal System Point Protection:

   1. No switch point shall be installed in the main track unless it has the proper signal system point protection in place and tested.

   2. No switch protection shall be removed from any normally closed signaled switch point unless the switch point is replaced by a straight rail and signal circuits have been corrected and tested.

   3. All rail bonding and fouling circuit protection must be intact at all times on all signaled switches.

   4. SCRRA will perform installation and testing of signal devices.

   5. Contractor must coordinate installation or removal of turnout with SCRRA Engineer for required signal testing.

3.09 INSTALLING DERAILS

A. Install derails per manufacturer's instructions at locations designated in Contract Plans and in accordance with SCRRA Engineering Standards.

3.10 DRILLING

A. Rail ends for bolted joints shall be drilled in accordance with SCRRA Track Maintenance, Right-of-Way and Structures, Engineering Instructions Section 2.1.15.
1. Any additional holes in rail will be sufficient cause for rejection.

B. A variation of 1/32" in size and location of bolt holes will be allowed.

C. Holes shall be located with the proper size rail-drilling template and marked with a center punch prior to drilling.

D. Drilling through joint bars is prohibited.

3.11  RAIL ENDS

A. Rail shall be cut with rail saw to a tolerance of 1/32" from square.

1. All burrs shall be removed and ends made smooth.

2. Torch cut rails will be rejected.

B. Battered or mismatched ends shall be built up or ground off to conform to minimum tolerance of 1/16" on top and gage side to adjoining rail.

3.12  RAIL END HARDENING

A. At all rail end locations not eliminated by field welding, rail ends shall be field end hardened in accordance with the AREMA Manual, Volume 1, Chapter 4, Section 2.1.17.1, “Supplementary Requirements” including all insulated joints.

3.13  PROCEDURES FOR PLACEMENT OF CWR

A. Rail shall be laid or adjusted to the Preferred Rail Laying Temperature in accordance with SCRRA Track Maintenance and Engineering Instructions Section 2.2.2, Preferred Rail Laying Temperatures.

B. Tie cribs shall be filled with ballast immediately after laying rails and after each track raise.

1. Track shall be surfaced, stabilized, and lined and all ties tamped and anchored, prior to returning track to full service.

C. If the rail temperature exceeds 120° F, the Engineer reserves the right to suspend rail-laying operations, or direct that the rail be cooled.

1. These actions shall not entitle Contractor to any additional compensation or time.

D. Welded rails shall be positioned for installing in a manner to minimize handling and to prevent buckling.

E. The rail base and tie plate or concrete tie rail seat area shall be cleaned to remove foreign material that may interfere with the full bearing contact with the base of the rail.
1. Rails shall be placed base down, parallel with track, avoiding excessive bending or damage, using suitable mechanical equipment.

2. Do not place rails on signal equipment, manhole covers, electrical connections, or near any other installation that could be susceptible to damage.

F. An approved rail thermometer shall be used to determine rail temperature.
   1. The thermometer shall be placed on the web or base of rail shaded from the sun and left long enough to record the rail temperature accurately.
   2. The temperature shall be checked frequently.
   3. All rail thermometers shall be calibrated.

G. Tools used for field cutting rails shall be approved rail saws.
   1. Torch-cut rails shall not be installed in the track.
   2. Any rail damaged by torches shall be rejected and removed before installation in the track.

H. Rail shall be de-stressed in accordance with SCRRRA Track Maintenance and Engineering Instructions Section 8.3 only after final track line and grade has been achieved and ballast stabilized, or as required by the Engineer.
   1. Rail shall be re-anchored after de-stressing has been achieved.
   2. Rail shall have adequate anchor patterns installed at all stages of construction.

3.14 ANCHORING CWR

A. As used in this Article the term "rail anchor" also refers to elastic rail fasteners. Install rail-anchoring devices when the rail is within the permissible anchoring temperature.
   1. Anchor opposite rail only when its temperature is within 5˚ F of the previously anchored rail's temperature at the time of its anchoring.
   2. Temperatures shall be measured in accordance with SCRRRA Track Maintenance and Engineering Instructions Section 2.2.3, Instructions for Taking Rail Temperatures.
   3. No train operation is permitted over rail that does not have a full complement of anchors per SCRRRA ES2351-01 through ES2351-04.
   4. If it is necessary to operate trains before de-stressing rail, following the movement of trains, anchors shall be removed for the de-stressing procedure and re-applied.
B. Prior to joining CWR strings, adjust the CWR strings to the Preferred Rail Laying temperature, vibrate to relieve internal rail stresses, and fully anchor.

C. Join CWR strings when the rail gap is at the specified gap.
   1. If the rail gap is not within the recommended tolerances for joining CWR strings, and the remainder of the string has been adjusted, un-anchor the CWR strings for 400 feet on each side of the rail gap and readjust each CWR string to within the Preferred Rail Laying Temperature.
   2. Re-anchor the CWR strings before installing the rail joint or weld.
   3. If the recommended rail gap cannot be obtained in this manner, cut a section of rail from the end of one of the CWR strings and insert a rail plug not less than 19'-6" long on tangent track and curves less than 2°; and not less than 30 feet long in curves of 2° or greater to provide the recommended rail gaps, or crop the rail as necessary to provide the recommended gap.
   4. If the Contractor elects to use an artificial means of adjusting the rail for anchoring, submit the method and equipment proposed to the Engineer and obtain Engineer’s acceptance.
   5. A rail vibrator shall accompany the rail heating process to assure free expansion of the rail in advance of the heated area.
   6. Witness marks shall be made at four (4) or more stations on unanchored rail across the base of the rail and tie plates to confirm actual expansion of the rail in accordance with the calculations.

D. Contractor must not make any joints or welds within the body of a curve unless approved by the Engineer.

3.15 ADJUSTMENT BY MECHANICAL HEATING

A. Rail shall be adjusted for temperature after it has been laid on tie plates but before it is anchored.

B. Rail gaps shall be provided at the end of each continuous welded rail equal to the amount of the expansion that is required for that rail.

C. Heating shall begin at the end of the rail and be steadily applied moving forward and without reversing direction until the required expansion has been obtained for that rail.

D. Complete anchoring application shall follow heating as closely as possible.
   1. Any deviation or delay will require reheating the rail.

E. Prevent damage to other work during the heating process.
3.16 THERMAL ADJUSTMENT CALCULATION

A. The adjustment of the rail for thermal forces shall be done as per SCRRA's Procedures for Installation, Maintenance and Inspection of CWR.

B. When it is necessary to adjust the rail already in track, the required increase or decrease may be found by taking the difference between the Preferred Rail Laying Temperature and recorded rail temperatures at each string of CWR and calculating the amount of adjustment as specified herein.

C. The number of inches by which a CWR segment shall be increased or decreased to adjust its length for a temperature higher or lower than that at which it was anchored or adjusted may be calculated using the following formula:

1. \[ \text{Req. Adjustment (inches)} = 0.0000067 \times \Delta T \times L \times 12 \]

D. Example:

1. To adjust the length (L) of a 400 feet CWR, fastened at a rail temperature of 65 degrees, to correspond to the length of this rail at a Preferred Laying Temperature (PRLT) of 110 degrees, subtract 65 from 110 to obtain a difference of 45 degrees (\(\Delta T\)) and multiply as follows:

   Station 1, 100 \times 12 \times 0.0000067 \times 45 = 0.36" = 3/8"
   Station 2, 100 \times 12 \times 0.0000067 \times 45 = 0.48" = 1/2"
   Station 3, 100 \times 12 \times 0.0000067 \times 45 = 0.96" = 1"
   Station 4, 400 \times 12 \times 0.0000067 \times 45 = 1.44" = 1 1/2"

3.17 RAIL ANCHORAGE RECORD

A. Compliance record shall be kept in the format similar to that shown in SCRRA Track Maintenance and Engineering Instructions Section 2.2.3 Instructions for Taking Rail Temperatures and provided to the Engineer in an acceptable, reproducible form.

1. It shall contain the following data for each end of a CWR and at each 400 FT interval during installation:

   a. Date and time.
   b. Track number and rail (East or West, North or South).
   c. Station location.
   d. Weather, air and base of rail temperature.
   e. Type of fastener.
   f. Length of rail being anchored.
3.18 PROCEDURES FOR PLACEMENT OF JOINTED RAIL

A. This Article covers both the permanent construction and rehabilitation of jointed rail and the temporary use of rail joints in the CWR pending field welding.

1. When laying jointed rail, each rail shall be carefully placed on the ties with ends square, using standard expansion shims placed between the ends of adjoining rails to ensure proper opening of joint.

2. Shims shall be removed after all joint bolts are tightened.

B. Using temperatures taken on the rails when they are being laid or adjusted; the thickness of the shim to be used for 39 feet rails will be determined by the following table:

<table>
<thead>
<tr>
<th>Ranges (deg. F)</th>
<th>Shim (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20 - 0</td>
<td>3/8</td>
</tr>
<tr>
<td>0 - 25</td>
<td>1/4</td>
</tr>
<tr>
<td>25 - 50</td>
<td>3/16</td>
</tr>
<tr>
<td>50 - 75</td>
<td>1/8</td>
</tr>
<tr>
<td>75 - 100</td>
<td>1/16</td>
</tr>
<tr>
<td>Over 100</td>
<td>Laid Tight</td>
</tr>
</tbody>
</table>

C. Joint Bars shall be well oiled and with full number and correct size of bolts, nuts and spring washers.

D. Joint bolts shall be tightened before spiking rail and the two center bolts shall be tightened in advance of the end bolts.

E. Bolts shall be placed with the nuts alternatively on the inside and outside of the rail.

1. Nuts shall be placed with the flat side toward the rail.

2. Track bolts, joint bars and finishing surfaces of rails at joint bars shall be swabbed with oil.

3. Use outer four bolt holes only when installing bolted joints that will be eliminated by field welding.

4. Do not drill inside holes (holes closest to rail ends) at future field weld locations.

3.19 TRACK CRITERIA AND TOLERANCES

A. Track shall be constructed to the alignment and grade prescribed.

1. Gage shall be 4’ - 8½”.
2. Deviation from established gage and cross-level shall not exceed 1/8\" and profile grade and horizontal alignment variation shall not exceed 1/8\" measured at the center of a 62 feet chord.

B. Provide vertical and horizontal control stakes every 50 feet on curves and every 100 feet on tangents.

C. Tangent track shall be level and superelevation and runoff spirals shall be provided on all curves in conformance with SCRR A ES2201 through ES2204 unless otherwise indicated in the Contract Plans.

D. Contractor must not cut rail strings except as required to fit rail to turnouts, crossings or limits of work.

E. A thermometer designed to measure rail temperature shall be used in accordance with SCRR A Track Maintenance and Engineering Instructions during rail installation to assure compliance with the SCRR A Preferred Rail Laying Temperature.

1. Final installed or Adjusted Rail Temperature shall be within 10 degrees below or 10 degrees over the Preferred Rail Laying Temperature.

### 3.20 WELDING OF CONTINUOUS WELDED RAIL

A. Rail welding shall be in accordance with the approved procedure and Section 34 72 30, Field Welding Rail.

### 3.21 WALKWAYS

A. CPUC walkways shall be provided within track work limits in accordance with the Contract Plans, SCRR A ES2105, SCRR A Track Maintenance and Engineering Instructions, CPUC General Order No. 118.

B. Installation of walkways are incidental to installation of track.

### 3.22 INSULATED JOINTS

A. Each insulated joint installed by the Contractor must be tested with an insulated joint tester, either the Harmon 1501A1JC or equal approved by the Engineer.

1. Test shall measure no less than 100 ohms across the joint.

2. Test results shall be uniquely identified with a specific joint and submitted to the Engineer in Compliance Record.

B. The rail ends at each insulated joint shall be beveled and hardened in accordance with the manufacturer’s procedures as approved by the Engineer.

1. Contractor must comply with rail end hardening and beveling requirements specified in this Section.
3.23 INNER GUARD RAILS

A. Inner Guard Rails will be required:

1. For all bridge spans where exposed structural steel is present above the top of rail.

2. Where individual spans are over 100 feet in length

3. Where entire structure is over 800 feet in length and at least one span crosses over a waterway that normally contains water which is at least 15 feet deep.

4. On any bridge as directed by SCRRA or the Contract Documents.

B. Inner Guard Rails shall extend 50 feet beyond the span or spans to be protected as required above. SCRRA ES2302 and ES2304 indicate details for construction of Inner Guard Rails. Inner Guard Rails require use of special Concrete Ties as shown in ES2406 and ES2407.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Trackwork will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. All material, work and services included in Sections SS 34 11 10, Continuous Welded Rail (CWR); SS 34 11 15, Other Track Materials (OTM); SS 34 11 23, Special Trackwork; SS 34 11 26, Ballast; SS 34 11 27, Sub-Ballast and Aggregate Base; SS 34 11 33, Concrete Railroad Ties; SS 34 11 34, Wood Railroad Ties; SS 34 11 36, Elastic Rail Fasteners; 34 11 40, Precast Concrete Grade Crossing Panels; and 34 72 30, Field Welding Rail will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

C. Trackwork will be measured by the individual unit constructed in accordance with the Contract Documents and as measured by the Engineer.

1. The quantities included in the approved Schedule of Quantities and Prices, or Schedule of Values as derived from the plans will be used as the basis for this measurement for new track construction.

2. The quantities included in the approved Schedule of Quantities and Prices, or Schedule of Values as derived from the plans will be used as the basis for this measurement for rehabilitation or repair of track.
3. Unless otherwise noted, the construction of special trackwork, from point of switch to last switch tie, and track constructed at grade crossings will be counted separately per complete unit as designated in the Schedule of Quantities and Prices.

4. Measurement limits for various trackwork items will not overlap.

4.02 PAYMENT

A. Trackwork furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Trackwork constructed, rehabilitated, or repaired in accordance with the Contract Documents will be paid for at the contract unit price(s) as listed in the Schedule of Quantities and Prices.

1. Payment for Trackwork will be made only upon documentation of fully completed trackwork and full restoration of track speed to the design speed as shown in the Contract Plans.

2. All work must be complete prior to payment being made, including but not limited to welding, distressing, final surfacing, and completion of punch list items related to track work.

END OF SECTION
SECTION 34 72 20
TRACK SHIFTING, RELOCATION, AND RESURFACING

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish all supervision, labor, materials, equipment, transportation and incidentals necessary to shift, relocate or resurface railroad track as shown on the Contract Plans and specified herein. Railroad track as used herein is defined as "an assembly of rails, ties and fastenings over which cars, locomotives and trains are moved." This “track” assembly includes, the rail, ties, special trackwork, other track material (OTM), ballast, and walkways although not an exclusive listing.

B. Section 34 72 00 will govern track construction work associated with this Section.

C. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section SS 34 11 10 – Continuous Welded Rail (CWR).
4. Section SS 34 11 15 - Other Track Materials (OTM).
5. Section SS 34 11 23 – Special Trackwork.
6. Section SS 34 11 26 - Ballast.
7. Section SS 34 11 27 - Sub-Ballast and Aggregate Base.
8. Section SS 34 11 33 - Concrete Railroad Ties.
9. Section SS 34 11 34 - Wood Railroad Tie.
10. Section 34 71 50 – Highway-Rail Grade Crossings.
11. Section 34 72 00 - Trackwork.
12. Section 34 72 30 – Field Welding Rail.

1.02 REFERENCES

A. Full compliance with applicable rules, regulations, and General Orders of California Public Utilities Commission is required. Representatives of that State agency will inspect railroad related work for compliance with General Orders.

C. AREMA Portfolio, American Railway Engineering and Maintenance of Way Association, Portfolio of Trackwork Plans.

D. FRA:
   1. 49 CFR Part 213, Track Safety Standards, most current and addenda, Federal Railroad Administration
   2. 49 CFR Part 214, Railroad Workplace Safety, most current and addenda, Federal Railroad Administration

E. CPUC, California Public Utilities Commission General Orders.

F. SCRRA, Southern California Regional Rail Authority
   1. Engineering Standards.


1.03 SYSTEM DESCRIPTION

A. Perform all track shifting, relocation and resurfacing work as shown on the Contract Plans, and in accordance with this Section.

   1. Prior to shifting or relocating track, all drainage structures and grading, including placement of Sub-Ballast as per Section 34 11 27 shall be completed and accepted by the Engineer.

   2. In addition the other requirements specified herein, shifted, relocated, and resurfaced track shall be stabilized using a Ballast Stabilizer in accordance with Division 01.

   3. Following shifting, relocating, resurfacing and stabilizing of track, rail shall be distressed in accordance with SCRRA Track Maintenance and Engineering Instructions Section 8.3.

   4. Track shifting shall include all work to shift existing track more than 1 foot and less than 10 feet and providing Ballast per Section 34 11 26, resurfacing and regulating track in its new location.

   5. Track relocation shall include all work to relocate existing track a distance greater than 10 feet including installation of Ballast per Section 34 11 26, resurfacing and regulating track in its new location.
6. Resurfacing, shall include shifting of existing track up to 1 foot, and involves resurfacing indicated track and all special trackwork, including lining, raising, tamping, and regulating track in conformance with SCRRRA engineering standards, provisions of this specification, and to the lines and grades shown on the Contract Plans. The Ballast per Section 34 11 26 required to fill cribs and provide adequate shoulders must be provided by the Contractor.

7. Rough and final surfacing of the entire track section shall be performed as required to provide minimal profile smoothing and adjustment. This surfacing may include providing and placing Ballast per Section 34 11 26, tamping, stabilizing and regulating ballast.

B. The Contractor, as with any Work within the SCRRRA Right of Way, must submit a SSWP for each track segment that requires shifting, relocating, or resurfacing the active track in accordance with Division 01, Coordination with SCRRRA.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:

1. Refer to Division 01, Coordination with SCRRRA, for submittal of applicable SSWP.

2. Refer to Division 01 for submittal of personnel resumes and railroad equipment list.

1.05 QUALITY ASSURANCE

A. Quality Assurance:

1. Contractor must perform track shifting, relocating, and surfacing under supervision of a qualified Railroad Construction Project Manager, Railroad Track Construction Manager, and Track Foreman. Work shall be performed by personnel experienced in similar railroad track work, as required under Division 01. The surfacing crew shall include a ground man, with a minimum of six months experience, qualified to check profile and alignment behind the tamper.

1.06 PROJECT CONDITIONS

A. This work may occur on an active railroad track.

B. The Contractor must coordinate all phases of the Work to prevent undue interference with the SCRRRA daily operations, or with other phases of the Project, whether performed by SCRRRA forces or another contractor’s forces.
PART 2 - PRODUCTS

2.01 GENERAL

A. Materials to be installed under this Contract must be provided by the Contractor unless indicated otherwise in the Contract Documents.

B. Materials damaged or broken prior to or during installation must be replaced at the Contractor’s expense with no additional cost to SCRRA.

C. Labor, material not furnished by SCRRA, or equipment required for track resurfacing but not expressly shown on the Contract Plans shall be as if shown on the Plans and included in the Contractor’s bid price.

D. Material must be new, except as otherwise indicated herein, and meet the requirements stated herein and of the AREMA and SCRRA Standards.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor personnel and equipment shall meet the requirements set forth in Division 01.

B. Contractor must exercise care in his progression of work under this Contract to avoid and prevent damage to the track being shifted, relocated, or resurfaced, adjacent tracks, and structures and facilities, such as existing pavements, pavement bases, drainage structures, light poles, fire hydrants, signal facilities (track wires, bootlegs, signal masts, guy wires, signals, cables, conduits) utilities, signage and buildings. Contractor must repair or replace damaged structures or facilities to satisfaction of the owner at no cost to SCRRA, except that SCRRA will repair and test signal facilities at the Contractor’s sole expense. The Contractor must be responsible to coordinate his work with SCRRA to arrange for the timely and orderly removals or relocations of this signal equipment and facilities. Failure of the Contractor to provide reasonable and adequate coordination for timely removal and relocation of signal facilities will not allow for an extension of time or provide grounds for extra cost to SCRRA.

C. Contractor must perform Work under this Section in accordance with these Specifications and consistent with track resurfacing standard industry practice.

D. Contractor must periodically review the supply of materials, labor and equipment to ensure a uniform flow of work. Contractor must keep the Engineer informed regarding material shortages or developing problems that require corrective action.

E. Shifted, relocated, and resurfaced track shall meet the following tolerances as well as the standards for FRA 49CFR213 class 5 track.

1. Except for pre-existing rail gauge corner rail wear,
a. Deviation from correct gage of 56-1/2" shall not exceed + or - 1/4 inch at any point.

b. Deviation measured in any section of 20 consecutive crossties shall not exceed 1/8 inches at 75 percent of the crossties, and 1/4" at the remaining 25 percent.

c. Newly installed or re-installed ties will be spiked not to exceed + or – 1/8" irrespective of pre-existing rail gauge corner wear.

<table>
<thead>
<tr>
<th>TRACK SURFACE</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff in any 31 FT of rail at the end of a raise may not be more than</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Deviation from uniform profile on either rail at the mid-ordinate of a 62 feet chord may not be more than</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>Deviation from designated elevation on spirals may not be more than</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Variations in cross levels on spirals in any 31 feet may not be more than</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>Deviation from zero cross level at point on tangent or from designated elevation on curves between spirals may not be more than</td>
<td>3/16&quot;</td>
</tr>
<tr>
<td>Difference in cross level between two points less than 62 feet apart on tangents and curves between spirals may not be more than</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

2. Alignment - maximum deviation from uniformity measured in conformance FRA Safety Standards Section, 213.55.

a. Tangent Track 1/4" - at mid-ordinate on a 62 feet chord.

b. Curved Track 1/4" - from correct mid-ordinate on a 62 feet chord.

F. Elastic clips, rail anchors, and spikes shall be loosened prior to shifting track to prevent skewed ties. Rail, fasteners, or crossties damaged during track shifting must be replaced by the Contractor at Contractor’s expense. Rail anchors are not to be slid longitudinally along the base of the rail. They must be removed prior to shifting track and reapplied in the correct location after track is shifted to its final location.

3.02 RESURFACING, ALIGNMENT AND DRESS

A. Contractor must perform shifting and resurfacing within the stated project limit station areas as specified to bring the line and surface into compliance within the track geometry tolerances specified.

B. Contractor must resurface the track to zero crosslevel on tangent track and to the proper crosslevel elevation, with spirals, for the curves as shown on Contract Documents.
C. Ballast shall be spread and track raised in a series of lifts. No single lift shall be higher than 2 inches except in crossings and turnouts. In raising the track, jacks or equipment shall be regulated to avoid bending of angle bars or straining of joints. When jacks are used they shall be simultaneously used and properly spaced at not more than quarter points of the rail to avoid breaks or bends in the rail when the track is raised. Both rails shall be raised simultaneously and to proper crosslevel by utilizing automatic tampers or standard track level boards with each set of track raising jacks. Each tie shall be tamped from 15 inches inside the rail to the end of the tie. Tamping shall not be permitted at the middle of a tie. Both ends of a tie shall be tamped simultaneously and tamping inside and outside the rail shall be done at the same time.

D. Ties that become loose during track raise shall be placed in proper position, tie-plates properly placed, holes plugged with “Tight Spike” or approved tie plugs and spiked before tamping. During each track raise, track shall be uniformly tamped.

E. After ballasting is completed and the track is resurfaced and lined, according to the tolerances, ballast shall be mechanically stabilized using a track stabilizer and ballast shall be trimmed neatly and surplus material shall be spread evenly along the ballast shoulder.

F. After stabilizing is completed, rail shall be distressed in accordance with SCRRA Track Maintenance and Engineering Instructions Section 8.3.

G. Contractor must perform the necessary operations to ensure that all ties are at right angles to the track as practical with standard railroad procedures. Crib between ties shall be fully ballasted and dressed.

H. Contractor must perform two tamping squeezes per tie up to two (2) inches of raise with one additional insertion and squeeze for each additional one (1) inch of raise. Joint ties shall be given one additional squeeze more than other ties. The Contractor must not cause a center-bound track condition.

I. In locations where squeeze tampers cannot fill and compact ballast, such as but not limited at frogs, guard rails, switch portions of turnouts and headblocks, mechanically tamp with approved hand-held air tools or other power tamping tools. Hand tamping shall be done simultaneously from both sides of the tie.

J. On curves, the high rail shall be used as the line rail and the low rail shall be used as the grade rail.

K. When surfacing turnouts, the straight side of the turnout shall be used as the line rail.

L. After ballast regulating in turnouts, cribs for switch points, switch rods, and guardrails shall be pocketed 3 inches and cleared of ballast to permit free operation of the switch and signal rods.

M. After the ballast is regulated, dressed and consolidated using a track stabilizer, Contractor must ensure that track bolts and rail anchors, or elastic track
fasteners are tight and in proper alignment.

N. For track resurfacing the total track raise will be the minimum amount necessary to smooth the track profile. It shall be the responsibility of the Contractor to provide smooth transitions that meet the required surfacing tolerances as listed above to grade crossings and turnouts, using the ballast stockpiled near the worksite. In addition, the Contractor must maintain vertical overhead clearances under structures by limiting the amount of track raise. Adjustment of turnouts and connecting tracks to match profile and alignment adjustments on adjacent track must be provided by Contractor at no additional expense.

O. Any temporary surfacing runoffs made to accommodate interim rail traffic prior to completion of track surfacing must meet FRA Track Class 5 Standards.

3.03 WALKWAYS

A. Walkways shall conform to SCRRA Engineering Standards ES2109 and General Order No.118-Public Utilities Commission of the State of California.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Track shifting will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.

B. Track Relocation will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.

C. Track Surfacing will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement. Surfacing, stabilizing and de-stressing of shifted track is incidental to this item and will not be measured.

D. All material, work and services included in Sections Other Track Materials (OTM); SS 34 11 26, Ballast; SS 34 11 27, and Sub-Ballast and Aggregate Base; will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.
E. Work of shifting, relocating and resurfacing existing track will include furnishing all labor, materials, tools, equipment, supplies, supervision, installation of Contractor provided ballast and walkway rock, laser aligned tamping, resurfacing, regulating, stabilizing and de-stressing to SCRRA standard cross section and any other incidental work necessary for shifting, relocating and resurfacing existing track as described in the Contract Documents.

4.02 PAYMENT

A. Track shifting, relocating and resurfacing furnished and completed in accordance with the Contract Documents will be paid for at the contract unit price, as listed on the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section consists of the Contractor performing field welding of continuous welded rail (CWR) strings using the flash butt welding process or approved thermite-welding method.

B. The Contractor must make assessment as to the number of welds, including the method of welding for each weld, to be performed under this Contract.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 34 72 00 - Trackwork.
   4. Section 34 72 20 - Track Shifting, Relocating and Resurfacing.

1.02 REFERENCES

A. SCRRRA: Engineering Standards, and Track Maintenance and Engineering Instructions.

B. American Railway Engineering and Maintenance of Way Association (AREMA):
   1. Manual for Railway Engineering


D. ASTM International (ASTM):
   1. ASTM E164 Standard Practice for Ultrasonic Contact Examination of Weldments.

1.03 SUBMITTALS

A. Submit under the provisions of Division 01:
   1. Procedure: Submit proposed materials, methods and procedures to be used for mobile flash butt field welding of CWR, including:
a. Manufacturer's trade name and technical data for the welding process, including welding machine performance standards.

b. Method of welding high strength rail if different from requirements for standard rail.

c. Methods of transporting material and mobile equipment to the site and duration of welding operations.

d. Method used for cutting and cleaning to parent metal of the rail ends.

e. Minimum and maximum spacing between rail ends.

f. Method used for maintaining the rails in alignment during welding.

g. Method used for grinding and contouring rail removing weld upset following the welding process.

2. Procedure: Submit proposed methods and procedures to be used for thermit welding of CWR, including:

a. Manufacturer's trade name and technical data for the welding process.

b. Method used for cutting and cleaning of the rail ends.

c. Minimum and maximum spacing between rail ends.

d. Method used for maintaining the rails in alignment during welding.

e. Method used for preheating the rail ends including time and temperature.

f. Tapping procedure including the minimum time required to cool the weld under the mold insulation.

g. Method used, including a description of special tools and equipment for removing the gates and risers and finishing the weld to the final contour.

3. Refer to Division 01 for submittal of resumes for individual(s) directly supervising, inspecting, and performing field welding of rail.

4. Procedure: Submit rail end hardening procedure.

5. Testing: Submit testing company qualified in use of the Ultrasonic testing method in accordance with ASTM E164.

6. Field Weld Record: Submit as specified herein.
1.04 QUALITY ASSURANCE

A. Provide qualified personnel for supervision and performance of work in accordance with Division 01.

B. Perform certification testing of all welds to ensure that work is performed in accordance with the Contract Documents, and within the tolerances provided herein.

PART 2 - PRODUCTS

2.01 MATERIALS

A. For electric flash butt welding, materials, equipment and process shall be as provided by Holland L.P. or other approved equivalent.

B. For thermite welding, Materials and equipment shall be as manufactured by "Boutet," "Orgotherm," "Elektro-Thermite," or other approved equivalent for standard or high strength (alloy or heat treated) rail, as appropriate.

PART 3 - EXECUTION

3.01 GENERAL

A. Electric flash butt welding, methods and procedures shall comply with the AREMA Manual, Volume 1, Chapter 4, Section 2.3, Specifications for the Quality Assurance of Electric-Flash Butt Welding of Rail.

B. Thermite welding, methods and procedures shall comply with the AREMA Manual, Volume 1, Chapter 4, Section 2.5 Specification for the Quality Assurance of Thermite Welding Rail, with the welding kit manufacturer's recommendations, and as specified herein.

C. Rail ends for thermite welding shall be prepared in accordance with the recommendations of the welding kit manufacturer.

D. For thermite welding, the rail ends shall be preheated prior to welding to a sufficient temperature and for sufficient time to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

E. The completed weld shall be finished by mechanically controlled grinding to conform to the same requirements specified for shop welding.

F. Thermite welds shall not be made at the following locations:

1. Within 5 inches of the edge of any bolt hole in the rail.

2. Within 2 inches of a Cadweld or copper bond wire (If this type of bond exists, remove any presence of copper by grinding. The rail ends must be inspected and cleaned after grinding is complete).
3. Closer than 2 feet from an existing plant weld.

4. Closer than 6 feet to an existing thermite weld.

5. On both ends of a rail plug simultaneously unless the rail is 15 feet or longer on tangent track and 24 feet long or longer on curved track.

G. Follow Manufacturer recommendations for compromise welds.

H. Follow recommendations of rail manufacturer for welding high strength (alloy or heat-treated) rails.

I. Thermite welds shall be located in cribs between ties. The edge of the weld must be no closer than 3 inches from the edge of the nearest tie.

J. Electric Flash Butt welds with the base of the rail smoothly ground may be located anywhere.

3.02 FIELD WELDING RECORD AND RAIL MARKINGS

A. Field welding record shall be continuously maintained and furnished to the Engineer within seven (7) workdays of completing the weld. The record shall include the following minimum details, noting that a different recording and marking procedure will be required for free end welds or for destress welds used to close up openings in rail:

1. Date and time of weld(s).

2. Location by station, specifying track and rail.

3. Contractor foreman initials.

4. Weather, air and rail temperature for destress welds (welds made to close up rail).

5. Track condition, anchorage and rail stress for destress welds, or the word “FREE” for free end welds.

B. Rail shall be permanently marked on the web of rail in legible characters at least 1-1/2 inches high at each field weld with the above information in accordance with Section 3.1.19, Marking Thermite Welds of the SCRRA Track Maintenance and Engineering Instructions. If an existing destress weld is located within 400 feet of a new destress weld, lines shall be marked through the old weld’s marking and an arrow marked indicating the direction towards the new destressed weld.

3.03 TOLERANCES OF FIELD WELDS

A. A straight edge 36 inches in length, applied to finished welded joint area shall be used to check for the following maximum variations (measurements shall be taken with a 6 inches steel taper gauge):

1. Rail Head:
a. Vertical Offset: 0.020 inches.
b. Horizontal Offset: 0.040 inches.
c. Vertical Crown: 0.030 - 0.045 inches.
d. Horizontal Kink: 0.020 inches.

2. Rail Base:
   a. Horizontal Offset: 0.060 inches.
   b. Offset Bending: 0.010 inches per inch.

3.04 FINISHING OF FIELD WELDS

A. Sharp edges and burrs shall be removed, including chimneys from thermite welds. Top of base of rail shall be ground smooth at chimney locations.

B. Weld joints shall be smooth on top and sides of head and straight in line. No over grinding is permitted. Web of rail at thermite welds shall not be ground. All mold residues shall be removed from the weld area and properly discarded.

C. Finishing of welds shall be sufficient to allow testing using the Ultrasonic test method as described below. Welds rejected because of insufficient or unsatisfactory finishing of welds shall be refinished, repaired, or replaced at the Contractor’s expense until the weld meets the testing criteria.

3.05 FIELD WELD TESTING

A. Fabricate CWR strings so that the branding of all individual rail section appears on the field side of installed track.

B. Rail welds must be tested by the Contractor through the use of an SCRRRA approved testing agency using the Ultrasonic testing method in accordance with ASTM E164.

C. Each completed weld shall have full penetration and complete fusion and be entirely free of cracks. Total area of internal defects such as porosity and slag inclusions shall not exceed 0.060 sq in and the largest single porosity or slag defect permitted shall not exceed 1/8 inches dia.

D. Other causes for rejection of welds shall be:
   1. Cracks that show in the finished weld.
   2. Pit holes that show in web and base of weld after finish grinding. Pit holes in head not exceeding 1/4 inches in depth may, if approved by the Engineer, be repaired by gas welding.
   3. Over-grinding of weld.
E. Welded joints not meeting these Specifications and tolerances will be replaced at no additional cost to the SCRRRA. The defective weld shall be cut out, and a new section of rail of a length described in Article 3.06 herein shall be inserted, welded into place as described in this Section, and retested.

3.06 CUTTING IN SHORT SECTION RAIL AND THERMITE WELDING THE ENDS

A. A short section of rail shall be cut in the CWR, when required by the Engineer, for the following reasons:

1. To repair defective rail(s).
2. To repair defective weld(s).
3. To destress rail.
4. To make a connection between rail strings or adjust rail to meet a specific point (i.e. to connect CWR to stock rail or frog).

B. The short section of rail to be cut in shall be at least 19 feet-6 inches long on tangents and curves less than 2 degrees; and 30 feet long on curves 2 degrees or greater and rail to be cut in shall be of the same weight, size, section, and class of rail being replaced or joined.

C. Before cutting out rail in CWR and inadvertently losing all thermal control, prevent remaining CWR from further movement by applying full box anchors for at least 200 feet each way from the proposed cut. After cutting CWR, a rail expander/puller or other means shall be used to prevent rail movement until a weld or temporary joint is installed.

D. The ends of the short rail section and the CWR shall be saw cut.

E. Follow manufacturer’s recommended procedures specified for completing field welding by thermite process.

F. Repair of rail due to damage by Contractor shall be at Contractor’s expense.

G. When repairing a defective rail or weld, the new rail shall be the same length as rail being replaced, or as required to achieve thermal adjustment.

H. When performing field welding, rail temperature adjustments shall be made in accordance with Section 34 72 00 using either heating of rail or mechanical rail pullers. The first weld of a replacement plug may be at ambient temperature, but the second (destress weld or rail closure weld) shall be installed in accordance with Section 34 72 00.

PART 4 - MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this
Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for Field Welding Rail as described by the Contract Documents.

END OF SECTION
SECTION 34 72 40
TRACK COLLECTOR PAN SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK
A. Work Included: The work of this Section includes the furnishing and installation of a Track Collector Pan System at locations shown on the Contract Drawings.

1.02 CERTIFICATION
A. Except as otherwise specified, the Contractor shall submit for each of the materials furnished, certification by each manufacturer or producer that the material is in compliance with these specifications.

1.03 SUBMITTEDS
A. Submittals shall comply with provisions of Section 01 33 00, Submittal Procedures shall include the following:
   1. Shop drawing, catalogue cuts and other data indicating proposed materials, details, layouts and construction information to the Engineer for review.
   2. Manufacturer's certification for all materials furnished.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S REFERENCE
A. HDPE Enviropan®, as manufactured by Century Group, Inc. -- Sulpher, LA 1-800-527-5232
B. Other manufacturers’ product having equal characteristics and quality when approved by the engineer.

2.02 MATERIALS
A. The Track Collector Pan System shall be constructed from a series of pre-formed HDPE panels. The total assembly of panels shall form a 12 foot wide (cross track direction) and 90 feet long (down track direction) drip pan. Each 30 foot length of pan assembly shall consist of three panels: two are field side panels, with one gage panel between rails. Refer to diagrams at the end of this section.

B. Physical Specifications:
   1. Temperature Range -100°F to +200°F
2. Volume Capacity 474 Gallons per 30’ Section
3. Weight ¼” Material Thickness Field Pan 68 lbs.
4. Gauge Pan 93 lbs.
5. Cross Drain 60 lbs.
6. Tensile Strength at Yield 3600 psi
7. Elongation at Break 600%
8. Flexural Modulus 165,000 psi
9. Tensile Impact 170 ft. lbs/in²

B. The collector pans shall be connected by cross drains to a collector header pipe.

C. The concrete mix is the proprietary information of the manufacturer. However, concrete compressive strength shall be no less than 4500 psi. If alternate manufacturer is proposed, material physical data shall be submitted with substitution request.

2.03 DESIGN & FABRICATION REQUIREMENTS

A. Collector pans shall be fabricated from molds that provide a continuous, monolithic pan section.
SECTION VIEW OF PAN ASSEMBLY ACROSS TRACK

TYPICAL SECTION THRU CROSS DRAIN

SCALE: 1" = 1'-0"
PART 3 - EXECUTION

3.01 SITE STORAGE
   A. Panels shall be stored on level, dry ground evenly supported every four feet using wood shoring.

3.02 INSTALLATION
   A. Unless otherwise specified, collector pans shall be installed in accordance with the manufacturer's installation instructions.
   B. Refer to Addendum 1 for complete installation details.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT
   A. Track Collector Pan System work shall be measured by the unit or fraction thereof furnished and placed in accordance with the Contract Documents and as measured by the Engineer. The quantities contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the plans, will be used as the basis for this measurement.

4.02 PAYMENT
   A. Track Collector Pan System work completed in accordance with the Contract Documents will be paid for at the Contract Unit price, as listed in the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, materials, and equipment to install track collector pans as recommended by the manufacturer including but not limited to center pans, side pans, end pans, and all other work necessary and incidental to construction of the track collector pan system.

END OF SECTION
SECTION 34 80 11

STONE REVETMENT (RIPRAP)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Stone revetment (riprap) for protection of slopes against erosion.
   a. Drainage outflow area.
   b. Slope riprap.
   c. Geotextile and sand cushion base.
   d. Other areas indicated and shown on the Drawings.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 31 20 00 - Earthwork.

1.02 REFERENCES

A. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   b. T103, Soundness of Aggregates by Freezing and Thawing.

2. ASTM International (ASTM):

3. Corps of Engineers (COE):
   a. CRD-C100, Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing.

1.03 SUBMITTALS

   A. Shop Drawings:
      1. See Division 01 for requirements for the mechanics and administration of the submittal process.
      2. Product technical data including:
         a. Acknowledgement that products submitted meet requirements of standards referenced.
      3. Certifications.
      4. Test reports.
      5. Submit all tests and certification in a single coordinated submittal. Partial submittals will not be accepted.

PART 2 - PRODUCTS

2.01 MATERIALS

   A. Stone:
      1. Durable broken quarry run stone Apparent Specific Gravity minimum 2.50 ASTM C127.
      2. Does not disintegrate on exposure to water or weathering.
      3. Free from structural fractures and defects.
      4. Not containing shale, unsound sandstone, or other material which will disintegrate.
      5. Graded within limits specified.
      7. Ensure that dirt and fines accumulated from interledge layers or from blasting or handling operation is less than 2 percent by weight.
8. Gradation of the material:

   a. Ungrooted riprap to be loaded and quarried shall conform to the following limitations unless otherwise specified:

<table>
<thead>
<tr>
<th>RIPRAP CLASS</th>
<th>AVERAGE WEIGHT PER STONE (LBS)</th>
<th>DIMENSION (IN)</th>
<th>MINIMUM LAYER THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>50 to 200</td>
<td>9 to 14</td>
<td>1' - 6&quot;</td>
</tr>
<tr>
<td>II</td>
<td>200 to 1000</td>
<td>14 to 24</td>
<td>2' - 0&quot;</td>
</tr>
<tr>
<td>III</td>
<td>1000 to 4000</td>
<td>24 to 38</td>
<td>3' - 0&quot;</td>
</tr>
<tr>
<td>IV</td>
<td>&gt; 4000</td>
<td>&gt; 38</td>
<td>4' - 0&quot;</td>
</tr>
</tbody>
</table>

   b. Grouted riprap shall have the following gradation:

<table>
<thead>
<tr>
<th>NOMINAL STONE SIZE (INCHES)</th>
<th>% OF MIX SMALLER THAN GIVEN SIZE (BY WEIGHT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>70 to 100</td>
</tr>
<tr>
<td>18</td>
<td>50 to 70</td>
</tr>
<tr>
<td>12</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>

9. The following allowances shall be acceptable to produce the required ungrouted riprap protection:

   a. Riprap Class I - No allowances permitted.
   b. Riprap Class II - 15 percent of riprap Class I.
   c. Riprap Class III - 15 percent of riprap Class I and 15 percent of Class II.
   d. Riprap Class IV - 15 percent of riprap Class I, 15 percent of Class II, and 15 percent of Class III.

10. Grouted riprap:

   a. Riprap shall be angular (not rounded), each rock having its greatest dimension not greater than 3 times its least dimension. Elongated rocks shall be hand adjusted to a vertical verses horizontal position.
   b. The specific gravity of the riprap rock shall be 2.5 or greater.
   c. Broken concrete or asphalt pavement shall not be acceptable for use in the work.
d. Riprap and grout colors may be limited by local flood control districts or other regulatory entities. Contractor is responsible for ascertaining and complying with any such requirements.

B. Geotextile:
   1. Geotextile shall be Class 2 Non-Woven in accordance with AASHTO M288 with an AOS of 70.

C. Sand Cushion:
   1. Sand cushion shall be clean sand, free of angular gravel.

D. Grout:
   1. Concrete for the grout shall be an approved batch meeting the following requirements:
      a. All concrete shall develop 3,000 psi compressive strength within 28 days, the cement shall be Type II modified or Type V, the stone aggregate shall have a maximum diameter of ½", and the slump shall be within a range of 3 to 6 inches.
      b. The water/cement ratio shall not exceed 0.48.
      c. Add 1.5 lbs of synthetic fiber-reinforcing per cy of grout per manufacturer's instructions.

E. Synthetic Fiber-Reinforcing:
   1. 100 percent virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured for use in concrete.
   2. Physical characteristics:
      a. Specific gravity: 0.91.
      b. Fiber length: ¾".
      c. Provide in accordance with ASTM C1116.
      d. Acceptable manufacturers:
         1) Fibermesh.
         2) Grace Construction Products.

2.02 SOURCE QUALITY CONTROL

A. Perform all tests at an approved independent laboratory.
B. Obtain samples in conformance with COE CRD-C100.

C. Source Tests:
   1. Supply certified tests and service records to determine acceptability and application of stone materials.
   2. In event suitable test reports or a service record that is satisfactory are not available, as in case of newly operated sources, subject material to tests necessary to determine its acceptability for use.
   3. Tests to which materials to be subjected include:
      a. Specific gravity.
      b. Soundness in magnesium sulfate.
      c. Soundness in freezing and thawing.

D. Material Acceptability Tests:
   1. Initial test: On material from each ledge sampled prior to start of construction.
      a. Specific gravity.
      b. Soundness in magnesium sulfate.
      c. Soundness in freezing and thawing.
   2. Control tests:
      a. Perform control tests including one specific gravity, one soundness in magnesium sulfate, and one soundness in freezing and thawing for each type of stone revetment material for every 100 tons of material.

E. Specific Gravity Test:
   2. Not less than 2.40 minimum.

F. Soundness in Magnesium Sulfate:
   1. Conform with ASTM C88, except maintain samples immersed in solution at a temperature of 80˚ F (26˚ C) +2˚ F.
   2. Not more than 12 percent loss at five cycles.

G. Soundness of Aggregates in Freezing and Thawing:
1. Conform with AASHTO T103 method as modified herein.
2. Ensure loss at 12 cycles of not more than 10 percent.
5. Permit length of freezing and of thawing cycles of 2 hours with 1 hour of freezing following by 1 hour of thawing.
6. Perform thawing by circulating thaw fluid around pan containing stone immersed in a depth of ¼" rather than by total immersion.

PART 3 - EXECUTION

3.01 PREPARATION

A. Trim and dress all areas to required cross sections.
B. Bring areas that are below allowable minus tolerance limit to grade by filling with material similar to adjacent material.
C. Compact base to density specified for backfill in accordance with Section 31 20 00.
D. Do not place any stone material on prepared base prior to inspection by Engineer.

3.02 PLACING

A. Ungrouted Riprap:
   1. Where indicated on Drawings, place geotextile on prepared foundation within limits indicated.
      a. Geotextile overlaps shall be a minimum of 1’ – 0”.
      b. Geotextile shall be secured to slope per the manufacturer's recommendation.
   2. Where indicated on Drawings, place sand cushion on geotextile within limits indicated.
      a. Sand cushion shall have a minimum thickness of 4 inches.
   3. Place stone revetment material on prepared base within limits indicated.
4. Place on prepared base to produce a well-graded mass of stone with minimum percentage of voids.

5. Place to required thickness and grades.

6. Place to full thickness in a single operation to avoid displacing the underlying material.

7. Distribute entire mass to conform to gradation specified.
   a. Do not place stone by dumping into chutes or by similar method likely to cause segregation.

8. Keep finished stone revetment free from objectionable pockets of small stones or clusters of larger stone.
   a. Hand place as necessary to obtain a well-graded distribution.

9. Ensure a final tolerance of within 3 inches from indicated slope and grade lines.

10. Place stone revetment in conjunction with embankment construction to prevent mixture of embankment and stone revetment materials.

11. Maintain stone revetment until accepted.

12. Replace any displaced material to lines and grades shown.

B. Grouted Riprap:

1. The Contractor must notify the SCERA a minimum of two working days of his intent to perform any grouting activities prior to placement of any grout to allow scheduling of inspection activities. Grout operation shall not proceed without the approval of the SCERA.

2. Contractor must clean with a water blast operation faces and edges of any existing to-remain structural elements such as wingwalls or abutments to which the grouted riprap will come in contact.

3. Riprap shall be placed prior to grouting. It is desirable that elongated stones along the top layer of riprap have a vertical orientation.

4. Dewatering shall be implemented to guarantee that the grout will not be placed in water or be exposed to stream flows for a period of 24 hours after the grout has been placed.

5. Contractor must keep riprap, boulders and concrete walls that are to receive grout wet at all times prior to injecting grout.
6. The concrete grout shall be placed by injection methods by pumping under low pressure, positive displacement methods, through a 2 inches maximum diameter hose to ensure complete penetration of the grout into the rock layer.

7. The voids at the surface of the riprap will not be grouted. The depth of grout measured from the prepared subgrade bed shall be 18 inches. Operator shall be able to stop the flow of grout when required, and will place grout in the voids and not on the surface of the riprap.

8. A "pencil" vibrator will be used to make sure all voids are filled between and under the riprap. The intent is to fill all voids from the subgrade level around the riprap for a minimum depth of 18 inches. In all cases, grout must penetrate to the subgrade of the riprap. The pencil vibrator may be used to smooth the appearance of the surface, but the Contractor must use a wood float to smooth and grade the grout to drain. When placing grout, it shall be placed between the riprap and against earth, rock, or concrete excavated sidewalls.

9. Contractor must clean and wash any spillage before the grout sets. The visible surfaces of the riprap will be free of grout to provide a clean natural appearance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Ungrouted Riprap:

1. Ungrouted riprap of the various classifications will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Grouted Riprap:

1. Grouted riprap of the various gradations will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Ungrouted Riprap:
1. Ungrouted riprap furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

2. The contract price paid unit of ungrouted riprap for each classification shall include compensation to the Contractor for furnishing riprap, all labor, materials, equipment and any other incidentals to place riprap complete-in-place, including haul from the suppliers source, necessary stockpiling at the job site, reloading for placement, placement, overestimates of salvageable boulders, disposing of any rejected riprap, excavation and removal of material, over-excavation for construction, backfilling, and any other miscellaneous items and work shown or reasonable implied on the Plans, in the Specifications for this work, and elsewhere in the Contract Documents.

3. Geotextile and sand base and other associated materials and incidentals and installation thereof shall be considered part of the riprap and full compensation therefore shall be considered as included in the contract unit price paid for ungrouted riprap.

B. Grouted Riprap:

1. Grouted riprap furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

2. The contract price paid per unit of grouted riprap for each classification shall include compensation to the Contractor for furnishing riprap, all labor, materials, equipment and any other incidentals to place riprap complete-in-place, including haul from the suppliers source, necessary stockpiling at the job site, reloading for placement, placement, overestimates of salvageable boulders, disposing of any rejected riprap, excavation and removal of material, over-excavation for construction, backfilling, and any other miscellaneous items and work shown or reasonable implied on the Plans, in the Specifications for this work, and elsewhere in the Contract Documents.

3. Geotextile and sand base and other associated materials and incidentals and installation thereof shall be considered part of the riprap and full compensation therefore shall be considered as included in the contract unit price paid for grouted riprap.

END OF SECTION
SECTION 34 80 21

PILING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Driven piling indicated in the Contract Documents.

B. Description:
   1. Piles:
      a. These Specifications shall govern the furnishing, driving, building up and cutting off of steel pipe piles and sheet piles in accordance with the lines, grades, and locations shown on the plans or as directed by the Engineer.

   2. Settlement of embankment fill shall be substantially complete prior to the driving of piling unless otherwise shown on the plans.

   3. Foundation piling shall not be driven until the excavation is complete.

C. Related Specifications Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

   2. Division 01 - General Requirements.

   3. Section 03 21 00 – Reinforcing Steel.

   4. Section 03 31 00 - Structural Concrete.

   5. Section 31 20 00 - Earthwork.

   6. Section 34 80 43 - Precast and Prestressed Concrete for Railroad Bridges.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):

B. ASTM International (ASTM):


C. American Welding Society (AWS):
   1. D1.5, Bridge Welding Code.

D. American Railway Engineering and Maintenance-of-Way Association (AREMA):
   1. AREMA Manual for Railway Engineering.

E. Southern California Railroad Authority (SCRRA) Standards.

F. In case of conflict between SCRRA Standards and AREMA, SCRRA Standards take precedence; use in lieu of conflicting portions.

1.03 DEFINITIONS

A. Certified Welder: Meeting the qualification requirements of AWS D1.5.


1.04 SUBMITTALS

A. Shop Drawings:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Steel pile type, size, dimensions and grade of steel.
      b. Pile tip protection/closure device.
      c. Manufacturer and type of pile splicing device.
      d. Load test equipment description with calibration charts.

B. The Contractor shall provide to the Engineer a description of all pile driving equipment to be employed in the work, prior to commencement of pile installation. This shall include details including weights of pile hammer, power plant, leads, pile cushion, cap block and helmet.

C. The Contractor shall visit the site and review the Geotechnical Report and test borings prior to selecting the pile driving hammer.
D. The Contractor shall provide to the Engineer Plans demonstrating compliance of driving equipment and steel casing with Contract Documents. Plans shall include shop and erection details, casing details, and enclosures, splices, driving helmets, and reinforcement.

E. The Contractor shall perform and submit the results of wave equation analysis for proposed installation equipment and piling material.
   1. Calculations shall be performed and sealed by a Professional Civil Engineer licensed in the State of California.
   2. Pile compressive stresses must be limited to allowable values during installation in accordance with the AREMA Manual for Railway Engineering, Chapter 8, Part 4.
   3. The results of the wave equation analysis shall demonstrate that the pile stresses are higher at the top of the pile compared to the tip, that the piles can achieve the required penetration into the hard strata without damaging the pile, and that an excessive number of blows per foot are not needed to achieve the required penetration and capacities.
   4. The recommended pile driving criteria for the driving of piles (chart with bearing as a function of ram fall and blow count) shall be submitted for review.


G. Pile reports shall be submitted by the Contractor to the Engineer within 3 days of completion of driving. The pile record shall be completed per Article 3.11 of these specifications.

H. As-built pile location Drawing(s):
   1. Sealed by licensed land surveyor registered in the State of California.
   2. Include deviations beyond acceptable tolerances from specified locations.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Welders and welding processes to be qualified in accordance with AWS D1.5 requirements.
      a. Welders to have been qualified during the 12 month period prior to commencement of welding.

1.06 PROJECT CONDITIONS

A. Do not begin pile installation until the earthwork in the area where piles are to be driven has been completed, to the extent possible, as shown in the Contract Documents.
B. Jetting or predrilling of piling will not be permitted unless shown on the plans.

C. The use of followers shall only be permissible if driving pile through the existing bridge deck.
   1. If followers are used, their use shall be incorporated into the Contractor's wave equation analysis.

D. All work shall comply with these Specifications, the AREMA Manual for Railway Engineering, and the SCRAA standards.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Submit pile manufacturer information to the Engineer for review and approval prior to ordering and fabricating material.

2.02 MATERIALS

A. Timber Piles:
   1. Timber piles shall be in accordance with Chapter 7, Part I, Article 1.9 of the AREMA Manual for Railway Engineering for first-class piles with a minimum tip circumference of 25 inches.
   2. If preservative treatment is specified in the special provisions or on the plans, it shall be in accordance with Chapter 3, Part 6 of the AREMA Manual for Railway Engineering.
   3. The method of storing and handling timber piles shall be such as to avoid damage to the piles. Piles shall be handled with hemp or synthetic fiber slings or wire rope encased in rubber hose, taking care to avoid dropping, bruising, breaking or penetrating the outer fibers.

B. Steel Piles:
   1. Steel Bearing Piles: Steel bearing piles shall be of the section shown on the plans and shall be structural steel, containing no less than 0.2 percent copper, conforming to ASTM A572, Grade 50, or ASTM A588. Piles shall not be painted before driving.
   2. Steel Sheet Piles: Steel sheet piles shall be of the section and length shown on the plans and shall conform to ASTM A328 unless otherwise shown on the plans.
C. **Steel Pipe Piles:**

1. Steel pipe piles shall be of the outside diameter and wall thickness shown on the plans and shall conform to ASTM A252, Grade 2 or 3 for piles less than 14 inches in diameter and shall conform to ASTM A252 Grade 3 for piles 14 inches and greater in diameter unless other material is specified on the plans. Piles shall have an end treatment as shown on the plans. Piles shall not be painted before driving.

2. All concrete materials and reinforcing steel and their preparation and placement, used in filling steel pipe piles, shall be in accordance with Section 03 31 00 and Section 03 21 00. All concrete shall have a minimum compressive strength equal to that shown on the plans.

D. **Storing and Handling:**

1. Piles to be stored shall be placed on skids above ground and a sufficient number used to prevent visible deflection in the stored piles. Piles shall be kept clean and fully drained at all times. The method of handling shall be such that no damage will result to the piles.

**2.03 CONCRETE PILES**

A. **Precast:**

1. Precast concrete piles shall be of the type, size and length shown on the plans.

2. All concrete materials and steel reinforcing and their preparation and placement shall be in accordance with Section 03 31 00 and Section 03 21 00. All concrete shall have a minimum compressive strength equal to that shown on the plans.

B. **Prestressed:**

1. Prestressed concrete piles shall meet the requirements, and shall be of the type, size, and length shown on the plans, manufactured in accordance with Section 03 31 00 and Section 03 21 00.

C. **Defects and Breakage:**

1. Piles cracked in the process of curing, handling or driving, which in the opinion of the Engineer can be satisfactorily repaired, shall be repaired at the Contractor's expense and under the direction of the Engineer. If repair is not possible in the opinion of the Engineer, the piles shall be replaced at the Contractor's expense.

D. **Storing and Handling:**

1. The method of storing and handling piles shall be such as to minimize the danger of fracture by impact or undue bending stresses. Unless otherwise
provided, piles shall be handled by means of a suitable bridle or sling attached to the pile at the pick-up points marked on the pile. Use of rubberized cables is also acceptable. The use of chain slings will not be permitted.

2. Piles shall be stored above ground on adequate blocking located within 1 foot of the pick-up points marked on the pile that will prevent undue stresses in the piles. When piles are only partially supported during hauling, the overhang shall not exceed the lengths permitted for pick-up. If piles are stacked for storage, blocking for all layers shall be in the same vertical plane.

2.04 PILE CAPACITY

A. The driven compressive capacity of piles shall be equal or greater than the allowable working compressive load capacity, if provided and as stated on the Contract Plans.

2.05 FABRICATION

A. Ends of piles to be machine cut and square making an angle of 90 degrees with the longitudinal axis of the pile.

B. Tolerances:

1. HP piles: Conform to requirements for "HP" shapes as indicated in AISC Manual of Steel Construction.

PART 3 - EXECUTION

3.01 INSPECTION

A. Such services shall be arranged and contracted by the Contractor.

B. Payment to be included in the lump sum price.

3.02 LINES AND LEVELS

A. Complete necessary excavation and furnish lines and levels as required to install piles at their indicated locations.

3.03 DRIVING PILES

A. Driving Equipment:

1. Piles shall be driven with air, hydraulic or diesel powered hammers approved by the Engineer prior to use. The use of drop hammers will not be permitted. The use of steam hammers are not permitted unless approved by the SCRRA. The weight of the ram of the hammer shall not exceed 7000 lbs unless approved in writing by the Engineer. The hammer to be used shall have the approval of the Engineer. Steel sheet
piles and steel H piles may be driven with vibratory hammers if approved by the Engineer.

2. The hammer shall be operated at all times at pressures and speeds recommended by the manufacturer. If steam or air hammers are used, air compressor capacity shall be adequate to maintain full rated pressure throughout the driving period of any pile. The air compressor shall be equipped with an accurate pressure gage at all times.

3. Pile drivers shall be equipped with leads which are constructed in such a manner as to afford freedom of movement of the hammer and to provide adequate support of the pile during driving. The longitudinal axis of the leads and hammer shall coincide with the longitudinal axis of the pile. Except where piles are driven through water, the leads shall be long enough so that a follower will not be necessary. Where a follower is required for driving piles underwater, one pile in each group of ten shall be long enough to permit driving without a follower. This pile shall be used as a test pile for proper correlation of the follower-driven piles bearing capacity. This pile shall be paid for as a permanent pile and not as a "test pile."

B. Driving Tolerances:

1. Piles for bent construction shall be driven with a degree of accuracy that will permit framing into bents with a minimum of pulling or jacking. Under ordinary conditions, pipe piles, after driving and before framing, shall not vary from the vertical or from the required batter by more than 1/8 inches per foot of pile above finished ground, except that under ordinary conditions, the maximum deviation of the top of the pile from the plan location shall be 2 inches in the direction of the structure centerline and 4 inches in the direction along the centerline of the bend.

2. Foundation piles shall be driven to the vertical or batter line shown on the plans and the top of the completed pile shall not be more than 4 inches in any direction from the position shown on the plans. The center of gravity of the completed pile group shall not vary by more than 3 inches from the center of gravity determined from plan location.

3. If necessary to meet the required tolerances, pilot holes or guide templates may be used. Generally, the diameter of pilot hole shall be as specified in Article 3.03.F.1.

C. Protection of Pile Heads:

1. A steel driving head suitable for the type and size of piles being driven shall be used. Steel bearing piles and steel sheet piles shall be driven with a driving head compatible with the specific pile shape driven.
2. For concrete piles, a cushion block shall be provided between the driving head and the top of the pile. Wood cushion blocks, wire rope mat, belting, or other suitable material shall be used, subject to the approval of the Engineer, to prevent damage to the pile. Cushion blocks shall be changed as necessary to maintain an effective cushion.

D. Pile Damage and Misalignment:

1. Care shall be exercised to avoid damage to piles from overdriving. Any pile that is damaged to the extent that it will not perform its design function; any pile that is driven off location or alignment beyond the allowable tolerances; or cut off below ground line. The Contractor shall cease driving and as directed by the Engineer. If the defective pile condition is due to Contractor’s negligence, the cost of replacement and redriving shall be borne by the Contractor.

E. Pile Penetration:

1. All piles shall be driven to a penetration as required by these specifications. The length of the piles shown on the plans is the length which is estimated to give the minimum required penetration and bearing.

2. When test piles are required by the contract, the pile lengths and penetration required will be established by the Engineer on the basis of the test pile data. These lengths and elevation of pile tips shall supersede requirements shown on the plans.

3. Unless otherwise shown on the plans or directed in writing by the Engineer for cases where piles penetrate into competent rock, foundation piles shall be driven to a penetration of a minimum 10 feet below bottom of footing, and other piles to a penetration of at least 15 feet below natural or finished ground line, whichever is lower.

4. When the specified penetration cannot be obtained without overdriving the piles, the Contractor shall provide either pilot holes or jetting equipment or a combination of both.

F. Pilot Holes:

1. If piles cannot be driven to the required penetration and the material is not suitable for jetting, the Engineer may permit pilot holes to be drilled to facilitate driving. The Engineer will designate the diameter and depth of the drilled hole. Ordinarily, a drill diameter of 12 inches will be satisfactory for timber piles and typically a drill diameter 4 inches less than the diagonal of square piles, 2 inches less than the diagonal of octagonal piles, and 1 inch less than the diameter of round piles will be satisfactory for steel pipe and concrete piles.
2. Where pilot holes are required in granular material which cannot be sealed off by ordinary "mudding" drilling methods, a casing pipe of sufficient diameter shall be placed around the boring device. The casing shall be of sufficient length to extend through the loose materials and shall be held in position until the pilot hole is completed and the pile placed ready for driving.

3. If the hard material extends below the desired penetration, the drilling shall be stopped 1 foot above that level and the pile driven the remaining distance if it is possible to do so without damaging the pile. If the pile does not completely fill the pilot hole, the space between the pile and the wall of the hole shall be filled with dry granular material prior to driving as directed by the Engineer.

4. Pilot holes shall be considered as incidental to piles and no direct payment will be made for this work.

G. Jetting:

1. If piles cannot be driven to the required penetration and the material is not suitable for pilot holes, the Engineer may permit jetting to facilitate drilling.

2. For jetting operations sufficient power shall be provided, in addition to that used for operating the hammer, to supply water volume and pressure sufficient to freely erode the material adjacent to the pile.

3. Jetting shall be stopped a minimum of 2 feet above the desired tip elevation and the final penetration obtained by driving without jetting. In silty soils it is possible that jetting may loosen the soil around piles already driven. If such a condition is considered possible, piles shall be redriven after all jetting within 25 feet has been completed.

4. Jetting shall be considered as incidental to piles, and no direct payment will be made for this work.

H. Shooting Pilot Holes:

1. The use of explosives for drilling of pilot holes will not be permitted.

I. Bearing Capacity:

1. All piles shall be driven to the allowable working compressive load specified on the plans, in the special provisions, or by the Engineer. The bearing values shall be determined using the following formula unless otherwise shown on the plans:
\[ P = \frac{3eEw_r + n^2W_s}{s + c} \]

\( P \) = Allowable working compressive load (lbs) (based on factor of safety of 4.0)
\( e \) = Hammer efficiency =0.6 to 0.9 (varies with hammer type and condition)
\( E \) = Hammer energy per blow = \( W_r \times h \) for single acting steam or air hammer or open cylinder Diesel hammer
\( s \) = Penetration of pile per hammer blow (inches/blow)
\( c \) = Average temporary compression (inches) = 0.1
\( W_r \) = Weight of ram of hammer (lbs)
\( h \) = Hammer ram stroke (feet) average during 1 inch of pile penetration
\( n \) = Coefficient of restitution = 0.65 to 0.9 (varies with material and hammer)
\( W_p \) = Weight being driven (pounds) includes pile and pile follower, anvil, drive cap and adapter as applicable

2. When measuring penetration per blow to determine if adequate bearing capacity has been obtained, the hammer shall be running freely and at the speed specified by the manufacturer for full rated energy output.

3. If, for some unavoidable reason, driving must be interrupted before final penetration is reached, the penetration per blow to determine bearing capacity shall not be measured until 12 inches of penetration or refusal has been obtained after driving has been resumed.

J. Pile Driving Near Fresh Concrete:

1. Piles shall not be driven within 150 feet of concrete that was placed within the previous 24 hours. If piling are driven within 150 feet of concrete that has not attained its specified 28-day strength, the following distances, based on the concrete strength and pile hammer rated energy, shall be maintained between the concrete and the nearest pile.

3.04 TEST PILES

A. The furnished length of test piles shall be a minimum of 10 feet longer than the estimated length of the permanent piles shown on the plans or as directed by the Engineer.

B. Wherever possible, test piles shall be driven in a location as shown on the plans. If not so used in the permanent structure, test piles shall be cut off at least 3 feet below final grate or extracted as directed by the Engineer. Extraction of test piles shall be considered incidental to the test pile item, and no separate compensation will be made for this work.

C. Ground elevations shall be brought to finished grade wherever possible prior to driving test piles, so that the test pile will be comparable to the piles used in the permanent structure.
D. Equipment used for driving test piles shall be adequate for handling the lengths provided without splicing. The hammer and all accessories used shall be the same make and model as that to be used in driving the permanent piles.

E. Driving of a test pile shall continue until a penetration and bearing capacity is obtained as indicated by these specifications. Typically, test piles shall be driven to not less than 125 percent of the ultimate pile capacity required for permanent piles in the bridge structure.

3.05 TIMBER PILES

A. Pile Preparation:

1. When the furnished length is much longer than the required length, the Engineer may permit shortening the tip end before driving so as to have the desired diameter at the cut-off.

2. Pile tips shall be cut perpendicular to the axis of the pile.

3. The piles for bents shall be matched as much as possible in diameter to facilitate framing and bracing.

B. Cut-offs:

1. Piles which are to be encased in concrete shall be cut-off square with a saw to the elevation shown on the plan or established by the Engineer. The pile heads shall then be swabbed with preservative as specified on the contract documents.

2. Piles which are to support steel or timber caps shall be brought into final position and held while cut-off is made. Any chains or jacks used in positioning the piles shall be arranged so that the surface of the pile below cut-off will not be damaged. Cut-off shall be made with a saw to a true plane and to the exact elevation shown on the plans so that the cap will bear on the entire cross section of each pile in the bent. No shims will be permitted between the pile and the cap. Piles must show a solid head at the plane of cutting, and after cut-off, the pile caps shall be protected with preservative, fabric, and plastic cement as specified on the contract documents.

3. Cut-off portions of piles furnished by SCRRRA remain the property of SCRRRA, and shall be hauled to and loaded into rail cars by the Contractor. In the event rail cars are not available, the cut-offs will be stockpiled at a location designated by the Engineer. Stubs under 5 feet in length shall be disposed of by the Contractor in accordance with all applicable environmental laws and regulations. No extra payment will be allowed for this work.

C. Treatment of Damaged Surfaces:
1. Any pile surface below cut-off that has been scuffed, torn or otherwise damaged shall be treated in accordance with the requirements of the applicable plans.

3.06 STEEL BEARING PILES AND STEEL SHEET PILES

A. Splices and Build-ups:

1. The length of steel bearing piles and steel sheet piles shown on the plans may be built up in sections either before or during driving operations. The sections, unless otherwise shown on the plans, shall be of identical cross-section. Pile splices shall be made by full penetration butt welding the entire cross-section or as otherwise shown on the plans. All welding shall be in accordance with AWS D1.5. Care shall be taken to properly align the sections connected so that the axis of the pile will be straight. Pile splices above a point 15 feet below finished ground line shall be reinforced as shown on the plans, unless otherwise directed by the Engineer. Field splices shall be avoided for lengths under 60 feet. No more than two (2) splices will be permitted on each pile.

B. Cut-Offs:

1. Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inches between pile and pile cap.

3.07 STEEL PIPE PILES

A. Splices and Build-ups:

1. The length of a steel pipe pile may be built up in sections either before or during the driving operation. The minimum length of a section measured between welded splices shall be 5 feet, and between drive splices shall be 30 feet. Only one welded splice and no drive splices will be permitted in that portion of the pile exposed above ground line or normal water line. Drive splices shall be 15 feet below the ground line, unless directed by the Engineer.

2. Care shall be taken to properly align the sections to be spliced to insure a straight axis. The sections shall be spliced together in accordance with details shown on the plans. All welding shall be in accordance with the AWS D1.5.

B. Cut-Offs:
1. Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by the Engineer. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inches between pile and pile cap.

C. Placement of Concrete:

1. After all driving, splicing, and positioning of pile is completed, the pile shall be free from buckles, splits, distortions, water or other foreign matter. The Contractor shall provide equipment, lighting, and facilities necessary for the proper inspection of the piles. Any damaged, improperly driven, or otherwise defective pile shall be removed and replaced at the Contractor's expense.

2. The tops of piles shall be kept covered after driving until the concrete is placed. No concrete shall be placed in the piles in any unit until the driving of all piles in that unit has been completed. No concrete shall be placed until the Engineer has inspected the completed pile and reinforcing steel, when required, and given his approval to proceed. Unit is defined as a pier, bent or abutment.

3. Concrete shall be placed in a continuous operation taking care to prevent segregation. Special placing devices shall be used if necessary.

3.08 PRECAST AND Prestressed CONCRETE PILES

A. Splices:

1. Splices for precast and prestressed concrete piles will not be permitted.

B. Build-ups:

1. Build-ups shall be made in accordance with the details shown on the plans. The concrete used for the build-up shall be of the same quality as that used originally in the pile. Just prior to placing the concrete, the top of the pile shall be coated with an epoxy bonding compound approved by the Engineer.

2. When additional driving of precast non-prestressed piles is required, the built-up portion shall obtain a compressive strength equal to the design compressive strength of the original pile prior to redriving.

C. Cut-Offs:

1. Concrete at the end of a pile terminating in cast-in-place concrete shall be cut back the required amount leaving the reinforcing steel or prestressing steel exposed. The final cut of the concrete shall be normal to the axis of the pile. Any damage to the pile below the plan cut-off elevation shall be remedied by further cut-back and build-up.
3.09 OBSTRUCTIONS

A. Should any obstruction including but not limited to boulders, rocks, rubble, fill, existing foundations or timbers be encountered which prevent driving of pile to its required tip elevation or final driving resistance, threaten pile damage or cause pile to drift from required location horizontally or vertically, cease driving and take corrective action as directed by Engineer.

3.10 DAMAGED PILES

A. Replace damaged piles as directed by the Engineer at no additional expense to the SCRRRA.

B. Each pile to be free from defects and damage due to construction, fabrication, delivery, installation or other causes.

C. Damaged piles include but not necessarily limited to piles bent, buckled, cracked, with fabrication tolerances beyond those indicated, or with any other defect as determined by the Engineer that would weaken the pile.

D. Should any pile as determined by the Engineer be damaged, be too short to develop required final driving resistance or to reach required tip elevation or otherwise not conform to this Specification Section, withdraw pile and drive another pile in its place.
   1. If it is impossible to withdraw damaged or rejected pile, install another pile at location indicated by the Engineer.
   2. Revise foundation as directed by the Engineer as required by new location of pile.
   3. Additional pile and foundation to be at the Contractor's expense.

E. Correct to satisfaction of Engineer at no additional cost to the SCRRRA any pile or other construction that has been damaged by pile installation.

3.11 PILE REPORT

A. Provide Engineer with a copy of a pile report for all driven pile providing the following information:
   1. Pile location and number.
   2. Date and time driven.
   3. Weather.
   4. Hammer (manufacturer, model, and serial number).
   5. Hammer cushion and cap block.
   6. Pile type.
8. Length of pile (tip to cut off).
9. Description of piles that were rejected (pile number, location, reason for rejection).
10. Cut off elevation.
11. Pile tip elevation.
13. Length spliced on.
14. Length furnished.
15. Length cut off.
16. Hammer blow count and ram fall for each foot along full length of pile.
   a. Penetration of last foot of driving in blows per inch.
17. Final driving resistance and calculated bearing.
18. Stroke or hammer speed at final resistance.
19. Name of person recording information
20. Pile driving record (shown at the end of the specifications).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Piles

   1. General:

      a. Piles delivered of the various kinds, sizes, types, and weights will be measured by the lineal foot, except steel sheet piles will be measured by the square foot, of acceptable pile delivered at the site of work and furnished in accordance with the lengths specified on the plans.

      b. Piles driven of the various kinds, sizes, types, and weights will be measured to the nearest 1/10 lineal foot of net length of pile in place, except steel sheet piles will be measured by the square foot of acceptable pile in place, after all cut-offs and build-ups have been made.
c. That portion of piles driven below the elevation required by the plans and piles driven below the elevation at which the minimum penetration and bearing requirements were first obtained will not be measured for payment.

d. Determination of installed pile lengths:

1) Estimated lengths of steel piling shown on the Contract Plans shall be considered as approximate only and as having been determined for design and estimating purposes from the test borings taken at the site.

2) The Contractor shall be entirely responsible for furnishing piles of sufficient lengths to obtain the required penetration and specified bearing for each pile.

2. Timber Piles:

a. Piles supplied by the SCRRRA which fail during driving, due to an inherent weakness in the pile and not due to negligence on the part of the Contractor, and which are extracted or cut-off at the direction of the Engineer, will be measured for payment by the lineal foot of pile in the leads. Piles supplied by the SCRRRA and broken during driving due to Contractor's negligence will not be measured for payment. Piles supplied by the Contractor and broken during driving will not be measured for payment.

b. Cut-off portions of piles will not be measured for payment.

3. Steel Piles: Cut-off portions of piles will not be measured for payment.

4. Concrete Piles, Precast and Prestressed:

a. 2 feet will be added to the length of piles, measured for payment in accordance with Paragraph 1.07.A.1. for each authorized build-up made, other than those made necessary by improper casting, handling or driving of piles.

b. Cut-off portions of piles, when piles are supplied by the Contractor in the lengths shown on the plans or ordered by the Engineer, will be measured by the lineal foot of cut-off above design elevation. Cutbacks made below design elevation for the purpose of making build-ups will be considered incidental to the work and will not be measured.

c. When piles of extra length are furnished to eliminate protrusion of reinforcing steel required for splicing, such extra length will not be measured for payment as either piles or cut-off portion of piles.

B. Test Piles
1. Test piles of the various kinds, sizes, types and weights, when the piles do not become a part of the permanent structure, will be measured by the lineal foot of pile in the leads and driven in accordance with these specifications and in the location specified on the plans or by the Engineer. When test piles becomes a part of the permanent structure, they will be measured by the lineal foot of acceptable pile in place after all cut-offs and build-ups have been made in accordance with the provisions of Paragraph 1.07.A covering the various kinds of piles.

C. Reinforced Pile Tips

1. Reinforced pile tips will be measured by the number of reinforced tips installed on steel bearing piles and driven in place.

4.02 PAYMENT

A. Piles

1. Piles Delivered:
   a. Piles delivered will be paid for at the contract unit price per lineal foot or square foot, as designated in Article 4.01, of the various kinds, sizes, types, and weights.
      1) The contract unit price shall include full compensation for all work and costs involved for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles. This price shall not include compensation for concrete or reinforcing steel in steel pipe piles which will be paid for under Section 34 80 41 and Section 34 80 42.

2. Piles Driven:
   a. Piles driven will be paid for at the contract unit price per lineal foot or square foot, as designated in Article 4.01, of the various kinds, sizes, types, and weights.
      1) The contract unit price shall include full compensation for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive and cut-off the piles and complete the work. The Contractor shall accept the contingencies of driving greater or lesser length of piles or other changes of features in construction which this may involve, all without modification of the unit price fixed by the Contract.

3. Timber Piles:
   a. The contract price per lineal foot of acceptable timber pile shall also include full compensation for preparing the piles, disposing of the pile heads, treating the pile tops as specified in Paragraph
3.05.B. and the treating of damaged surfaces, splits, and checks as specified in Paragraph 3.05.B.

4. Splices for Steel Bearing Piles and Steel Pipe Piles:
   a. Payment for the work and materials, exclusive of additional length of pile, required in making each pile splice shall be made at a unit price per splice equal to two times the unit price bid for "Steel Bearing Piles Driven" or "Steel Pipe Piles Driven," as applies, of the size and weight on which the splice is made except that no payment will be made for any splice on any pile whose actual length left in place, after all cut-offs, splices, or build-ups have been made, is not greater than the length shown on the plans or specified by the Engineer, nor will payment be made for more than one splice on anyone pile less than 120 feet long.

5. Steel Sheet Piles:
   a. No direct payment will be made for cut-off portions of piles.

6. Concrete Piles, Precast and Prestressed:
   a. Cut-off portions of piles, measured in accordance with Paragraph 4.01.A.4.b., will be paid for at one half the unit price bid per lineal foot for concrete piles.

B. Test Piles
   1. Test piles will be paid for at the contract unit price per lineal foot of test pile of the various kinds, sizes, types, and weights.
      a. The contract unit price shall include full compensation for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles; and for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive the piles and complete the work. Payment will be made for splices authorized by the Engineer at the rate specified in Paragraph 4.02.A.4.

C. Reinforced Pile Tips
   1. Payment for reinforced pile tips on steel bearing piles, if required, shall be made at the contract unit price per each.
      a. The contract unit price shall include full compensation for furnishing all material, labor and equipment required to install the tips. Payment will be made only for reinforced tips required as shown on the plans or as requested by the Engineer.

END OF SECTION
# PILE DRIVING RECORD

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REMARKS: 

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SECTION 34 80 22
CAST-IN-DRILLED HOLE (CIDH) PILES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Construction of CIDH pile foundations.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 – Reinforcing Steel
   4. Section 03 31 00 - Structural Concrete.


1.02 REFERENCES

A. ADSC West Coast Chapter, Standard CIDH Pile Anomaly Mitigation Plan “A” and Plan “B”.

B. American Railway Engineering and Maintenance-of-Way Association (AREMA):

C. American National Standards Institute (ANSI):
   1. A135.4 – Basic Hardboard Standards

D. ASTM International (ASTM):

E. American Petroleum Institute (API):
1. RP 138-1, Standard Procedure for Field Testing Water-Based Drilling Fluids.

F. American Welding Society (AWS):
1. D1.1, Structural Welding Code - Steel.

G. California Department of Transportation (Caltrans):
2. California Test 233, Method of Ascertaining the Homogeneity of Concrete in Cast-In-Drilled-Hole (CIDH) Piles Using the Gamma-Gamma Test Method.

1.03 SUBMITTALS

A. See Division 01 for requirements for the mechanics and administration of the submittal process.
B. Log of installation of all CIDH Piles.
C. Shop Drawings of all reinforcing and accessories required for the CIDH Piles.
D. Product Technical Data including:
   1. Acknowledgement that products meet the requirements of the standards referenced.
2. Proposed concrete mix design for the CIDH Piles:
   a. See Section 03 31 00 for information to be included in the mix design submittal.

E. Test Reports:

F. Contractors qualifications as specified in Article 1.02.B. in this Specification Section.

G. CIDH Pile installation plan as specified in Article 3.02.A. in this Specification Section.

H. Slurry test results as specified in Article 2.01.A. in this Specification Section.

I. AWS Welder Certification.

### 1.04 QUALITY ASSURANCE

A. Qualifications:

   1. Contractor Qualifications:
      a. Two (2) weeks prior to the pre-construction conference, the Contractor must submit the contractor’s qualification as specified in the following to Engineer.
      b. Unless otherwise indicated, the minimum Contractor’s experience shall consist of successful installation of at least 5 CIDH Pile Projects of similar or greater size, and similar geotechnical conditions installed within the past 3 years.

         1) The mentioned documentation shall reference and detail the size of the CIDH piles, methods used during installation, methods used for stabilizing the CIDH pile wall excavations, local soil conditions, actual construction time, contract time, names and phone numbers of owner’s representatives who can verify the Contractor’s participation on those projects.

         2) The Contractor must provide documentation of their superintendent’s qualifications, record experience, and prior project references demonstrating that they can handle unusual site conditions and equipment breakdowns.
c. The CIDH pile work shall be performed under the supervision of the Contractor’s superintendent, who shall be fully knowledgeable and experienced in construction of CIDH pile foundations of similar size and geotechnical conditions as those shown on the plans.

1) In addition, the Contractor’s superintendent performing the work shall have at least 5 years of experience installing similar size CIDH piles within the last 8 years.

2) The Engineer may accept or reject the Contractor’s CIDH Pile Subcontractor and its superintendent based on their qualifications and previous field performance.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Slurry:

1. Only mineral or polymer slurries shall be used in the drilling process unless other drilling fluids are approved in writing by the Engineer.

2. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement.

3. In the event of a sudden significant loss of slurry to the excavation, the construction of the foundation shall be stopped until either methods to stop slurry loss or an alternate construction procedure has been approved by the Engineer.

4. All tests specified below shall be performed when the slurry temperature is above 40˚ F.

5. Mineral slurry or polymer slurry shall be premixed thoroughly with clean, fresh water, and adequate time (as prescribed by the manufacturer) allotted for hydration in slurry tanks.

   a. Slurry tanks of adequate capacity will be required for slurry circulation, storage, treatment, and disposal.

   b. No excavated slurry pits will be allowed.

   c. The Contractor must draw sample sets from the slurry tanks and test the samples for conformance with the specified material properties prior to introduction into the shaft excavation.

   d. A sample set shall be composed of samples taken at mid-height and within 2 feet of the bottom of the slurry tanks.
6. The Contractor must sample and test all slurry in the presence of the Engineer, unless otherwise directed.
   a. The date, time, names of the persons sampling and testing the slurry, and the results of the tests shall be recorded.
   b. A copy of the recorded slurry test results shall be submitted to the Engineer at the completion of each pile, and during construction of each pile when requested by the Engineer.

7. Sample sets of all slurry, composed of samples taken at mid-height and within 2 feet of the bottom of the pile, shall be taken and tested during shaft excavation as necessary to verify the control of the properties of the slurry.
   a. As a minimum, sample sets shall be taken and tested at least once every 2 hours after beginning slurry use.
   b. When the test results show consistent specified properties, sample sets shall be taken and tested at least once every 4 hours of slurry use.
   c. Slurry shall be recirculated, or agitated with the drilling equipment, when tests show that the sample sets do not have consistent specified properties.

8. When samples are found to be unacceptable, the Contractor must clean, recirculate, desand, or replace the slurry to maintain the required slurry properties.
   a. Cleaning of the bottom of the excavation and placement of the concrete shall not begin until tests show that the sample sets have consistent specified properties.

9. The Contractor must demonstrate to the satisfaction of the Engineer that stable conditions are being maintained.
   a. If the Engineer determines that stable conditions are not being maintained, the Contractor must immediately take action to stabilize the shaft.
   b. The Contractor must submit a revised installation plan, which corrects the problem and prevents future instability.
   c. The Contractor shall not continue with pile construction until receiving the Engineer's approval of the revised pile installation plan.

10. Controlled Slurry:
a. Slurry shall consist of a stable colloidal suspension of various pulverized clays or polymers thoroughly mixed with water with the properties given in the Required Slurry Property Table below.

b. Water used to mix slurry shall be potable.

### REQUIRED SLURRY PROPERTIES TABLE

<table>
<thead>
<tr>
<th>Items to be measured</th>
<th>Range of results at 60° F</th>
<th>Test Methods</th>
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</thead>
<tbody>
<tr>
<td>1. Density before concrete placement, lb/ft³ for slurry 1 foot from shaft bottom</td>
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<td>(Mud Balance)</td>
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<td></td>
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<td>ASTM D4380</td>
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<tr>
<td>Mineral slurries (bentonite/attopulgite)</td>
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<tr>
<td>a. No end bearing</td>
<td>85 maximum</td>
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<td>b. With end bearing</td>
<td>70 maximum</td>
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<tr>
<td>Polymer slurry</td>
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<tr>
<td>a. No end bearing</td>
<td>64 maximum</td>
<td></td>
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<tr>
<td>b. With end bearing</td>
<td>64 maximum</td>
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<tr>
<td>2. Marsh funnel viscosity, sec/qt, for entry</td>
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<td>(Marsh funnel and CUP American</td>
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<td>Petroleum Institute (API - RP138-1),</td>
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<td>Section 2.2.</td>
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<tr>
<td>a. Mineral slurries (bentonite/attopulgite)</td>
<td>26 to 50</td>
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</tr>
<tr>
<td>b. Polymer slurry</td>
<td>40 to 90*</td>
<td>Standard Procedure for Field Testing</td>
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<td>Water-Based Drilling Fluids</td>
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<td>3. Sand content be volume, percent, before concrete placement for slurry 1 foot</td>
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<td>(Sand screen set)</td>
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<td>ASTM D4381</td>
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<td>from shaft bottom</td>
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<td>Mineral slurries (bentonite/attopulgite)</td>
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<td>b. With end bearing</td>
<td>20 maximum</td>
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<tr>
<td>Polymer slurry</td>
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<tr>
<td>a. No end bearing</td>
<td>1 maximum</td>
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### REQUIRED SLURRY PROPERTIES TABLE

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Property/Value</th>
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<tbody>
<tr>
<td>b. With end bearing</td>
<td>1 maximum</td>
</tr>
<tr>
<td>4. pH, during excavation</td>
<td>7 to 12</td>
</tr>
</tbody>
</table>

c. The Contractor must wait 30 minutes, after the last drilling and scouring, to allow contaminants to settle out before taking and testing a sample set of slurry.

1) After the reinforcing steel cage is placed in the excavation, a sample set of slurry shall be taken and tested immediately prior to concrete placement.

### B. Concrete:

1. All materials, proportioning, air entraining, mixing, slump, and transporting of PCC shall be in accordance with Section 03 31 00 except as modified herein.

2. The water/cement ratio shall not exceed 0.45.

3. The concrete for construction of drilled shafts shall have a slump of 8 inches ±1.5 inches.

4. Concrete admixtures:
   a. Comply with Section 03 31 00.

### C. Reinforcing Steel:

1. Provide reinforcing steel conforming to requirements of Section 03 21 00.
   a. Reinforcing sizes, number, configuration, spacing and lengths to be as indicated on Plans.

### D. Steel Casing (Permanent and Temporary):

1. Permanent steel casing shall have sufficient strength to withstand handling stresses, drilling and installation stresses, concrete pressures, and surrounding earth and water pressures, if required.
   a. Steel for permanent casing shall conform to the requirements of ASTM A283: Grade C, ASTM A36, or ASTM A929.
   b. Submit size, wall thickness, type of steel, and length of permanent casing to the SCRR for acceptance.
2. Temporary steel casing shall have sufficient strength to withstand handling stresses, drilling and installation stresses, concrete pressures, and surrounding earth and water pressures, or if required, for protection of personnel or to permit advancement of shaft through caving ground.
   a. Submit size, wall thickness, type of steel, and length of permanent casing to the SCRR for acceptance.

3. Furnish full-penetration welds meeting the requirements of "Structural Welding Code - Steel" (ANSI/AWS D1.1) of the American Welding Society requirements for joints in non-corrugated permanent steel casings.
   a. Welders shall be AWS certified.

4. Deliver casing to site in undamaged condition.
   a. Handle and protect casing to maintain diameter within 2 percent.

E. Expanded Polystyrene:

1. Expanded polystyrene must be commercially available polystyrene board with (1) a flexural strength of at least 35 psi when tested under ASTM C203 and (2) a compressive yield strength from 16 to 40 psi at 5 percent compression. Face the surfaces of expanded polystyrene that concrete is placed against with 1/8 IN thick hardboard complying with ANSI A135.4. Other facing materials may be used that provide equivalent protection. Secure the hardboard using nails, waterproof adhesive, or other authorized means.

PART 3 - EXECUTION

3.01 CONSTRUCTION TOLERANCES:

A. The CIDH Pile shall be within 3 inches of plan position at the top of shaft.

B. The vertical alignment of pile excavation shall not vary from the plan alignment by more than 1/4 inches/feet.

C. Full depth reinforcing steel cages shall be set at no less than 6 inches above the bottom of the excavated shaft prior to placement of concrete.

D. After all the concrete is placed, the top of the reinforcing steel cage shall be no more than six (6) Inch above and no more than 2-3/4 inches below plan position.

E. The top elevation of the shaft may have a tolerance of up to +1 inches or -3 inches from the plan top of pile elevation.

1. Sufficient reinforcement bar splice length for splices above the shaft shall be attained.
F. Excavation equipment and methods shall be designed so that the completed shaft excavation will have a planar bottom.
   1. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of 3/8 in/ft of diameter.

G. CIDH Pile excavations and completed shafts not constructed within the required tolerances are unacceptable.
   1. The Contractor shall be responsible for correcting all unacceptable pile excavations and completed shafts to the satisfaction of the Engineer.
   2. Materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance CIDH pile excavations shall be furnished without either cost to the Contracting Authority or an extension of the completion dates of the project.

H. The elevations, dimensions, and depth of the CIDH Piles shall be as specified on the Plans.

I. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe.

3.02 INSTALLATION

A. The installation of the CIDH pile must be done in a continuous operation with no unplanned interruptions. If an unplanned interruption cannot be avoided, the engineer shall be notified immediately and the contractor must submit remedial measures for approval.

B. CIDH Pile Installation Plan:
   1. The Contractor must submit a signed statement that they have inspected the project site and all the subsurface information made available in the contract documents.
   2. No later than 1 month prior to constructing CIDH Piles, the Contractor must submit a CIDH Pile installation plan for review by the Engineer.
      a. This plan shall provide information on the following:
         1) Name and experience record of firm(s) and associated personnel for the following:
            a) Driller.
            b) Drilled shaft superintendent.
2) List of proposed equipment to be used including cranes, drills, augers, bailing buckets, grooving equipment, scouring equipment, final cleaning equipment, core sampling equipment, confirmation boring equipment, tremies or concrete pumps, casing, slurry equipment, airlift pumps, etc.

3) Details of overall construction operation sequence, the sequence of pile construction in bents or groups and pile construction.

4) Details of pile excavation methods.

5) Details of steel casing and forms, including installation and extraction methods.

6) Details of the type and methods to mix, circulate, desand, test, and dispose of slurry (if applicable).
   
a) If polymer slurry is proposed, submit data on load transfer and manufacturers requirements for slurry control.

7) Details of methods to clean the pile excavation, including air lift methods and spin bucket methods as applicable.

8) Details of reinforcement placement including support and cage centering methods.

9) Reinforcing steel cage splicing method, if proposed, including details of dimensions, installation, splice location, support and cage centering methods, and estimated time required for splicing.

10) Details of concrete placement including procedures for tremie or pumping methods and method to prevent slurry intrusion at the discharge end.

11) Details of methods to control cuttings, water and slurry, with adjacent traffic conditions (vehicular or railroad if applicable).

12) Details of final discharge of concrete at top of pile, of removing contaminated concrete, and verifying concrete uniformity for site specific conditions.

13) Details on casing to be used, including specific length/depth of all casing proposed, and specific evaluation and determination of casing (size, depth, etc.) required to prevent any shaft installation procedure from having an effect or impact on adjacent structures, railroads, etc.
14) Details of casing being seated into rock to seal groundwater from entering the drill hole.

3. The Engineer will evaluate the CIDH pile installation plan for conformance with the Contract Documents.
   
   a. Within 14 calendar days after receipt of the plan, the Engineer will notify the Contractor of additional information required and changes necessary to meet the Contract requirements.

   b. All procedural approvals given by the Engineer shall be subject to trial in the field and shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed in the Contract Documents.

4. A pre-drilling conference will be required for this work prior to the start of pile excavation. The Engineer and SCRRRA will set up the conference.
   
   a. The Engineer, Contractor, and drilling staff shall discuss the anticipated pile installation process.

C. Pile Excavation:

1. Protection of Existing Structures:
   
   a. Precautions shall be taken to prevent damage to existing structures and utilities.

   b. These measures shall include but are not limited to vibration monitoring, or subsidence control during driving of casings, sheets, or drilling.

2. Construction Method:

   a. If the concrete is to be placed under the wet condition as defined in this Specification, the Contractor must construct CIDH piles in such a manner that the elevation of the water or slurry inside the pile will be equal to or higher than the ground water elevation at the time of concrete placement.

   b. The CIDH Piles may be constructed by casing method to produce sound, durable concrete foundation shafts free of defects.

   1) Wet method may be combined with casing method with approval from the Engineer only if the excavation can not be dewatered and concrete placed in the dry, as defined elsewhere in this Specification Section.
2) Wet Method:
   a) The wet method consists of keeping the shaft filled with slurry a minimum of 4 feet above the highest expected water table during drilling and excavation, desanding of the slurry when required, final cleaning of the excavation by means of a bailing bucket, air lift, pump or other approved device and placing shaft concrete which displaces the slurry.

3) Casing Method:
   a) The casing method is used to advance the hole through unstable material.
      (1) Undercutting to the outside diameter of the casing may be required.
   b) The purpose of the steel casing is to stabilize the side walls during drilling to prevent cave-ins from unstable material and vibrations. The purpose of the casing is also to prevent any pile installation procedure from having an impact on adjacent structures and railroads.
   c) If voids exist between the permanent casing and the drill hole, lean grout or a sand/gravel mix shall be placed as directed by the Engineer.

c. Surface and subsurface obstructions shall be removed by the Contractor.
   1) Special tools and/or procedures may be required.
   2) No separate payment will be made for removing obstructions.

d. Excavations required for the CIDH Piles shall be performed through whatever materials encountered, of the dimensions, and to the elevations shown in the Plans.
   1) The excavation and installation method shall be suitable for the intended results and materials are encountered.
   2) Blasting is not permitted.

3. Excavation in rock is defined as the excavation that cannot be drilled or accomplished with conventional augers designated to excavate hard soil or soft rock and that requires special tools and procedures to make the excavation advance.
a. Rock drilling tools such as augers with fitted rock teeth, core barrel, buckets with significant down crowding, or roller bits combined with extra drilling pressure by a hydraulic or percussion system are used for the rock drilling excavation.

4. The Contractor shall anticipate and make available at the job site all equipment necessary and essential to penetrate soft and hard rock during the construction of the drilled shafts.

a. The equipment for excavation, drilling, and cleaning operations shall have adequate capacity; including power, torque, and down thrust to excavate a hole to an elevation equal to the lowest tip elevation of the production drilled shafts installed from the equipment operation elevation at the time of drilled shaft construction, plus 25 feet or plus 25 percent of the maximum length of the production drilled shafts, whichever is greater.

1) The Contractor must have drilling tools available to increase diameter of shaft should initial drilled hole be out of vertical tolerances stated in this Specification.

5. CIDH piles shall be installed in such a manner that no voids shall exist between the overburden and the casings.

6. The drilling sequence shall be such that for every pile drilled, at least two piles are skipped. The piles adjacent to the freshly poured pile may only be drilled a minimum of 24 hours after placement of concrete.

7. The Contractor must extend CIDH pile tip elevations if the Engineer determines that the material encountered during excavation or present at tip elevation is unsuitable and/or differs from that anticipated in the design of the CIDH pile.

8. After the pile excavation has been completed, the Contractor shall immediately proceed with shaft construction.

9. Safety:

a. The Contractor shall not permit any worker to enter the CIDH pile excavation for any reason unless; a suitable casing has been installed, the water level has been lowered and stabilized below the level to be occupied, and an adequate safety equipment and procedures have been provided to the personnel entering the excavation which includes OSHA certification for confined-entry-space.
10. Record Information:

a. For each CIDH pile construction, the Contractor must provide the Engineer with an excavation record including but not limited to the following: the location; dimensions; verticality; description of the materials encountered at all elevations; drilling time in each of the various strata; elevation of the water table during excavation; description of any change in excavated material; elevation of top and bottom of the finished pile; depth to the steel casing; condition of the bottom of the excavation and deviation from plan location.

1) All unusual observations shall be reported to the Engineer within 8 hours of discovery.

2) Two (2) copies of the excavation records, signed by a responsible representative of the Contractor and cosigned by a representative of the Engineer, shall be furnished to the Engineer within one (1) day after the pile excavation is completed.

b. The Contractor must retain additional CIDH pile installation records including, but not limited to the following: Concrete volume, concrete pouring rate, and other pertinent data to the CIDH pile operations.

1) Copies of these installation records shall be submitted to the Engineer within one (1) day after the finish of the installation.

D. Steel Casing (Temporary and Permanent):

1. The procedure and methods to install and seal the steel casings shall not produce stresses in excess of 25 percent over the design allowable for the type of steel used.

a. The Contractor must submit computations of critical stresses imposed on the steel casing during installation.

b. The casing shall not be more than one inch out of round before and after installation.

2. Welding of steel casings shall be by a semi-automatic or automatic welding process to fully develop the casing.

a. All welding shall be in accordance with ANSI/AWS D1.1.

3. Nondestructive testing of the welds will not be required; however, the Contractor shall be responsible for placing a sound, watertight casing.

4. After installation but prior to excavation of the rock socket, the casings shall be inspected for location, alignment and condition.
a. Any casing that shows bends or kinks or other deformations that would impair the strength or efficiency of the complete shaft shall be either removed and replaced or repaired by the Contractor in a manner satisfactory to the Engineer.

b. Repairing or replacing casing when ordered by the Engineer shall be done at no additional cost to the Contracting Authority.

E. Dewatering and Rock Socket:

1. The Contractor shall determine the elevation of the top of the rock and at the bottom of the casing at each drilled shaft location.

   a. The method shall be approved by the Engineer, and the elevation determined during the presence of Engineer or the Engineer's representative.

2. Prior to excavation of the rock socket, the Contractor shall seat the casing in the sound rock for a minimum depth of 1 foot and attempt to dewater the shaft.

   a. If the shaft cannot be dewatered to the dry condition or the satisfaction of the Engineer, the Contractor shall attempt to seal the shaft by carrying the casing further into the rock.

   b. This procedure shall be followed for each drilled shaft.

   c. The Contractor will not be required to carry the casing more than an additional 3 feet (a total of 4 feet) into the sound rock. The casing may be advanced four feet into the sound rock during initial placement.

   d. The preliminary tip elevations of the casings are shown in the plans based on available borings.

   e. The actual elevation shall be determined based on actual rock elevation and conditions encountered during excavation as determined by the Contractor using the method(s) approved by and in the presence of the Engineer.

   f. After the casing has been seated sufficiently to allow dewatering to achieve the dry condition or the satisfaction of the Engineer or to the maximum depth specified above, the Contractor shall excavate the rock socket.

   1) The aforementioned dry condition is defined as less than 12 inches of water accumulation above the base over a 1 hour period.
CAST-IN-DRILLED HOLE (CIDH) PILES

3. The method of excavating the rock socket shall be capable of providing a cylindrical opening of the specified diameter and to the full depth shown on the plans or to the depth directed by the Engineer.
   a. Excavation shall be along the axis of the shaft and over breakage at the rock surface shall be avoided so as not to destroy the seal of the bottom of the steel casing.
   b. The methods of excavating the rock socket shall have proper control to prevent undercutting of the steel casing.

4. No rock projections shall extend inside the rock socket diameter.
   a. All overburden, loose rock fragments, and other debris shall be removed from the rock socket and shaft prior to placing the shaft concrete.
   b. The inside surface of the casing shall be clean and free of extraneous material prior to placing of concrete.

F. Final Cleaning:

1. If a slurry cake builds up on the sidewalls of the drill hole, the Contractor shall remove it prior to concrete placement at no additional cost.
   a. If mineral slurry is used, the sidewalls shall be reamed prior to placement of reinforcement.
   b. The Contractor must adjust operations so that the maximum time that the slurry is allowed to remain in the shaft is 24 hours.

2. The Contractor must clean the base of each pile so that a minimum of 50 percent of the base will have less than ½” of sediment at the time of concrete placement.
   a. The maximum depth of sediment or debris at the base of the pile shall not exceed 1 inch.

3. For dry piles, visual inspection will be performed by the Engineer.

4. For slurry piles, the Contractor must use an air lift to clean the bottom of the pile.
   a. After a wait period equal to the time to set the reinforcing steel cage and concrete placement setup, the Contractor shall measure the amount of sediment in the bottom of the pile.
b. If the amount of sediment meets the above requirements, the Contractor shall clean the base of the pile a second time with the air lift and immediately proceed with shaft construction.

c. If after the described wait period the amount of sediment exceeds the requirements, the Contractor shall clean the pile by air lift and repeat the above procedure until the sediment accumulation meets the requirements.

d. The Engineer may approve, at no additional cost to the SCRRA, an alternate method to clean the bottom of the pile.

G. Inspection of Shaft and Rock Socket

1. The Contractor must provide suitable means of access and lighting facilities for the Engineer to check locations, dimensions, and alignment of the casings, inspect conditions of the casings, and inspect and determine that the rock sockets are satisfactory.

a. Final shaft depths will be measured with a suitable weighted tape or other approved methods after final cleaning.

2. At all times when a person is in a dewatered casing, provision shall be made for pumping fresh air to said person; and any required lighting shall be by electric lights.

a. Any mechanical equipment used inside the casing shall be operated by air or electricity.

b. The use of gasoline engines or other types of equipment producing fumes placed in the excavation for pumping or drilling are not permitted.

3. If the shaft cannot be dewatered, the Contractor must provide a method for visual inspection to confirm that the shaft is in an acceptable condition and that rock socket cleanliness requirements are met.

H. Reinforcing Steel Cage Construction and Placement:

1. The reinforcing steel cage consisting of longitudinal bars, ties, cage stiffener bars, spacers, cage centering devices, and other necessary appurtenances, shall be completely assembled and placed immediately after the pile excavation is inspected and accepted, and prior to concrete placement.

2. The reinforcing steel in the pile shall be tied and supported so that the reinforcing steel will remain within allowable tolerances given in this Specification Section.

a. Reinforcing added to stiffen a reinforcing cage will be at the Contractor's expense and as approved by the Engineer.
b. Concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient intervals, near the top and bottom and at intervals not exceeding 10 feet along the shaft, to ensure concentric spacing for the entire cage length.

c. Spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the pile.

d. The spacers shall be of adequate dimension to ensure a minimum distance of 3 inches or as shown in the plan which ever is greater between the cage and the excavated hole.

e. When a full depth reinforcing steel cage is used, it shall be supported at the bottom by approved cylindrical feet to ensure that the bottom of the cage is maintained at the proper distance above the base.

3. The elevation of the top of the steel cage shall be checked before and after the concrete is placed.

   a. If the reinforcing cage is not maintained within the specified tolerances, corrections shall be made by the Contractor to the satisfaction of the Engineer.

   b. No additional piles shall be constructed until the Contractor has modified the reinforcing cage support in a manner satisfactory to the Engineer.

4. At no time shall the reinforcing cage be allowed to rest at the bottom of the drill hole.

I. Concrete Placement:

1. Placement of concrete pile:

   a. Concrete shall be placed as soon as possible after reinforcing steel placement.

   b. The Contractor shall coordinate batching and delivery of the concrete with the batch plant so that the time limits, as stated in the Standard Specifications, between batching and delivery are not exceeded.

   c. Concrete placement shall be continuous.

   d. Concrete placement shall continue after the pile excavation is full until good quality concrete is evident at the top of shaft.

   e. Remove a sufficient volume of concrete to ensure elimination of all contaminated concrete at the top of shaft using small pumps.
f. Concrete shall be placed either through a tremie or concrete pump.

2. Placement of Concrete by Tremie:

a. The tremie used to deposit concrete shall be constructed so that it is watertight and will readily discharge concrete.

b. The tremie shall not be less than 10 in dia., and there shall be no aluminum parts in contact with concrete.

c. The discharge end of the tremie shall be constructed to prevent water or slurry intrusion and permit the free flow of concrete during placement operations.

d. The tremie shall have sufficient mass that it will rest on the pile bottom before start of concrete placement.

e. The length of the tremie shall be sufficient to extend to the bottom of the pile.

f. The discharge orifice shall be maintained between 5 feet and 10 feet below the surface of the fluid concrete.

g. The tremie shall be supported so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete.

h. The flow of the concrete shall be continuous and the concrete in the tremie shall maintain a positive pressure differential at all times to prevent introduction of air pockets or contaminants into the concrete.

3. Placement of Concrete by Pump:

a. Concrete pumps and lines may be used for concrete placement.

b. All pump lines shall have a minimum 4 inches dia. and be constructed with watertight joints.

1) Concrete placement shall not begin until the pump line discharge orifice is at the pile base elevation.

c. A plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins.

1) The plug shall either be removed from the excavation or be of a material, approved by the Engineer, which will not be a detriment to the pile if not removed.

d. The discharge orifice shall be maintained between 5 feet and 10 feet below the surface of the fluid concrete.
1) When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation.

e. The pumping operation shall be performed in a manner that prevents introduction of air pockets into the concrete.

1) If breaking of the pump line is required, the discharge orifice shall be temporarily positioned 3 feet to 5 feet below the surface of the fluid concrete in the hole.

2) Additional methods to eliminate introduction of air into the concrete may be proposed by the Contractor.

4. The elapsed time from the beginning of concrete placement in the pile to the completion of the placement shall not exceed 3 hours.

a. All admixtures, when approved for use, shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the 3 hours placement limit.

b. The Contractor may propose placement time over 3 hours provided the Contractor submits trial mix documentation that all concrete in the pile will retain a minimum 4 inches slump for the entire placement period.

J. The concrete in the rock socket shall be, if at all possible, placed in the dry.

1. The Contractor will be required to make a diligent effort to dewater the rock socket.

2. If, after making such effort, it is determined by the Engineer that it is not possible to dewater the socket sufficiently to allow the concrete to be placed in the dry; the Contractor, with the Engineer's written approval, shall proceed with the placement of the concrete under water.

K. The casing segment above the top elevation of the drilled shaft shall be left empty.

L. Installation of Expanded Polystyrene

1. Place expanded polystyrene in position before placing concrete.

3.03 TEMPORARY CASING WITHDRAWAL

A. Provide means and opportunity for the Engineer to inspect the operation during the withdrawal of casing and placing of concrete.

B. Coordinate casing withdrawal carefully with concrete placement.
1. Maintain head of concrete to exceed the anticipated outside soil and water pressure above the bottom of the casing at all times during casing withdrawal.

C. Check concrete level prior to, during, and after withdrawing casing to confirm that separation of shaft concrete has not occurred.
   1. Do not vibrate concrete internally before the casing is withdrawn.
   2. A casing vibratory extractor is permitted.
   3. Do not withdraw casing after concrete has attained initial set as determined by the Engineer.

3.04 FIELD QUALITY CONTROL

A. Inspection of Pile:
   1. For piles that have been dewatered, or constructed in the “Dry”, the Contractor shall provide a method for visual inspection to confirm that the pile is acceptable.

B. Acceptance Testing of Pile:
   1. For piles constructed by the “wet” or “slurry-displacement” method, the contractor shall provide acceptance testing by a qualified independent testing firm.
      a. Contractor must submit qualifications of proposed testing firm for review and approval by the Engineer at least 14 days prior to the planned start of construction.
      b. Testing firm shall have conducted acceptance testing of CIDH piles in similar circumstances and using the same test methods on at least 5 projects in the last 3 years.
   2. Vertical inspection pipes for acceptance testing shall be provided in all CIDH concrete piling constructed by the “wet” or “slurry displacement” methods.
3. The furnishing and placing of inspection pipes shall conform to the following:

a. Inspection pipes shall be Schedule 40 PVC pipe with a nominal inside diameter of 2 IN. Watertight PVC couplers are permitted to facilitate pipe lengths in excess of those which are commercially available. The Contractor shall log the location of the inspection pipe couplers with respect to the plane of pile cut off, and these logs shall be delivered to the Engineer upon completion of the placement of concrete in the drilled hole.

b. Each inspection pipe shall be capped at the bottom and shall extend from 3 FT above the pile cutoff down to the bottom of the reinforcing cage. A temporary top cap or similar means shall be provided to keep the pipes clean before testing. If pile cutoff is below the ground surface or working platform, inspection pipes shall be extended to 3 FT above the ground surface or working platform. Approved covers or railings shall be provided and inspection pipes shall be located as necessary to minimize exposure of testing personnel to potential falling hazards.

c. Inspection pipes shall be completely clean, dry, and unobstructed at the time of testing providing a 2 IN DIA clear opening.

d. The inspection pipes shall be installed in straight vertical alignment, parallel to the main reinforcement, and securely fastened in place to prevent misalignment during installation of the reinforcement and placing of concrete in the hole. The CIDH concrete piling shall be constructed so that the relative distance of inspection pipes to vertical steel reinforcement shall remain constant.

e. When any changes are made to the tip of CIDH concrete piling, the Contractor shall also extend the inspection pipes to the bottom of the reinforcing cage.

f. Inspection pipes shall be placed radially around the pile, inside the outermost spiral or hoop reinforcement and no more than 1 IN clear of the outermost spiral or hoop reinforcement.

g. Inspection pipes shall be placed around the pile at a uniform spacing not exceeding 33 IN measured along the circle passing through the centers of inspection pipes. A minimum of four (4) inspection pipes per pile shall be used. Inspection pipes shall be placed to provide the maximum diameter circle that passes through the centers of the inspection pipes while maintaining the spacing required herein.
h. Inspection pipes shall be placed a minimum of 1-1/2 inch clear of the vertical reinforcement. When the vertical reinforcement configuration does not permit this clearance while achieving radial location requirements, distance to vertical rebar shall be maximized while still maintaining the requirement for radial location.

i. Where the dimensions of the pile reinforcement do not permit inspection pipes to be placed per these requirements, a plan for tube placement shall be submitted to the Engineer for approval in the CIDH Pile Installation Plan with a request for deviation before fabricating pile reinforcement.

4. After placing concrete and before requesting acceptance tests, each inspection pipe shall be tested by the Contractor in the presence of the Engineer by passing a 1-1/4 inch diameter rigid cylinder 4.5 feet long through the length of pipe. If an inspection pipe fails to pass the 1-1/4 inch diameter cylinder, the Contractor shall immediately fill all inspection pipes in the pile with water.

5. For each inspection pipe that does not pass the 1-1/4 IN DIA cylinder, the Contractor shall core a nominal 2 inch diameter hole through the concrete for the entire length of the pile. Cored holes shall be located as close as possible to the inspection pipes they are replacing and shall be no more than 5 IN clear from the reinforcement.

a. Coring shall not damage the pile reinforcement. Cored holes shall be made with a double wall core barrel system utilizing a split tube type inner barrel. Coring with a solid type inner barrel will not be allowed. Coring methods and equipment shall provide intact cores for the entire length of the pile. The coring operation shall be logged by an Engineering Geologist or Civil Engineer licensed in the State of California and experienced in core logging. Coring logs shall be in conformance with the Caltrans "Soil and Rock Logging, Classification, and Presentation Manual." Coring logs shall include Core Recovery (REC), Rock Quality Designation (RQD), locations of breaks, and complete descriptions of inclusions and voids encountered during coring, and shall be delivered to the Engineer upon completion. Concrete cores shall be preserved, identified with the exact location the core was recovered from within the pile, and delivered to the Engineer upon completion. The Engineer will evaluate the portion of the pile represented by the cored hole based on the submitted core logs.
6. Acceptance tests of the concrete shall be made by a qualified technician employed by the approved testing firm. Acceptance tests will evaluate the homogeneity of the placed concrete. Tests will include gamma-gamma logging (GGL) conducted in conformance with California Test 233. The Contractor shall not conduct operations within 25 FT of the gamma-gamma logging operations. The Contractor shall separate reinforcing steel as necessary to allow the technician access to the inspection pipes to perform gamma-gamma logging or other acceptance testing. After requesting acceptance tests and providing access to the piles, the Contractor shall allow 7 days for the technician to conduct these tests. The testing firm shall submit acceptance test results and interpretations to the Engineer no later than 7 days after completion of testing for each shaft.

7. The Engineer will make determination of acceptance after receiving test results. No superimposed construction shall proceed without acceptance of the CIDH pile by the Engineer.

8. The Engineer may elect to require additional tests to further evaluate a pile. These tests may include cross-hole sonic logging (CSL) and other means of inspection selected by the Engineer. When the Engineer elects to require additional tests to further evaluate anomalies for a rejected pile, no time requirement exists for performing these tests. The Contractor may progress with the mitigation plan process without waiting for these supplemental results.

9. Inspection pipes and cored holes shall be dewatered and filled with grout after notification by the Engineer that the pile is acceptable. Inspection pipes and holes shall be filled using grout tubes that extend to the bottom of the pipe or hole or into the grout already placed.

10. If the Engineer determines that a pile does not meet the requirements of the specifications and California Test 233, Part 5C, then that pile will be rejected and all depositing of concrete under slurry or concrete placed using temporary casing for the purpose of controlling groundwater shall be suspended until written changes to the methods of pile construction are approved in writing by the Engineer.

C. Mitigation of Rejected Pile:

1. The Engineer will determine whether the rejected pile requires mitigation due to structural, geotechnical, or corrosion concerns. The Engineer will consider the estimated size and location of the anomaly and potential effects upon the design. The Engineer will provide the conclusions of this analysis to the Contractor for development of a mitigation plan, if required. The Contractor shall allow 35 days for the Engineer to determine whether the pile requires mitigation and provide information to the Contractor. Day 1 of the 35 days shall be the 1st day after results of acceptance testing have been provided to the Engineer. If additional information is submitted to the Engineer that modifies the size, shape, or nature of the anomaly, the Contractor shall allow 15 additional days for
the subsequent analysis.

2. If the Engineer determines that a rejected pile requires mitigation, the Contractor shall submit to the Engineer for approval a mitigation plan for repair, supplementation, or replacement for each rejected CIDH concrete pile. If the Engineer determines that it is not feasible to repair the rejected pile, the Contractor shall not include repair as a means of mitigation and shall proceed with the submittal of a mitigation plan for replacement or supplementation of the rejected pile.

3. Pile mitigation plans shall include the following:
   a. The designation and location of the pile addressed by the mitigation plan.
   b. A review of the structural, geotechnical, and corrosion design requirements of the rejected pile.
   c. A step by step description of the mitigation work to be performed, including plans if necessary.
   d. An assessment of how the proposed mitigation work will address the structural, geotechnical, and corrosion design requirements of the rejected pile.
   e. Methods for preservation or restoration of existing earthen materials.
   f. A list of affected facilities, if any, with methods and equipment for protection of these facilities during mitigation.
   g. The assigned contract number, full name of the structure as shown on the contract plans, and the Contractor’s (and Subcontractor's if applicable) name on each sheet.
   h. A list of materials, with quantity estimates, and personnel, with qualifications, to be used to perform the mitigation work.
   i. The seal and signature of an engineer who is licensed as a Civil Engineer by the State of California. This requirement is waived for approved mitigation plans when either of the following conditions are present:
      1) The proposed mitigation will be performed in conformance with the most recent version of "ADSC Standard Mitigation Plan 'A' - Basic Repair" without exception or modification.
2) The Engineer has determined that the rejected pile does not require mitigation due to structural, geotechnical, or corrosion concerns, and the Contractor elects to repair the pile using the most recent version of the "ADSC Standard Mitigation Plan 'B' - Grouting Repair" without exception or modification.

D. The most recent version of the "ADSC Standard Mitigation Plan" is available at: http://www.dot.ca.gov/hq/esc/geotech/ft/adscmitplan.htm

1. For rejected piles to be repaired, the Contractor shall submit a pile mitigation plan that contains the following additional information:
   a. An assessment of the nature and size of the anomalies in the rejected pile.
   b. Provisions for additional pile testing if required by the Engineer.

2. For rejected piles to be replaced or supplemented, the Contractor shall submit a pile mitigation plan that contains the following additional information:
   a. The proposed location and size of additional piles.
   b. Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental piles.

3. All provisions for CIDH concrete piling shall apply to replacement piles.

4. The Contractor shall allow the Engineer 20 days to review the mitigation plan after a complete submittal has been received.

5. When repairs are performed, the Contractor shall submit a mitigation report to the Engineer within 10 days of completion of the repair. This report shall state exactly what repair work was performed and quantify the success of the repairs relative to the submitted mitigation plan. The mitigation report shall be stamped and signed by an engineer that is licensed as a Civil Engineer by the State of California. The mitigation report shall show the assigned contract number, full name of the structure as shown on the contract plans, and the Contractor (and subcontractor if applicable) name on each sheet. The Engineer will be the sole judge as to whether a mitigation proposal is acceptable, the mitigation efforts are successful, and to whether additional repairs, removal and replacement, or construction of a supplemental foundation is required.

3.05 CLEANING

A. Control and Disposal of Materials:

1. Disposal of excavated material, as well as slurry and/or water removed from the shaft excavation, shall be the responsibility of the Contractor.
2. All slurry and water, displaced during final cleaning and concrete placement, shall be collected and properly disposed off site.

3. Open pits for collection of materials will not be allowed.

4. All excavated material, slurry, water, and other matter shall be controlled by the Contractor so that at no time it enters or encroaches upon the adjacent travel lanes, railroad and water ways.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. CIDH Piles will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. The length of each CIDH Piles to be paid for shall be the length, measured along the longest side, from the tip elevation shown on the plans, or the tip elevation ordered by the Engineer for the diameter of the pile shown on the plans, to the plane of the pile cut-off. No reduction in the length for payment will be made for any CIDH pile where the tip elevation is revised in conjunction with a request by the Contractor to increase the pile diameter.

C. Reinforcing Steel of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Reinforcing Steel.

4.02 PAYMENT

A. CIDH Piles will be paid the contract unit price, as listed in the Schedule of Quantities and Prices.

B. The contract unit price shall include full compensation for all equipment, labor and materials necessary to satisfactorily construct the shafts; including drilling and excavation of shaft and rock socket, furnishing, installing and removing temporary casing, furnishing and placing concrete, confirmation boring and lab testing, reporting boring logs and lab test results, CSL (steel pipe) or gamma-gamma (PVC pipe) non-destructive testing and reporting, shaft inspection, disposal of excavated materials and water, and all other materials.

C. Full compensation for furnishing all reinforcing steel in piles and pile extensions, including reinforcement required to extend beyond the pile or extension as shown on the Plans, shall be considered as included in the Contract price per unit for furnishing piling of the type or class shown in the Schedule of Quantities and Prices, and no additional compensation will be allowed therefor.

END OF SECTION
SECTION 34 80 23

SUBDRAINAGE SYSTEM FOR RAILROAD BRIDGES AND RETAINING WALLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes Foundation Drainage System.

B. Related Specification Sections include but are not necessarily limited to:

   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 31 20 00 - Earthwork.

1.02 REFERENCES

A. ASTM International (ASTM):

   3. F405, Corrugated Polyethylene (PE) Tubing and Fittings.
   4. F667, Large Diameter Corrugated Polyethylene Pipe and Fittings.

1.03 SYSTEM DESCRIPTION

A. Extent: Furnish and install foundation drainage as a complete system as shown.

B. Outlet Connections: Foundation pipe shall be terminated as shown on the Drawings.

C. Drainage Lines: Construct drainage lines of perforated pipe.

D. Outlet Line: Construct outlet lines of closed-joint non-perforated pipe.
1.04 SUBMITTALS

A. See Division 01 for requirements for the mechanics and administration of the submittal process.

B. Samples:
   1. Materials:
      a. Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.

C. Certificates:
   1. Materials:
      a. Certifications from the manufacturers attesting that materials meet Specification requirements.
      b. Certifications are required for drain pipe, drain tile, fittings and filter fabric.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage:
   1. Inspect materials delivered to site for damage; unload, and store with minimum handling.
   2. Do not store materials directly on the ground.
   3. The inside of pipes and fittings shall be free of dirt and debris.
   4. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.

B. Handling:
   1. Handle materials in such a manner as to deliver to the trench in sound undamaged condition.
   2. Pipe shall be carried and not dragged to the trench.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Plastic Pipe: Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.
B. Polyvinyl Chloride (PVC) Pipe: ASTM F758, Type PS 46, ASTM D3034, or ASTM F949 with a minimum pipe stiffness of 46 psi.

C. Corrugated Polyethylene (PE) Pipe and Fittings:
   1. Use ASTM F405 for pipes 3 to 6 inches in diameter inclusive, ASTM F667 for pipes 8 to 24 inches in diameter.
      a. Fittings shall be manufacturer’s standard pipe and shall conform to the indicated Specification.

D. Pipe Perforations:
   1. Water inlet area shall be a minimum of 0.5 SQ in/lf.
   2. Manufacturer’s standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Engineer.
      a. Circular Perforations in Plastic Pipe:
         1) Circular holes shall be cleanly cut not more than 3/8 inches or less than 3/16 inches in diameter and arranged in rows parallel to the longitudinal axis of the pipe.
         2) Perforations shall be approximately 3 inches OC along rows.
         3) The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows.
         4) The rows shall be spaced over not more than 155° of circumference.
         5) The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.
      b. Slotted Perforations in Plastic Pipe:
         1) Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing.
         2) Width of slots shall not exceed 1/8 inches nor be less than 1/32 inches.
         3) The length of individual slots shall not exceed 1-1/4 inches on 3 inches dia. tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inches dia. tubing, and 2-1/2 inches on 10 inches dia. tubing.
4) Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe.

5) Slots shall be centered in the valleys of the corrugations of profile wall pipe.

E. Fittings:
   1. Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

F. Bedding and Pervious Backfill for Foundation Drains:
   1. Bedding and pervious backfill shall be in accordance with Section 31 20 00.

G. Protective Covering for Pervious Backfill:
   1. Protective covering shall be building paper.

H. Filter Fabric:
   2. Not less than 4 oz/sy.
   3. Resistant to the chemical actions of the soil and water and non-biodegradable.
   4. Fabric to prevent the migration of soil particles into the subdrain while allowing the free flow of water from the subsoil to the subdrain pipe.

I. Geocomposite Wall Drain:
   1. Geocomposite wall drain shall consist of a manufactured core not less than 0.25 inches thick nor more than 2 inches thick with one or both sides covered with a layer of filter fabric.
      a. The drain shall produce a flow rate of at least 2.0 gal per minute per foot of width at a hydraulic gradient of 1.0 and a minimum externally applied pressure of 3,500 psf.
   2. Filter Fabric for the geocomposite drain shall conform to the provisions for Filter Fabric in this Specification.
   3. The manufactured core shall be either a preformed grid of embossed plastic, a mat of random shapes of plastic fibers, a drainage net consisting of a uniform pattern of polymeric strands forming 2 sets of continuous flow channels, or a system of plastic pillars and interconnections forming a semirigid mat.
4. The core material and filter fabric shall be capable of maintaining a drainage void for the entire height of the geocomposite drain.
   a. The filter fabric shall be integrally bonded to the core material.
   b. Core material manufactured from impermeable plastic sheeting having non-connecting corrugations shall be placed with the corrugations approximately perpendicular to the drainage collection system.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Trenching and Excavation:
   1. Perform required trenching and excavation in accordance with Section 31 20 00.
      a. Keep trenches dry during installation of drainage system.
      b. Changes in direction of drain lines shall be made with 1/8 bends.
      c. Use wye fittings at intersections.

B. Bedding:
   1. Place graded bedding, minimum 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drain pipe.
   2. Each section shall rest firmly upon the bedding, through the entire length, with recesses formed for bell joints.
   3. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.

C. Pipe Laying:
   1. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow.
   2. Bells and grooves of pipe sections shall face upgrade.
   3. Clean interior of pipe thoroughly before being laid.
   4. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes.
   5. Perforated pipe shall be laid with perforations facing down.
6. Any length that has had its grade or joints disturbed shall be removed and relaid at no additional cost to the SCRRRA.

7. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with Manufacturer's Specifications and as specified herein.

8. Tubing and piping with physical imperfections shall not be installed.

D. Jointing:

1. Perforated pipe:
   a. Perforated types of drain pipes shall be laid with closed joints.

2. Non-perforated Drain Tile:
   a. Non-perforated and plain-end drain tile shall be laid with 1/8" to ¼" open joints.
   b. Open joints shall be covered or wrapped.
   c. Covered joints shall have one thickness of the cover material placed over the joint.
   d. Material shall overlap the joint not less than 4 inches on each side and cover the tile for not less than the upper half or more than the upper two-thirds of the circumference of the tile.
   e. Strips of wire cloth wrapping material 3 inches wide shall be used for wrapped joints, with ends fastened together.

3. PVC pipe:
   a. PVC pipe joints shall be in accordance with ASTM D3034, ASTM D3212, or ASTM F949.

4. Perforated Corrugated Polyethylene Pipe:
   a. Perforated corrugated polyethylene pipe shall be installed in accordance with Manufacturer's Specifications and specified herein.
   b. No more than 5 percent stretch in a section will be permitted.

E. Outlet Lines:

1. The outlet end of drain lines connecting with an open gutter or outfall shall be covered with a removable wire basket of 16-mesh copper or bronze wire cloth fastened with brass or wire straps.
3.02 BACKFILLING

A. After joints and connections have been inspected and approved, place the specified pervious backfill material a minimum width of 6 inches on each side of the pipe and 12 inches above the top of the pipe.

1. Place the backfill preventing displacement of or injury to the pipe or tile.

2. Place a protective covering, as specified in Section 31 20 00, over the pervious backfill for the full width of the trench before regular backfill is placed.

3. Compact backfill as specified in Section 31 20 00.

3.03 TESTS

A. Pipe Tests:

1. Strength tests of pipe shall conform to field service test requirements of the ASTM Specification or AASHTO Specification covering the product (See paragraph 2.1. in this Specification Section).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Subdrainage System for Railroad Bridges, Retaining Walls, Concrete Masonry Wall, Concrete Retaining Wall, and Platforms will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Subdrainage system for will be paid at the Contract lump sum price.

1. The contract lump sum price paid for subdrainage system for Railroad Bridges, Retaining Walls, Concrete Masonry Wall, Concrete Retaining Wall, and Platforms shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the subdrainage system, complete in place, as shown on the Drawings, as specified in this Specification Section, and as directed by the Engineer.
2. Perforated drain pipe, non-perforated drain pipes, all connections and closures, joints, elbows, cleanouts and outlet hardware, concrete drainage swale or gutter, utility excavation and backfill and other associated material and incidentals and installation thereof will be considered part of the subdrainage system and full compensation therefore will be considered as included in the contract unit price paid for subdrainage system.

END OF SECTION
SECTION 34 80 31
BRIDGE DECK DRAINAGE SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Deck drainage system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 31 20 00 - Earthwork.

1.02 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA):

B. ASTM International (ASTM):

1.03 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.
1.04 SUBMITTALS

A. Shop Drawings:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Outlet/Downspout Fabrication and/or Layout Drawings:
      a. Bridge drainage piping Drawings (minimum scale 1 IN equals 10 FT) with information including:
         1) Dimension of piping lengths.
         2) Invert or centerline elevations of piping crossings.
         3) Acknowledgement of bury depth requirements.
         4) Line slopes and vents.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Copies of manufacturer’s written directions regarding material handling, delivery, storage and installation.
   4. Deck drain layout including:
      a. Elbows.
      b. Couplings.
      c. Lap details.
      d. End treatments.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prevent damage to pipe during transit.
   1. Repair abrasions, scars, and blemishes.
   2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Deck Drains:
   a. Contech Construction Products Inc.

B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. Deck Drain:

1. Corrugated steel pipe for deck drains shall be galvanized steel pipes with 1-1/2” x 1/4” corrugation manufactured from galvanized steel coils conforming to applicable requirements of ASTM A929 and manufactured in accordance with the applicable requirements of ASTM A760.

B. Drainage Piping:

1. Drainage piping shall be as shown on the Drawings.

2.03 INSPECTION AND TESTING

A. Materials shall be sampled and tested by the current methods recommended by ASTM.

B. The acceptance of any material by the inspector shall not be a bar to their subsequent rejection if found defective.

1. Rejected material must be promptly removed from the job and replaced with acceptable material.

C. No material shall be used until it has been accepted by the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Deck Drain:

1. Install corrugated steel pipe deck drain system as shown in the Drawings and in accordance with ASTM A798.
B. Buried Piping Installation:

1. Install expansion devices as necessary to allow expansion and contraction movement.

2. Laying Pipe In Trench:
   a. Excavate and backfill trench in accordance with Section 31 20 00.
   b. Clean each pipe length thoroughly and inspect for compliance to Specifications.
   c. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
   d. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
   e. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
   f. Lay pipe in only suitable weather with good trench conditions.
      1) Never lay pipe in water except where approved by Engineer.
   g. Seal open end of line with watertight plug if pipe laying stopped.
   h. Remove water in trench before removal of plug.

3. Lining Up Push-On Joint Piping:
   a. Lay piping on route lines shown on Drawings.
   b. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
   c. Observe maximum deflection values stated in manufacturer's written literature.
   d. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
   e. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.
4. Anchorage and Blocking:
   a. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
   b. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
      1) Concrete blocks shall not cover pipe joints.
   c. Provide bearing area of concrete in accordance with drawing detail.

5. Install insulating components where dissimilar metals are joined together.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Bridge Deck Drainage system will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Bridge Deck Drainage system will be paid at the contract lump sum price.
   1. The contract unit price paid for drainage system shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the drainage system, complete in place, as shown on the Drawings, as specified in this Specification Section, and as directed by the Engineer.
   2. Half-round perforated corrugated steel drain pipe, steel pipe, bottom pans, non-perforated round corrugated steel drain pipes, all connections and closures, joints, elbows, cleanouts and outlet hardware, concrete drainage swale or gutter, utility excavation and backfill and other associated material and incidentals and installation thereof will be considered part of the drainage system and full compensation therefore will be considered as included in the contract unit price paid for drainage system.

END OF SECTION
SECTION 34 80 32
ADHERED ELASTOMERIC WATERPROOFING FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Waterproofing membrane.
   2. Membrane protection.
   3. Flashing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 34 11 26 - Ballast.
   4. Section 34 80 33 - Hot Mix Asphalt (HMA) for Bridges.
   5. Section 34 80 52 - Metal Fabrications.

1.02 REFERENCES

A. Referenced Standards:

B. American Railway Engineering and Maintenance-of-Way Association (AREMA):

C. ASTM International (ASTM):

1.03 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Certification of applicator qualifications.

3. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.

4. Waterproofing layout:

b. Waterproofing membrane sheet layout and details including:

1) Splice locations.

2) Edge details.

3) Joint details.

c. Membrane protection:

4) Asphalitic panel or asphalt plank layout.

   a) Edge details.

   b) Joint details.

5. Manufacturer's authorized representative written acceptance of substrate.

6. Ponded water test report with results and all remedial measures taken as a result of a failing test.
1.05 QUALITY ASSURANCE

A. Qualifications:

1. Installer licensed or approved in writing by system manufacturer.

2. Installer shall have a minimum of five (5) years experience in the installation of products specified.

3. Installer shall have completed a minimum of three (3) projects in the last three (3) years on similar bridges.

1.06 WARRANTY

A. Warranty, signed by material manufacturer, stating membrane material will be free of manufacturing defects for a minimum period of 20 years.

B. Watertightness warranty signed by installer stating completed installation will remain water tight for a minimum period of 10 years.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

2. Waterproofing membrane:
   a. Carlisle Coating and Waterproofing, Inc.

3. Membrane protection:
   a. Asphalt planks:
     1) Elsro, Inc.
   b. Asphaltic panels:
     1) W.R. Meadows, Inc.

4. Bonding adhesive:
   a. Carlisle Coating and Waterproofing, Inc.

B. Submit request for substitution in accordance with Division 01.
2.02 MATERIALS

A. Waterproofing Membrane: Meet requirements of ASTM D6134, Type 1, EPDM or Type 2, Butyl.

B. Membrane Protection:
      a. Provide either asphaltic panels or asphalt planks, Type 1b.
   2. Total thickness: 1 inch consisting of two (2) ½” layers.

C. Adhesive for Securing Membrane and Membrane Protection: In accordance with the recommendations of the membrane manufacturer.

D. Cement:
   1. Self-vulcanizing butyl rubber compound conforming.
   2. Viscosity at 77˚ F Brookfield Viscometer (#3 Spindle at 10 rpm) 1,700-3,400 cps.
   3. Total solids (minimum): 30 percent.

E. Butyl Gum Tape for Splicing Either Membrane:
   1. Black, vulcanizable butyl rubber with an 8 mil polyethylene film backing.
   2. Tape thickness: 30 (+4) mils, including the backing.

F. Anti-bonding Paper:
   1. Tough paper with a weight not less than 5 lbs per 100 sf.
   2. In accordance with the recommendations of the membrane and membrane protection manufacturers.

G. Galvanized Sheet Metal: Meet the requirements of ASTM A924.

H. Steel Flashing, Flashing Anchors and Armor Plate: In accordance with Section 34 80 52.

I. Ballast: In accordance with Section 34 11 26.

2.03 INSPECTION AND TESTING

A. Sample and test materials by the current methods recommended by ASTM.
B. Acceptance of any material by the inspector shall not be a bar to its subsequent rejection if found defective.

1. Promptly remove rejected material from the job and replaced with acceptable material.

C. Do not use any material until it has been accepted by the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Waterproofing Membrane:

1. Apply adhesive to ballast retainers and entire surface to be waterproofed.
   a. Apply in a thin layer (by using a roller or brush as recommended by the manufacturer) at a minimum rate of one (1) gal per 60 sf based on both mating surfaces.

2. Membrane sheets:
   a. Position and draw tight without stretching.
   b. Uniformly roll up half of the membrane in a direction away from the starting edge or subsequent splice.
   c. Apply adhesive to the exposed area.
   d. Allow adhesive to dry so as to not stick to a dry finger touch and all solvent is evaporated.
   e. Unroll the membrane and press firmly and uniformly in place, using care to avoid trapping of air.
   f. Repeat the same procedure for the remaining half of the membrane sheets.
   g. Avoid wrinkles and buckles.
   h. Position each succeeding sheet to fit the previously installed sheet and splice.

3. Splices:
   a. Lap type as shown on the Drawings.
b. Clean all seam, lap and splice areas with heptane, hexane, toluene, trichloroethylene or white gasoline, using a clean cloth, mop or similar synthetic cleaning device.

c. Spread cement continuously on seam, lap and splice areas at a uniform rate of not less than 2 gal per 150 sf based on both mating surfaces.

d. After cement is allowed to dry until it will not stick to a dry finger touch, apply butyl gum tape to cemented area of membrane, press firmly into place, obtain full contact.

e. Avoid bridging and wrinkles.

f. Reinforce corner splices with two (2) continuous layers of rubber membrane over one (1) layer of butyl tape.

4. Flash all projecting elements passing through membrane waterproofing with prefabricated or field-fabricated boots or fitted coverings, as necessary to provide watertight construction.

a. Use Butyl gum tape between layers of rubber membrane.

5. Construct waterproofing at expansion joints of bridge decks, as shown on the Drawings.

6. Patch any holes in the membrane sheeting with a minimum overlap of 4 inches and in accordance with manufacturer's instructions.

7. Exercise care to prevent damage to the waterproofing membrane by men or equipment during construction.

B. Membrane Protection:

1. Asphalitic panels:

   a. Apply in two (2) layers with the joints staggered.

      1) Lay panels tightly jointed.

      2) Adhesive: Same as specified for the Butyl rubber or EPDM membrane.

      3) Fill any voids between the panels with a material compatible to both the membrane and the panel.

   b. Where edges or protrusions of asphalitic panels are exposed to prolonged sunlight exposure, coat exposed areas with Fiber Aluminum Roof Coating meeting ASTM D2824, Type II at a rate of 12 sf per gallon, for a 1/8 inches thickness.
2. Asphalt planks:
   a. Lay in a coating of bonding adhesive.
   b. Adhesive: Same as specified for the Butyl rubber or EPDM membrane.
   c. Adhesive: Apply at a rate of not less than 1 gal per 100 sf.
   d. Fill any voids between the panels with a material compatible to both the membrane and the panel.

C. Steel Flashing:
   1. Attach with bolts per the Drawings.
   2. Refer to Specification Section 34 80 52 for expansion bolt requirements.

D. Waterproofing Protection:
   1. As soon as the membrane protection has been completed, cover the waterproofing with HMA on concrete bridge decks or with a 6 inches layer of ballast on steel bridge decks to protect the waterproofing from sunlight.
   2. Do not place any equipment on the waterproofing prior to placement of the Waterproofing Protection.

3.02 FIELD QUALITY CONTROL

A. Employ and pay for services of material manufacturer's field service representative(s) to:
   1. Supervise installation.
   2. Sign and provide SCRRA with a written warranty.

B. Ponded water testing: On bridges with entire deck waterproofed with membrane waterproofing:
   1. Pond 2 inches of water for 24 hours on all horizontal surfaces:
      a. Plug all openings as required.
      b. Protect adjacent areas from water damage.
      c. Remove all water after test.
      d. Repair all leaks and other discrepancies as identified by manufacturer's authorized representative.
e. Retest repaired areas until satisfactory test results are obtained.

f. Furnish written report.

**PART 4 - MEASUREMENT AND PAYMENT**

**4.01 MEASUREMENT**

A. Adhered Elastomeric Waterproofing for Railroad Bridges will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

**4.02 PAYMENT**

A. Adhered Elastomeric Waterproofing for Railroad Bridges furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Adhesive, asphalt planks or sheets, steel sheeting, steel flashing, bolts and connectors for flashing, armor plates, adhesive anchors, butyl rubber or EPDM waterproofing membrane and other associated materials and incidentals and installation thereof shall be considered part of the waterproofing and full compensation therefore shall be considered as included in the contract unit price paid for waterproofing.

**END OF SECTION**
SECTION 34 80 33
HOT MIX ASPHALT (HMA) FOR BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hot mix asphalt (HMA) track underlay and paving.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 34 11 27 - Sub-Ballast and Aggregate Base.

1.02 REFERENCES

A. State of California, Department of Transportation, Standard Specifications (Caltrans).

1.03 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

   a. Acknowledgement that products submitted meet requirements of standards referenced.

   b. Manufacturer's installation instructions.

3. Asphalt design mix.

1.04 DELIVERABLES

A. Submit records of delivery of asphalt materials, identifying shipment numbers, dates and quantities, material designations and temperature at the time of placement.
B. Submit copies of aggregate tests, penetrations of asphalt cement, and percentages by weight and number of pounds of each of the materials making up the batch.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Asphalts:

1. Asphalt binder to be mixed with aggregate shall be steam-refined paving asphalt of the grade designated in the special provisions.
   a. The asphalt binder shall be in conformance with the Caltrans Standard Specifications, Section 92.
2. The amount of asphalt binder to be mixed with aggregate for asphalt concrete shall be in conformance with the requirements of the Caltrans Standard Specifications, Section 92.
3. Liquid asphalt for the prime coat shall be of the grade designated by the contract item or specified in the special provisions.
   a. The liquid asphalt shall be in conformance with the Caltrans Standard Specifications, Section 94.
4. Asphaltdic emulsion for the tack coat shall be of the grade designated by the Engineer.
   a. The asphaltic emulsion shall be in conformance with the Caltrans Standard Specifications, Section 94.
5. Paving asphalt to be used as a binder for pavement reinforcing fabric shall be a steam-refined paving asphalt in conformance with the Caltrans Standard Specifications, Section 92.
   a. The paving asphalt shall be PG 70-10.

B. Aggregate:

1. Aggregate shall be clean and free from decomposed materials, organic material and other deleterious substances.
   a. Coarse aggregate shall be material that is retained on the No. 4 sieve.
   b. Fine aggregate shall be material that is passing the No. 4 sieve.
c. Supplemental fine aggregate is added fine material passing the No. 30 sieve, including, but not limited to, cement and stored fines from dust collectors.

2. Aggregate grading shall be in conformance with the Caltrans Standard Specifications, Section 39.

C. HMA for track underlay: Type A with ¾” maximum, coarse aggregate gradation.

D. HMA pavement: Type A with ½” maximum, coarse aggregate gradation.

E. Prime Coat:
   1. Prime coat shall be an emulsified asphalt Type RS-2, conforming to Caltrans Standard Specifications, Section 94.

F. Tack Coat:
   1. Tack coat shall be a liquid asphalt Type SS-1, conforming to Caltrans Standard Specifications, Section 94.

PART 3 - EXECUTION

3.01 PREPARATION

A. When placing HMA for track underlay, provide subballast base course in accordance with Section 34 11 27.

B. When placing HMA for access road paving, provide an aggregate base course in accordance with Section 34 11 27.

C. Schedule placement of asphalt paving material when the precipitation probability, within 3 hours prior to the start of such operations, is less than 50 percent.

D. Laying of HMA shall not be permitted in wet weather.

E. Spreading of HMA shall not be permitted when the mixing temperature of HMA is below 250° F.

F. HMA shall only be placed when the atmospheric temperature is above 50° F.

G. When HMA is to be placed on an existing asphalt concrete, concrete, or brick surface, broom the existing surface clean prior to the application of the prime coat.
   1. Repair holes and depressions in existing surfaces by removal to sound material and replace with an asphalt-aggregate patching material.
   2. Compact patch to produce a tight surface conforming to the adjacent paving area.
3. Stabilize rocking Portland cement concrete slabs by undersealing or cracking and seating.

4. Fill wide joints and cracks with asphaltic concrete/sand mix material and compact.

### 3.02 SPREADING

A. The depositing, distributing, and spreading of the HMA shall be accomplished in a single, continuous operation by means of a mechanical spreader or a grader.

1. When laying HMA for track underlay and the use of a mechanical spreader or a grader is impractical, the Contractor must submit a request for the use of alternate equipment to the Engineer for review.

B. HMA for bridge and bridge approaches shall conform to the following thickness requirements:

1. The track underlay for the bridge approaches shall be permitted to be placed in one 8 inches lift.

2. The traffic surface shall be permitted to be placed in one 4 inches thick lift.

C. HMA for access road paving shall conform to the lift thickness requirements as designated in Caltrans Standard Specifications, Section 39.

D. The prime coat shall be applied at a rate of 0.25 gal/sq yd and shall be in conformance with the Caltrans Standard Specifications, Section 39.

E. The tack coat shall be applied in one application at a rate of 0.02 gal to 0.10 gal/sq yd of surface covered and shall be in conformance with the Caltrans Standard Specifications, Section 39.

F. Following application of the tack coat, the HMA shall be spread in conformance with the Caltrans Standard Specifications, Section 39.

1. Successive lifts may be laid upon previously laid lifts as soon as the previous lift has cooled sufficiently to show no displacement under equipment or loaded material delivery trucks.

### 3.03 COMPACTION

A. Rollers:

1. Steel-wheeled, tandem type power driven rollers shall provide a pressure of not less than 225 lbs/in width of main roll.

a. Rolls shall be smooth and without flat spots or other imperfections.
2. Pneumatic rubber-tired rollers shall be self-propelled with wheels mounted, grouped and spaced to provide uniform coverage with each pass.
   a. Rear group wheels shall not follow the tracks of forward group wheels.
   b. Maximum wheel load shall be 5,600 lbs.
   c. Tire compression on pavement, where the area of contact is measured on a hard, unyielding surface, shall be 80 psi plus five (5) psi for each wheel.
   d. The total maximum load per axle, whether single axle or a group of axles in the same alignment, shall be 22,400 lbs.
   e. Wheel loads and tire pressures shall be controlled to produce the required degree of compaction without rutting of the surface to be rolled.

B. Rolling:

1. Proceed continuously at the following rates:
   a. For track underlay mixture, when spread by hand, not in excess of 400 sq yd/hr, per roller.
   b. For track underlay, when spread by machine, not in excess of 600 sq yd/hr, per roller.
   c. For HMA paving, when spread by hand, not in excess of 300 sq yd/hr, per roller.
   d. For HMA paving, when spread by machine, not in excess of 400 sq yd/hr, per roller.

2. Immediately after spreading, thoroughly compact by rolling with approved rollers continuously from commencement to final completion at a speed not exceeding three (3) miles per hours.

3. Make initial rolling, using tandem type rollers, parallel to the center line of the paved surface beginning at the curbs or edges of the paved surface and working toward the center, overlapping on successive trips by one-half the rear wheel roller.
   a. Immediately following the initial rolling, further compact by pneumatic rubber-tired rollers or steel wheel vibratory tandem type rollers a minimum of eight (8) passes, except HMA track underlay which shall receive 4 passes.
b. Smooth shallow ruts and ridges with tandem rollers immediately following the rubber-tired rolling.

4. First make final roll longitudinally with the paved surface and then diagonally or at right angles.
   a. Continue until further compression results; the mixture has cooled; no marks show under the roller, and the surface is smooth and free from depressions, waves, bunches, and unevenness.

5. Test after the mixture has been rolled with approved straight edge and surface testing machine laid parallel to the centerline of the paved surface.

PART 4 - MEASUREMENT AND PAYMENT

3.01 MEASUREMENT

A. Prime Coat and Tack Coat will not be measured for payment. Costs associated with the prime or tack coats will be considered as incidental to the Hot Mix Asphalt Pavement.

B. Hot Mix Asphalt Pavement will be measured by the unit or fraction thereof installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the Contract Drawings will be used as the basis for this measurement. Separate measurements will be made for each specified thickness of asphaltic concrete Material as included on the approved Schedule of Values.

C. The mass of the material will be determined as provided in Section 9-1.01, “Measurement of Quantities”, of the current Caltrans Standard Specifications.

4.02 PAYMENT

A. Hot Mix Asphalt Pavement constructed in accordance with the Contract Documents will be paid for at the Contract Unit Price of the specified type and thickness as included on the approved Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals necessary for Hot Mix Asphalt Pavement described by the Contract Documents.

END OF SECTION
SECTION 34 80 43

PRECAST AND PRESTRESSED CONCRETE FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Precast and prestressed concrete.

B. Related Specifications Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 – Reinforcing Steel.
   4. Section 03 31 00 – Structural Steel.
   5. Section 34 80 61 - Painting and Protective Coatings for Railroad Bridges.

1.02 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA).
   1. Chapter 8 - Concrete Structures and Foundations.

B. ASTM International (ASTM):
   3. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

C. American Welding Society (AWS):
   3. D1.1, Structural Welding Code - Steel.

D. Precast/Prestressed Concrete Institute (PCI):
   1. PCI MNL-116-Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
   2. PCI Design Handbook - Precast and Prestressed Concrete.

1.03 SUBMITTALS

A. Shop Drawings:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

c. Sizes, types and manufacturer of neoprene bearing pads.

d. Hardware to be utilized to support suspended appurtenances.

3. Shop Drawings and erection plans for precast units, their connections and supports showing:

   a. Member size and location.

   b. Size, configuration, location and quantity of reinforcing bars and prestressing strands.

   c. Initial prestress forces.

   d. Size and location of openings verified by Contractor.

   e. Size, number, and locations of embedded metal items and connections.

   f. Required concrete strengths.

   g. Identification of each unit using same standard marking numbers as used to mark actual units.

4. Concrete mix design(s) including submittal information defined in Section 03 31 00.

5. Copies of source quality control tests.

6. Certification of manufacturer's testing facility qualifications.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Provide precast and prestressed concrete units produced by a certified manufacturer by the Prestressed Concrete Institute Plant Certification Program.

   a. Manufacturer shall be certified in Product Group and Category B1 for non-prestressed precast concrete.

   b. Manufacturer shall be certified in Product Group and Category B4 for prestressed precast concrete.

2. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a
minimum of three (3) years.

3. Assure manufacturer's testing facilities meet requirements of ASTM E329.

4. Welding operators and processes to be qualified in accordance with:
   a. AWS D1.1 for welding steel shapes and plates.
   b. AWS D1.4 for welding reinforcing bars.

5. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

   1. Headed studs and deformed bar anchors:
      b. KSM Division, Omark Industries.

   2. Bearing pads:
      a. Voss Engineering, Inc. ‘Fiberlast’

B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. Embedded Steel Plates and Shapes: ASTM A36.

B. Elastomeric Bearing Pads:

   1. AREMA Chapter 15, Article 10.6.2.

C. Random Oriented Fiber Elastomeric Pads: Made of high-quality ozone resistant virgin elastomer combined with synthetic fibers. Pads shall conform to the following minimum material properties:


   2. Compression:
3. Shear Modulus (G): 230 ±30 psi Based on tests conducted according to 70˚ to 80˚ F under uniform compressive stresses of 500, 1000 and 1500 psi and at an applied horizontal shear plus slip strain of 50 percent. This value is applicable to both concrete-to-concrete and steel-to-concrete surfaces. G is constant in all directions parallel to the bearing plane.

4. Tensile Strength (ASTM D412, Die C): 1000 ±100 psi

5. Elongation:
   a. Ultimate Elongation, %: 40 percent minimum.
   b. Ozone Resistance (per ASTM D1149) Exposed 50 hours @ 100 pphm @ 100˚ F Elongation: 40 percent minimum.
   c. Heat Aging (per ASTM D573) 70 hrs @ 212˚ F in forced air oven Elongation, % Change: —25 percent max. 6.
   d. Oil Imersion Oil Immersion per ASTM D4711 70 HRS @ 212˚ F in ASTM #3 oil Volume Change, %: 125 percent max.

D. Cement:
   1. Comply with ASTM C150, Type I or III.

E. Aggregates for Normal Weight Concrete:
   1. ASTM C33 with coarse aggregate meeting the gradation for size 67 as stated in ASTM C33.
   2. All fine aggregate to be natural not manufactured.

F. Admixtures:
   1. Only liquid admixtures may be used.
   2. All admixtures must be from same manufacturer.
   3. Air entraining admixtures shall conform to ASTM C260 and shall be used to produce 7 percent ±1 percent entrained air in the concrete after all admixtures have been incorporated.
   4. Water reducing admixtures shall be used only with the approval of the Engineer and shall conform to ASTM C949, Types A, B, D, or E.
   5. High-range water reducers (superplasticizers) and retarding admixtures, in quantities appropriate for the ambient temperatures, may be permitted, subject to the approval of the Engineer.
   6. The use of calcium chloride or any admixture containing chloride ions will not be permitted.
G. Flyash:
   1. Flyash, Type C, meeting the requirements of ASTM C618 may be used as a cement replacement with the approval of the Engineer.
      a. Type F may be used to modify potentially reactive aggregates.
      b. This mix shall be subject to the requirements of ASTM C1260.
      c. Flyash may replace up to 15 percent, by weight, of the cement.

H. Water:
   1. Potable, clean.

I. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.

J. Prestressing Strands:
   1. 270K high tensile strength uncoated seven (7) wire strand.
   2. Manufacture and test strands in accordance with ASTM A416.

K. Reinforcing Steel and Welded Wire Reinforcement: See Section 03 21 00.

L. Headed Studs:
   1. ASTM A108.
   2. Minimum yield strength: 50,000 psi.
   3. Minimum tensile strength: 60,000 psi.

M. Deformed Bar Anchors:
   1. ASTM A496.
   2. Minimum tensile strength: 80,000 psi.
   3. Minimum yield strength: 70,000 psi.

N. Electrodes:
   1. E70 series conforming to AWS A5.1 or AWS A5.5 for welding steel shapes and plates.
   2. E90 series conforming to AWS A5.5 for welding rebar.
O. Grout:

1. Grout shall consist of one part Type III Portland Cement to three parts of fine aggregate, by weight, mixed with a gaging solution made of one part Sika Set to five parts by volume.

2. The following mix proportions will yield one cubic foot of grout:
   a. 35 lbs cement.
   b. 105 lbs fine aggregate.
   c. 1.25 gal water.
   d. 1 qt Sika Set.

3. At temperatures above 50° F grout will take initial set in approximately 3 hours and reach design strength in approximately 24 hours.

2.03 MIXES

A. See Section 03 31 00.

B. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

2.04 FABRICATION

A. Do not fabricate units until Shop Drawings have been approved by Engineer and returned to Contractor and support locations have been field verified by Contractor.

B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with AREMA Chapter 8 and PCI MNL-116.

C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.

D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.

E. Finish all repairs smooth and to match adjacent surface texture and color.

F. Incorporate embedded plates, angles, lifting devices, and other inserts into members at time of manufacture.

   1. Provide embedded items as shown on the Plans unless prior approval is received from Engineer to do otherwise.

   2. Cast lifting devices into units as shown on Plans.
a. Remove or fill lifting devices after units are erected.

G. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.

H. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

I. Mark each unit as indicated on the erection plans.
   1. Place mark on non-exposed-to-view surface.

J. Coat or finish ends of exposed prestressing strands to prevent rusting.

K. Fabricate the following types of precast and prestressed units:
   1. Precast, prestressed slab beams.
      a. Reinforce as indicated.
   2. Precast, prestressed double-box beams.
      a. Reinforce as indicated.
   3. Precast concrete members as shown on Plans:
      a. Reinforce as indicated.

2.05 DELIVERY, STORAGE, AND HANDLING

A. Units shall be stored in such a way as to permit the Inspector's access to all sides at all times, and the Fabricator's access for shipment without additional moving.

B. Transportation of prestressed units shall not be undertaken until the full 28 day concrete strength has been achieved, or by order of the Engineer.

C. Units shall be handled such that the points of the support and direction of the reactions with respect to the unit are approximately the same during transportation and storage as when the unit is in its final position.
   1. Care shall be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage.
   2. Units damaged by improper storage or handling shall be replaced or repaired to the satisfaction of the Engineer by the Contractor at his expense.

D. Units shall be stored above ground on skids or other supports to keep items free of dirt and other foreign debris.
2.06 SOURCE QUALITY CONTROL

A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03 31 00 for concrete placed during fabrication.

1. 4 inches dia. x 8 inches cylinders will be allowed for testing.

2. Results of strength tests to be sent to The Engineer, Contractor and SCRRRA within 24 hours.

3. Test reports to indicate units they represent.

B. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.

C. The SCRRRA must be allowed to inspect all Contract work at his own discretion.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify acceptability and location of supports to receive units.

1. Check bearing surfaces to determine that they are level and uniform.

B. Do not place design live load on structure until supports have reached their 28 day required compressive strengths.

3.02 ERECTION

A. Give consideration to possible lack of stability or capacity of partially completed structure.

B. Contractor to be responsible for guying, shoring, and bracing individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.

C. Use only erection equipment adequate for placing units at lines and elevations indicated on Plans.

1. Do not damage units or existing construction during erection.

2. Erect units using lifting devices cast into the units.

D. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

E. Coat adjoining surfaces of wingwalls and end caps with grout prior to wingwall installation.
F. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections as indicated on Plans.

1. See Section 34 80 61.

### 3.03 FIELD QUALITY CONTROL

A. Causes for rejection of units include, but are not necessarily limited to the following:

1. Cracked units.
2. Chipped, broken, or spalled edges.
3. Units not within allowable casting tolerances.
4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
5. Non-uniform finish or appearance.
7. Improperly placed embedded items and/or openings.
8. Exposed wire mesh, reinforcing or prestressing strands.

### PART 4 - MEASUREMENT AND PAYMENT

#### 4.01 MEASUREMENT

A. Precast and prestressed concrete members will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

#### 4.02 PAYMENT

A. Precast and prestressed concrete members furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
B. Connection rods and associated hardware and other materials, bearing pads and embedded steel items shall be considered part of the member and full compensation therefore shall be considered as included in the contract unit price paid for furnishing and erecting the precast and prestressed unit in-place.

END OF SECTION
SECTION 34 80 51

STRUCTURAL STEEL FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Structural steel, including the fabrication and erection of framing and bracing members, including connections.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 03 31 00 - Structural Concrete.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):


2. Quality Certification Program for Fabricators.

B. American Railway Engineering and Maintenance-of-Way Association (AREMA).


C. ASTM International (ASTM):


5. A307, Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.


7. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.


10. A709, Standard Specification for Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges.


D. American Welding Society (AWS):


8. Steel stud connectors and their installation to comply with requirements of AWS Code.

1.03 SUBMITTALS

A. Shop Drawings:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Fabrication and/or layout Plans:
   a. Prepare Shop Drawings under National Institute of Steel Detailing Quality Procedures Program certification.
   b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
      1) All Shop Drawings must be checked and signed "approved" before submittal.
      2) Show all cuts, coping, and holes.
      3) Indicate all shop and field bolts.
      4) Indicate all shop and field welds using AWS symbols.
      5) Be reviewed and sealed by a Professional Engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
   c. Prepare complete erection Plans showing the location and marks of all pieces.
      1) Copies of up-to-date erection Plans shall accompany the Shop Drawings.
         a) Use match marks on the erection Plans to indicate the sheet number on which each particular member is detailed.

3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Detailed supplemental specification relating to load indicator washers or high-strength bolts - alternate design for approval of Engineer (submitted at Contractor's option if desired by Contractor for use).
   d. Source and certification of quality for high-strength bolts, nuts and washers.
4. Certifications:
   a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
   b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
   c. Welder qualification data and prequalified procedures.

5. Test reports:
   a. Certified copies of mill tests.
   b. Manufacturer’s load test and temperature sensitivity data for expansion anchor bolts and adhesive anchor bolts.
   c. Testing agency inspection and test reports for structural steel work in the shop and in the field.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Steel fabricator:
   a. Minimum of 10 years experience in fabrication of structural steel and shall be certified under AISC Quality Certification Program Category III.
   b. Use a Professional Engineer on fabrication staff.

2. Steel erector:
   a. Minimum of 10 years of experience in erection of structural steel.

3. Qualify welding procedures and welding operators in accordance with AWS.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members above ground on skids or other supports.

1. Keep free of dirt and other foreign material and protect against corrosion.

1.06 DEFINITION

B. SCRRRA: May mean the SCRRRA's Designated Representative for Construction as defined by the Building Code.

C. Galvanizing: Hot-dipped galvanizing per ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. High-strength bolts:
   a. Bethlehem Steel Corporation.
   b. Lewis Bolt & Nut Company.
   c. Nucor Fasteners.
   d. St. Louis Screw and Bolt Company.

2. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Division, TRW, Inc.
   b. Stud Welding Products, Inc.

3. Expansion anchor bolts:
   a. Kwik Bolts by Hilti, Inc.
   b. Trubolt by ITW Ramset/Red Head.
   c. Powerbolt by Powers Rawl.

4. Adhesive anchors bolts:
   a. HVA Adhesive Anchor System by Hilti.
   b. HIT HY 150 Adhesive Anchor by Hilti.
   c. HSE 2411 Epoxy Adhesive Anchor by Hilti.
   d. EPCON Ceramic 6 Epoxy by ITW Ramset/Red Head.
   e. Power Fast by Powers Rawl.
B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Plans):
   1. All main load-carrying members: ASTM A709, Grade to be noted on Plans.

B. Plate and Bar: ASTM A36.

C. Pipe: ASTM A53, Grade B (Type E or S) (Fy=35).

D. Hollow Structural Sections (HSS):
   1. Round: ASTM A500 Grade B or C.
   2. Square or rectangular: ASTM A500 Grade B or C.

E. High-Strength Bolts, Nuts and Washers, ASTM A325 with ASTM A563 nuts:
   1. High-strength bolts:
      a. Provide two (2) ASTM F436 washers for all bolts.
      b. Provide beveled washers at connections of sloped/tapered sections.
      c. Type to match.

F. Welding Electrodes (AWS):
   1. Shielded metal arc: AWS A5.1 or AWS A5.5, E70XX or E801X-X.
   2. Submerged arc: AWS A5.17 or AWS A5.23, F7XX-EXXX or F8XX-EXXX-XX.
   3. Gas metal arc: AWS A5.18, E70S-X or E70U-1 or AWS A5.28, ER805-XX, E80C-XXX.

G. Anchor Rods and Bolts:
   1. ASTM F1554, Grade 55 with weldability supplement S1 for threaded rods.

H. Deformed Anchor Rods:
   1. Deformed anchor rods:
      a. ASTM F1554, Grade 36.
      b. Minimum yield strength: 36,000 psi.
c. Minimum tensile strength: 58,000 psi.
d. Straight, unless indicated otherwise.

I. Nonshrink Grout: See Section 34 80 41.

2.03 FABRICATION

A. Comply with requirements of AREMA Chapter 15 and AISC Specification with modifications and additional requirements specified herein.

1. Identify high-strength steel material in fabricated members in accordance with ASTM A6.

B. Minimize the amount of field welding.

1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.

2. Shop connections: Bolted with high-strength bolts or welded.

C. One-sided or other types of eccentric connections not indicated will not be permitted without prior approval.

D. Field Connections: Provide bolts for all field connections except where shown otherwise on the Plans.

1. Use high-strength bolts unless shown or specified otherwise.

2. If structural steel details shown on design Plans are not compatible with selected erection procedures, submit proposed modifications for review.

3. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.

E. Cut, drill, or punch holes in accordance with AREMA Section 15.3.2.6 and AREMA Section 15.3.2.7.

F. Make splices only where indicated or where approved.

G. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

H. Flame cut bevels for welds, provided such cutting is done automatically.

1. Leave free of burrs and slag by grinding or planing the cut edges.

I. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8" radius.

J. Tolerances (unless noted otherwise on Plans):
1. ASTM A6: When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC Specification.

2. Fabrication tolerance:
   a. Member length:
      1) Framed members 30 feet or less: 1/16".
         a) Over 30 feet: 1/8".
   b. Member straightness:
      1) 10 percent of the unbraced length multiplied by 1/16" or ¼", whichever is greater.
   c. Specified member camber (except compression members):
      1) 10 percent of the unbraced length multiplied by 1/16" or ¼", whichever is greater.
      2) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
      3) Camber shall be measured in fabrication shop in unstressed condition.
   d. At bolted splices, depth deviation shall be taken up by filler plates.
      1) At welded joints, adjust weld profile to conform to variation in depth.
      2) Slope weld surface per AWS requirements.
   e. Finished members shall be free from twists, bends and open joints.
      1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

2.04 WELDING

A. Comply with AREMA Chapter 15, AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.

1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
   1. Conduct tests in presence of approved testing agency.
   2. Certification within previous 12 months will be acceptable, provided samples of the welder’s work are satisfactory.

C. Welding of Fracture Critical Members shall be in accordance with the requirements of AREMA Section 15.1.14.

D. Before Starting Welding:
   1. Carefully plumb and align members in compliance with specified requirements.
   2. Fully tighten bolts.
   3. Comply with Section 3 of AWS Code for assembly and surface preparation.
   4. Preheat base metal to temperature stated in AWS Code.
      a. When no preheat temperature is given in AWS Code and base metal is below 50°F, preheat base metal to at least 70°F.
      b. Maintain temperature during welding.
      c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 inches, whichever is greater, to specified preheat temperature.
      d. Maintain this temperature during welding.
   5. Each welder shall use identifying mark at welds.

E. Make flange welds before making web welds.

F. Where groove welds have back-up plates, make first three (3) passes with 1/8” round electrodes.
   1. Use backup plates in accordance with AWS Code, extending minimum of 1 inch either side of joint.

G. Flame cut edges of stiffener plates at shop or field butt weld.
   1. Do not shear.

H. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
I. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.

J. Do not perform welding when ambient temperature is lower than 0˚F or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

K. Deformed Anchors Rods:
   1. Automatically end welded in accordance with the AWS Code and manufacturer’s recommendations.
   2. Fillet welding of deformed bar anchors is not allowed unless approved by Engineer.

2.05 SHOP COATING

A. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

B. Do not coat following surfaces:
   1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
   2. All other members for which no coating is specified.

C. Clean thoroughly all surfaces not coated before shipping.
   1. Remove loose mill scale, rust, dirt, oil and grease.
   2. Protect machined surfaces.

2.06 SOURCE QUALITY CONTROL

A. Contractor must pay for all inspection and testing:
   1. Testing:
      a. Employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
      b. Independent testing agency shall have a minimum of five (5) years performing similar work and shall be subject to SCRRA’s approval.

B. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with AREMA Section 15.3.5.5 including the following non-destructive testing:
a. All full-penetration welds in girder webs and flanges shall be inspected by the radiographic method.

b. All flange to web welds shall be inspected by the ultrasound method.

c. All fillet welds on bearing stiffeners shall be inspected by the ultrasound method.

d. At least 25 percent of all other welds shall be inspected by the ultrasonic or magnetic particle method.

1) If any defects are found, 100 percent inspection by the ultrasonic or magnetic particle shall be required.

e. Inspection of welded work for Fracture Critical Members shall be in accordance with AREMA Chapter 15.

f. Time delay prior to NDT of weld repairs to groove welds of ASTM A588 or ASTM A709 material over 2 inches in thickness subject to tensile stress, shall be 16 hours minimum.

2. Inspect high-strength bolting in accordance with AREMA Section 15.3.5.4.

3. Inspect structural steel which has been erected.

4. Prepare and submit inspection and test reports to Engineer.

   a. Assist Engineer to determine corrective measures necessary for defective work.

C. All spans shall be shop-assembled and piece marked. During assembly and reaming, all bolts shall be placed in holes as work progresses to assure proper fit. Spans may be disassembled prior to shipping.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor is solely responsible for safety.

1. Construction means and methods and sequencing of work is the prerogative of the Contractor.

2. Partially complete structural members shall not be loaded without an investigation by the Contractor.
3. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment is the responsibility of the Contractor.

1. Use temporary bracing to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.

2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.

3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.

   a. If not obvious from experience or from the Plans, the Contractor shall confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.

4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.

1. Report defects in work-in-place which may influence satisfactory completion of the work.

2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:

1. Take field measurements as necessary to verify or supplement dimensions indicated on the Plans.

2. Contractor responsible for the accurate fit of the work.

E. Check the elevations of all finished pier caps and the location and alignment of all anchor bolts and bolt holes before starting erection.

1. Notify Engineer of any errors or deviations found by such checking.
3.02 ERECTION

A. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

B. Welding:
   1. Conform to AWS D1.5 and requirements of this Specification.
   2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.5 procedure.

C. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

D. Clean stored material of all foreign matter accumulated during erection period.

E. Clean bearing and contact surfaces before assembly.

F. Anchor Bolts:
   1. Cast-in-place anchor bolts:
      a. Anchor bolt location tolerance: 1/8".
      b. Tie anchor bolts in position to embedded reinforcing steel using wire.
      c. Welding or tack welding is prohibited.
      d. Provide steel templates for location anchor bolts.
   2. Anchor bolts installed in precast holes:
      a. If anchor bolts are to be grouted into the holes prior to the placement of the span, location tolerance of the anchor bolts shall be 1/8".
         1) If anchor bolts are to be installed after the span is placed, the hole location tolerance shall be 1/2".
      b. Grout anchor bolts into place with non-shrink grout.
      c. Used supplied bearing pads or sole plates as template.
      d. Refer to Section 34 80 41 for non-shrink grout requirements.
   3. Anchor bolts installed in drilled holes:
a. If anchor bolts are to be grouted into the holes prior to the placement of the span, location tolerance of the anchor bolts shall be 1/8".

1) If anchor bolts are to be installed after the span is placed, the hole location tolerance shall be 1/2".

b. Grout anchor bolts into place with non-shrink grout.

c. Used supplied bearing pads or sole plates as template.

d. Refer to Section 34 80 41 for non-shrink grout requirements.

G. Install high strength bolts with hardened washers.

1. Install and tighten in accordance with AREMA Chapter 15.

2. Coordinate installation with inspection.

   a. Do not start installation until coordination with Testing Agency is complete.

3. Slip-critical connections: Perform calibration testing for all methods of installation of high-strength bolts in accordance with AREMA Chapter 15.

   a. Turn-of-nut tightening: Torque wrenches shall be used only by laboratory personnel.

   b. Calibrated wrench tightening: Calibrate on a daily basis.

   c. Direct tension indicator tightening: If previously approved by Engineer.

4. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

H. Do not use gas cutting to correct fabrication errors.

1. Make no such corrections without prior approval of the Engineer.

2. Burning of holes: Not permitted.

I. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

J. Tighten and leave in place erection bolts used in welded construction.

K. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.
L. After bolts are tightened, upset threads of A307 unfinished bolts and anchor bolts to prevent nuts from backing off.

M. After erection, grind smooth all sharp surface irregularities resulting from field cutting or welding; power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

3.03 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
   1. Touchup coatings to comply with Section 34 80 61.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Structural Steel will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Structural steel for use in bridge structures will be measured by the unit computed by the Engineer from the nominal weight and dimensions shown on the Plans.
   1. The weight of rolled shapes and structural plates will be computed on the basis of their nominal weight and dimensions, without deductions for copies, cuts, and holes.
   2. The computed weight of the completed members will not include allowances for bolt holes or account for the weight of bolts, washers, nuts, and welds, whether installed in the shop or in the field.

4.02 PAYMENT

A. Structural Steel furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Structural steel for use in bridge structures will be paid for furnishing structural steel and erecting structural steel complete in-place.
1. The contract price paid for structural steel shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for all work involved in constructing, furnishing, transporting, handling, and erecting units in-place as shown on the Plans, as specified in these Specifications and as directed by the Engineer.

2. The contract price paid structural steel shall include, but shall not be limited to, furnishing all bolts, nuts and washers, stud connectors, welding materials, bearing plates and pads, or other materials required for the erection and connection or splicing of the structural steel, finishing the structural steel as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.

3. The contract price paid for structural steel shall include, but shall not be limited to, connecting and splicing the structural steel, installing stud connectors, installing bearing plates and pads, furnishing and applying caulks, sealants and fillers, furnishing and placing mortar or grout for masonry or bearing plates and anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.

4. The contract price paid for structural steel shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to structural steel as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

END OF SECTION
SECTION 34 80 52

METAL FABRICATIONS FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.

2. Design of all temporary bracing not indicated on Plans.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 34 80 51 - Structural Steel For Railroad Bridges.

4. Section 34 80 61 - Painting and Protective Coatings for Railroad Bridges.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):


B. ASTM International (ASTM):


10. A588, Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 inches Thick.

11. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.


C. American Welding Society (AWS):


2. D1.1, Structural Welding Code Steel.

D. Military Specifications:

1. MIL-N-25027, Nut, Self Locking, Heavy hex, (Non-Metallic Insert) 250° and 450° F, UNJC-3B, ¼” Through 2-1/2” Nominal Diameters, Nickel-Copper Alloy.

E. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1. Chapter 15 – Steel Structures
1.03 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Hardware: As defined in ASTM A153.

C. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

1.04 SUBMITTALS

A. Shop Drawings:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout Plans and details:
      a. Submit Plans for all fabrications and assemblies.
      1) Include erection Plans, Plans, Sections, details and connection details.

B. Miscellaneous Submittals:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Certification of welders and welding processes.
      a. Indicate compliance with AWS.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
   2. Fabricator shall have minimum of 10 years experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional Civil Engineer licensed in the State of California.
1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Headed studs and deformed bar anchors:
   b. Stud Welding Products, Inc.

2. Expansion anchor bolts:
   a. Hilti Inc.
   b. ITW Ramset/Red Head.
   c. Simpson Strongtie.

3. Epoxy adhesive anchor bolts:
   a. Hilti Inc.
   b. ITW Ramset/Red Head.
   c. Simpson Strongtie.

4. Galvanizing repair paint:
   a. ZRC Products.

B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. Steel:

1. Structural:
b. Plates and other rolled sections not specified above: ASTM A36.

2. Pipe: ASTM A53, Types E or S, Grade B.

3. Structural tubing:
   a. ASTM A588.

4. Bolts, nuts and washers, high strength:
   a. ASTM A325 with ASTM A563 nuts.
   b. Provide two (2) washers with all bolts.

5. Machine bolts, nuts and washers:
   a. ASTM A307 with ASTM A563 nuts.
   b. Provide one (1) spring lock washer and two (2) plain washers with all bolts.


7. Steel forgings: ASTM A668.

B. Stainless Steel:

1. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
   a. Bars, shapes: ASTM A276, Type 304.
   b. Tubing and pipe: ASTM A276, Type 304 or 316.
   c. Strip, plate and flat bars: ASTM A666, Type 304 or 316, Grade A.
   d. Bolts and nuts: ASTM F594, Type 303 or 304.

2. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
   a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L.

3. Welding electrodes: In accordance with AWS for metal alloy being welded.

C. Washers: Same material and alloy as found in accompanying bolts and nuts.

D. Embedded Anchor Bolts:
1. Type 304 or 316 stainless steel with two (2) matching nuts and matching washer.

2. Machine bolts with two (2) matching nuts and matching washer.

E. Expansion Anchor Bolts and Adhesive Anchor Bolts:

1. Stainless steel, Type 304, 314 or 316.

2. Provide minimum edge distance cover and spacing as recommended by manufacturer, or as indicated on Plans whichever is larger.
   a. Minimum embedment as recommended by manufacturer or eight (8) diameters of bolt, whichever is larger.
   b. Notify Engineer if required depth of embedment cannot be achieved at a particular anchor bolt location.
   c. Follow manufacturer's recommendations for installation and torque.

3. Provide elastic locknuts meeting the requirements of MIL-N-25027.

F. Deformed Anchors Rods: ASTM F1554, Grade 36 with a minimum yield strength of 36,000 psi and a minimum tensile strength of 58,000 psi.

G. Saddle Clips:

1. Meet steel grating manufacturer's recommendations.

2. Galvanized in accordance with ASTM A153.

H. Steel:

1. Galvanized in accordance with ASTM A123 when required to be galvanized.

I. Steel Hardware: Galvanized in accordance with ASTM A153 or ASTM B695 when required to be galvanized.

J. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.

2. Dried film shall contain not less than 93 percent zinc dust by weight.

3. Similar to ZRC by ZRC Products.

4. Volatile Organic Compounds (VOC): 0 lbs per gal.
2.03 MANUFACTURED UNITS

A. Steel Checkered Plate:
   1. Conform to ASTM A786.
      a. Diamond pattern: No.3 (large) or No.4 (medium).
      b. Use one (1) pattern throughout Project.
      c. Material: 36 ksi minimum yield strength.

B. Steel Grating:
   1. Bearing bars:
      a. Rectangular 1-1/2" x 3/16" unless shown otherwise on Plans.
      b. Maximum 1-3/16" OC spacing.
   2. Cross bars:
      a. Welded to bearing bars.
      b. Maximum 4 IN OC spacing.
   3. Top edges of bars: Serrated or grooved.
   4. Removable grating sections: Not wider than 3 feet and not more than 100 lbs unless shown otherwise on Plans.
   5. Finish:
      a. Galvanized.
      b. Clips and bolts: Galvanized.
      c. Seat angles: Galvanized steel.

2.04 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32" - 1/16" nominal radius.
C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Permanent Shop Connections:
   1. Welds to be continuous fillet type unless indicated otherwise.
   2. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1.
   3. Grind smooth welds that will be exposed.

E. Fabricate work in shop in as large assemblies as is practicable.

F. Tolerances:
   1. Rolling:
      a. ASTM A6.
      b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specifications.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32”.
         2) Framed members:
            a) 30 feet or less: 1/16”.
            b) Over 30 feet: 1/8”.
      b. Member straightness:
         1) ASTM A6 tolerance for wide flange shapes.
      c. At bolted splices, depth deviation shall be taken up by filler plates.
         1) At welded joints, adjust weld profile to conform to variation in depth.
         2) Slope weld surface per AWS requirements.
d. Finished members shall be free from twists, bends and open joints.
   1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

G. Fabricate grating, checkered plate, and accessories using galvanized steel unless shown otherwise on Plans.

### 2.05 SOURCE QUALITY CONTROL

**A. Surface Preparation:**
- Refer to Specification Section 34 80 61 for surface preparation requirements.

**B. Shop Applied Paint Coating Application:**

**C. Meet structural requirements of Specification Section 34 80 51 for inspection and testing items of structural nature.**

**D. Responsibilities of Testing Agency:**
- Inspect shop and field welding in accordance with AWS Code, Section 6 including the following non-destructive testing:
  - Visually inspect all welds.
  - In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
  - Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
- Inspect high-strength bolting in accordance with the AREMA Section 15.3.5.4.
- Inspect structural steel which has been erected.
- Inspect stud welding in accordance with AWS Code, Article 7.8.
- Prepare and submit inspection and test reports to Engineer:
  - Propose corrective measures necessary for defective work for approval by the Engineer.

**E. All items to be assembled in the field are to be shop-assembled prior to shipping:**
- During assembly and reaming, all bolts shall be placed in holes as work progresses to assure proper fit.
PART 3 - EXECUTION

3.01 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
   1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.
   1. Installation of product constitutes installer’s acceptance of substrate condition for product compatibility.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.02 INSTALLATION

A. Set metal work level, true to line, plumb.
   1. Shim and grout as necessary.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
   1. Plumb, align, and set structural steel members to specified tolerances.
   2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
      a. If not obvious from experience or from the Plans, the Contractor shall confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
   5. Remove and dispose of all temporary work and facilities off-site.
C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
   1. Report defects in work-in-place which may influence satisfactory completion of the work.
   2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:
   1. Take field measurements as necessary to verify or supplement dimensions indicated on the Plans.
   2. Contractor responsible for the accurate fit of the work.

E. Check the elevations of all finished pier caps and the location and alignment of all anchor bolts and bolt holes before starting erection.
   1. Notify Engineer of any errors or deviations found by such checking.

F. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

G. Welding:
   1. Conform to AWS D1.1 and requirements of Article 2.4.
   2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

H. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

I. Clean stored material of all foreign matter accumulated during erection period.


K. Grind welds smooth where field welding is required.

L. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

M. Unless noted or specified otherwise:
   1. Connect steel members to concrete and masonry using stainless steel expansion anchor bolts.
   2. Provide washers for all bolted connections.
3. Where exposed, bolts shall extend a maximum of ¾” and a minimum of ½” above the top nut.

N. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC Manual of Steel Construction.

1. Provide hardened washers for all ASTM A325 bolts.
   a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

O. After bolts are tightened, upset threads of ASTM A307 unfinished bolts or anchor bolts to prevent nuts from backing off.

P. Secure metal to wood with lag screws of adequate size with appropriate washers.

Q. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.

1. Provide full penetration welded splices where continuity is required.

R. Provide each fabricated item complete with attachment devices as indicated or required to install.

S. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

1. Maximum spacing: 2 feet OC with minimum of two (2) per side.

T. Repair damaged galvanized surfaces in accordance with ASTM A780.

1. Prepare damaged surfaces by abrasive blasting or power sanding.

2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer’s instructions.

3.03 CLEANING

A. After erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Metal fabrications for use in bridge structures will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Reinforcing Steel furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Metal fabrications for use in bridge structures will be paid at the Contract Unit Price for furnishing metal fabrications and erecting metal fabrications complete in-place.

1. The contract price paid for metal fabrications shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for all work involved in constructing, furnishing, transporting, handling, and erecting units in-place as shown on the Plans, as specified in these Specifications and as directed by the Engineer.

2. The contract price paid for metal fabrications shall include, but shall not be limited to, furnishing all bolts, nuts and washers, stud connectors, welding materials, or other materials required for the erection and connection or splicing of the metal fabrications, finishing the metal fabrications as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.

3. The contract price paid for metal fabrications shall include, but shall not be limited to, connecting and splicing the metal fabrications, installing stud connectors, furnishing and applying caulk, sealants and fillers, furnishing and placing mortar or grout for masonry or bearing plates and anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.
4. The contract price paid for metal fabrications shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to metal fabrications as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

END OF SECTION
SECTION 34 80 53
STEEL HANDRAILS FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel handrail and guardrail.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 34 80 61 - Painting and Protective Coatings for Bridges.

1.02 REFERENCES

A. ASTM International (ASTM):


B. American Railway Engineering and Maintenance-of-Way Association (AREMA):

C. American Welding Society (AWS):
   1. D1.1, Structural Welding Code Steel.

1.03 DEFINITIONS

A. Hardware: As defined in ASTM A153.

B. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Handrail: A railing as defined by AREMA Chapter 15.

1.04 SUBMITTALS

A. Shop Drawings:
   1. See Division 01 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout Plans.
      a. Plan showing profile, location, section and details of each railing, and type and details of anchorage system.
      b. Location and type of expansion joints.
      c. Materials of construction including shop-applied coatings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Miscellaneous Submittals:
1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Certification of welders and welding procedures indicating compliance with AWS.

3. Certification that railings have been designed and fabricated to meet the loading requirements specified.

1.05 QUALITY ASSURANCE

A. Qualify welding procedures and welding operators in accordance with AWS.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect from corrosion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Welded railing systems:
   a. Any manufacturer meeting this Specification Section.

2. Galvanizing repair paint:
   a. ZRC Products.

B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. Pipe: ASTM A53, Types E or S, Grade B.

B. Steel Angle, Sheet, Bar (Pickets) and Plate: ASTM A36.

C. Steel W and WT shapes: ASTM A992.

D. Machine Bolts, Nuts and Washers:

1. ASTM A307 with ASTM A563 nuts.

2. Provide one (1) spring lock washer and two (2) plain washers with all bolts.
E. Safety Chain and Quick Links: ASTM A466.

F. Eyebolts: ASTM A489.

G. Aircraft Cable: ASTM A1023.

H. Steel: Galvanized in accordance with ASTM A123 when required to be galvanized.

I. Steel Hardware: Galvanized in accordance with ASTM A153 or ASTM B695 when required to be galvanized.

J. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. Dried film shall contain not less than 95 percent zinc dust by weight.
   3. Similar to ZRC by ZRC Products.

K. Welding Electrodes: AWS D1.1, E70 Series.

L. Temporary Handrails:
   1. Material shall be either steel or timber, selected at the Contractor's discretion.
      a. Material shall be sturdy and slip-resistant.
   2. Material shall be supplied by the Contractor.

2.03 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
      a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
   3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
      a. Ease exposed edges to a radius of approximately 1/32”.
      b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
4. Form exposed connections by welding.

5. Provide for anchorage of type indicated on the Plans.
   a. Drill or punch holes with smooth edges.

6. Custom fabricate pipe railings to dimensions and profiles indicated.
   a. Fabricate guardrail vertical posts using 1-1/2" nominal diameter Schedule 40 pipe.
   b. Fabricate all guardrail top rails using 1-1/2" nominal diameter Schedule 40 pipe.
   c. All intermediate rails shall be fabricated using minimum 1-1/2" nominal diameter Schedule 40 pipe.

7. Fit exposed ends of handrails with solid terminations.

8. The ends of handrails shall not overhand terminal posts except where such overhang does not constitute a projection hazard.

9. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.

B. Finish: Galvanized after fabrication, unless shown otherwise in the Plans.

C. Welded Railing Fabrication:
   1. All welding to be continuous in accordance with AWS D1.1.
      a. All welded railing joints shall have full penetration welds.
   2. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
   3. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.

D. Install weeps to drain moisture from hollow sections of railing at exterior locations and in high humidity areas.
   1. Drill 3/8" vent in railings at each end of horizontal pipes.

E. Expansion Joints:
   1. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
      a. Top rail splices and expansion joints shall be located within 8 IN of post or other support.
b. Where railings span structure expansion joints; provide a railing expansion joint in the span crossing the structure expansion joint.

2. Provide expansion joints in any continuous run exceeding 20 feet in length.
   a. Space expansion joints at not more than 40 feet OC.

3. Provide minimum 0.10 inches of expansion joint for each 20 feet length of top rail for each 25° F differential between installation temperature and maximum design temperature.
   a. Maximum expansion joint width at time of installation shall not exceed 3/8”.
      1) Provide additional expansion joints as required to limit expansion joint width.

4. Provide slip-joint with internal sleeve.
   a. Extend slip joint min 2 inches beyond joint at maximum design width.
   b. Fasten internal sleeve securely to one side
      1) Provide allen-head set screw located in bottom of rail.
      2) Rivets or exposed screw heads are not acceptable.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.
   1. Installation of product constitutes installer’s acceptance of substrate condition for product compatibility.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.02 TEMPORARY HANDRAILS

A. Temporary handrails shall be installed where necessary to provide fall protection during construction.

B. The top edge height of the top rail shall be 42 inches ±3 inches above the walking/working surface.

C. At least two midrails shall be provided, evenly spaced between the walking/working surface and the top rail.
D. Temporary handrail posts shall be placed at a maximum of 10 feet intervals.

E. Entire handrail system, including anchorages, shall be capable of withstanding without failure, a force of 200 lbs applied in any outward or downward direction at any point.

F. Handrail system shall be surfaced to prevent injuries from punctures or laceration and prevent snagging of clothing. The ends of top rails and midrails shall not extend past the posts.

G. If conditions warrant, additional protection shall be provided such as screens or mesh to prevent slipping between the midrails and the walking/working surface.

3.03 INSTALLATION

A. Install products in accordance with Plans.

B. Set work accurately in location, alignment and elevation; plumb, level, and true.

C. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.

1. Provide shims as required.

D. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.

1. Lubricate expansion joint splice bar for smooth movement of railing sections.

E. Attach handrails to walls or guardrails with brackets designed for condition.

1. Anchor handrail to concrete with ¾” heavy hex ASTM A307 bolt with washer and heavy weight elastic locknut.

F. Anchor railings to metal structure with minimum 5/8” high strength steel bolts, nuts and washers.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.

1. Properly prepare surface in accordance with galvanizing repair paint manufacturer’s recommendations.

2. Apply minimum 6 mils DFT of galvanizing repair paint in accordance with manufacturer’s recommendations.

H. Prepare and paint railings in accordance with Specification Section 34 80 61.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Steel handrails for use in bridge structures will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Steel handrails for use in bridge structures will be measured from end to end along the face of the railing, including end and intermediate posts, and with no deductions for gaps in railing for lighting and sign supports. The measurement shall be made along the face of the rail elements without allowance for overlap at rail splices.

4.02 PAYMENT

A. Steel handrails for use in bridge structures furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Steel handrails for use in bridge structures will be paid at the Contract Unit Price for furnishing steel handrails and erecting steel handrails complete in-place.

1. The contract price paid for steel handrails shall include, but shall not be limited to, furnishing all bolts, nuts and washers, welding materials, or other materials required for the erection and connection or splicing of the steel handrails, finishing the steel handrails as required by these Specifications and the Plans, and conforming to the qualification and testing requirements associated with member fabrication.

2. The contract price paid for steel handrails shall include, but shall not be limited to, connecting and splicing the steel handrails, installing end treatments, anchor assemblies, and return and end caps, furnishing and placing mortar or grout anchor bolts, checking bolt tension, and conforming to qualification and testing requirements associated with member erection, connection or splicing.

3. The contract price paid for steel handrails shall include, but shall not be limited to, full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in cleaning and applying paint and protective coatings (non-metallic) and metallic coatings to steel handrails as shown on the Plans, and as specified in these Specifications and as specified by the Engineer.

END OF SECTION
SECTION 34 80 61
PAINTING AND PROTECTIVE COATINGS FOR RAILROAD BRIDGES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, and any other material, specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 – Reinforcing Steel.
   4. Section 03 31 00 - Structural Concrete.
   5. Section 34 80 52 - Metal Fabrications For Railroad Bridges.
   6. Section 34 80 53 - Steel Handrails For Railroad Bridges.

1.02 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM):
      a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      b. D4259, Standard Practice for Abrading Concrete.
      c. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      d. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   a. Certified Coating Thickness Calibration Standards.

3. The Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Paint Thickness with Magnetic Gages.
   b. SP 1, Solvent Cleaning.

4. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 5/NACE No. 1, White Metal Blast Cleaning.
   b. SP 6/NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/NACE No. 2, Near-White Blast Cleaning.
   e. SP 12/NACE No. 5, Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
   f. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Miscellaneous:
   1. Furnish coating material through one (1) manufacturer unless noted otherwise.

C. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.

D. Material shall not be thinned unless approved, in writing, by coating material manufacturer's authorized representative.

1.03 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified.
C. Corrosive Environment: Immersion in, or not more than 6 inches above, or subject to condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 to 9.

D. Highly Corrosive Environment: Immersion in, or not more than 6 inches above, or subject to condensation, spillage or splash of a highly corrosive material such as water, wastewater, or chemical solution; or exposure to highly corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range below five (5) or above nine (9).

E. Exposed Exterior Surface:
   1. Surface which is exposed to weather but not necessarily exposed to view as well as surface exposed to view.
   2. Exterior surfaces are considered corrosive environment.
      a. The following areas are considered highly corrosive:
         1) All chemical unloading stations and areas within 10 feet-0 inches of containment areas.
         2) All chemical unloading station containment areas.
         3) All areas within a 6 feet radius of chemical tank vents.
         4) All areas within 1 mile of coast.

F. Finished Area: An area that is indicated on Drawings to be painted.

G. Immersion Surface:
   1. Any surface immersed in water or some other liquid.
   2. Surface of any pipe, valve, or any other component of the piping system subject to condensation including the pipe support system.

H. Paint includes the following:
   1. High performance industrial coatings (HPIC) include: Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

I. Surface Hidden from View: Surfaces such as those within pipe chases and surfaces under overhanging walkways if over 5 feet above adjacent walking surfaces

J. HPIC: High performance industrial coatings.

K. Water level for purposes of painting: See Drawings.
1.04 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Applicator experience qualifications.
   a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.

3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's application instructions.
   c. Manufacturer's surface preparation instructions.
   d. If products being used are manufactured by Company other than listed in Article 2.02 - MATERIALS, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
   e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
   f. Coating manufacturer's recommendation on abrasive blasting.
   g. Manufacturer's recommendation for universal barrier coat.
   h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.

4. Manufacturer's statement regarding applicator instruction on product use.

5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

B. Samples:

1. Manufacturer's full line of colors for Engineer's preliminary color selection.

2. After preliminary color selection by Engineer provide two (2) 3 x 5 inches samples of each final color selected.
C. Miscellaneous Submittals:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Approval of application equipment.

3. Applicator's daily records:
   a. Submit daily records at end of each week in which painting work is performed unless requested otherwise by Engineer's on-site representative.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.

2. Applicators shall have minimum of 10 years experience in application of similar products on similar project.
   a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
   b. Include name and address of project, size of project in value (painting) and contact person.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:

1. Name or type number of material.

2. Manufacturer's name and item stock number.

3. Contents, by volume, of major constituents.

4. Warning labels.

5. Volatile Organic Compound (VOC) content.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. High performance industrial coatings:
   a. Tnemec.
   b. Tiger Drylac.
   c. Sherwin Williams.
   d. Diamond Vogel/Perdium.

2. Graffiti-resistant coating:
   a. Pro SoLo.

B. Submit request for substitution in accordance with Division 01.

2.02 MATERIALS

A. For unspecified materials such as thinner, provide manufacturer’s recommended products.

B. Paint Systems - General:

1. \( P = \) prime coat.

2. \( F_1, F_2 \ldots F_n = \) first finish coat, second finish coat \ldots \ nth finish coat, color as selected by Engineer.

3. If two (2) finish coats of same material are required, Contractor may, at his option and by written approval from paint manufacturer, apply one (1) coat equal to mil thickness of two (2) coats specified.

C. HPIC products listed in Article 2.02 - MATERIALS, Paragraph E. Paint Systems are manufactured by Tnemec.

1. Products of other listed manufacturers are acceptable for use providing the product is of the same generic resin, requires comparable surface preparation, has comparable application requirements, meets the same VOC levels or better, provides the same finish and color options and will withstand the atmospheric conditions of the location where it is to be applied.
D. Paint Systems (Systems not shown are not used):

1. HPIC SYSTEM #1 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s).
   a. Prime coat:
      1)  $P1 = 1$ coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
   b. Finish coat(s):
      1)  Interior:
          a)  $F1 = 1$ coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
          b)  $F2 = 1$ coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2)  Exterior:
          a)  $F1 = 1$ coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
          b)  $F2 = 1$ coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

2. HPIC SYSTEM #2 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
   a. Prime coat:
      1)  $P1 = 1$ coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
   b. Finish coat(s):
      1)  Interior:
          a)  $F1 = 1$ coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2)  Exterior:
          a)  $F1 = 1$ coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
3. **HPIC SYSTEM #3 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).**
   a. Prime coat:
      1) $P_1 = 1$ coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
   b. Finish coat(s):
      1) Interior:
         a) $F_1 = 1$ coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) $F_1 = 1$ coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

4. **HPIC SYSTEM #4 - Modified Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).**
   a. Prime coat:
      1) $P_1 = 1$ coat, 3 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).
   b. Finish coat(s):
      1) Interior:
         a) $F_1 = 1$ coat, 4 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) $F_1 = 1$ coat, 3 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

5. **HPIC SYSTEM #5 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).**
   a. Prime coat:
      1) $P_1 = 1$ coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
b. Finish coat(s):
   1) Interior:
      a) $F_1 = 1$ coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
   2) Exterior:
      a) $F_1 = 1$ coat, 3.0 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

6. HPIC SYSTEM #6 - Modified Polyamidoamine Epoxy.
   a. Prime coat:
      1) $P_1 = 1$ coat, 3 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).

7. HPIC SYSTEM #7 - Zinc-Rich Aromatic Urethane Primer.
   a. Prime coat:
      1) $P_1 = 1$ coat, 3.0 mils, 90-97 Tneme-Zinc (Zinc-Rich Urethane).

8. HPIC SYSTEM #8 - Modified-Acrylate Elastomer Primer and Top Coat.
   a. Prime coat:
      1) $P_1 = 1$ coat, 8 mils, Series 156 Enviro-Crete (Modified-Acrylate Elastomer).
   b. Finish coat:
      1) Exterior:
         a) $F_1 = 1$ coat, 8 mils, Series 156 Enviro-Crete (Modified-Acrylate Elastomer).

9. HPIC SYSTEM #9 - Acrylic Emulsion Primer with Acrylic Emulsion Top Coat(s).
   a. Prime coat:
      1) $P_1 = 1$ coat, 60 to 90 SF/GAL/coat, Series 180 W.B. Tneme-Crete (Acrylic Emulsion).
b. Finish coat(s):
   1) Exterior:
      a) $F_1 = 1$ coat, 125 to 150 SF/GAL/coat, Series 180 W.B. Tneme-Crete (Acrylic Emulsion).

10. HPIC SYSTEM #10 - Polyamidoamine Epoxy Coating.
   a. Prime coat:
      1) $P_1 = 1$ coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).

11. HPIC SYSTEM #11 - Modified Polyamidoamine Epoxy.
   a. Prime coat:
      1) $P_1 = 1$ coat, 5 mils, 135-1243 Chembuild (Modified Polyamidoamine Epoxy).

12. HPIC SYSTEM #12 - Waterborne Acrylic Emulsion Prime and Top Coats.
   a. Prime coat:
      1) $P_1 = 1$ coat, 80 to 110 SF/GAL/coat, Series 180, W.B. Tneme-Crete (Acrylic Emulsion).
   b. Finish coat:
      1) Exterior:
          a) $F_1 = 1$ coat, 175 to 200 SF/GAL/coat, Series 180, W.B. Tneme-Crete (Acrylic Emulsion).

   a. Patching/filling coat:
      1) $P/F_1 = 1$ coat, 60 to 80 SF/GAL/coat, Series 130 Envirofill (Waterborne Cementitious Acrylic).
   b. Finish coat:
      1) Interior:
          a) $F_1 = 1$ coat, 175 to 200 SF/GAL/coat, Series L69 Epoxoline (Polyamidoamine Epoxy).
          b) $F_2 = 1$ coat, 175 to 200 SF/GAL/coat, Series L69 Epoxoline (Polyamidoamine Epoxy).
14. HPIC SYSTEM #14 - Waterborne Vinyl Acrylic Primer with Water-base Acrylic-Emulsion Top Coat.
   a. Prime coat(s):
      1) P1 = 1 coat, 2.0 mils, Series 51-792 PVA Sealer.
   b. Finish coat(s):
      1) Interior and exterior:
         a) F1 = 1 coat, 2.5 mils, Series 6 Tneme-Cryl.

15. HPIC SYSTEM #15 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy Top Coat (with silica sand broadcast for slip resistance).
   a. Prime coat:
      1) P1 = 1 coat, 5 mils, Series L69 Epoxoline II.
   b. Slip resistance:
      1) Blend dry, washed 30 to 50 mesh silica sand into first finish coat (F1) at rate required to provide a heavy slip resistant finish.
   c. Finish coat:
      1) F1 = 1 coat, 4 mils, Series L69 Epoxoline II.
      2) F2 = 1 coat, Series L69 Epoxoline II.
         a) F2 coat mil thickness is to be as required to achieve non-slip texture specified.

16. HPIC SYSTEM #16 - Polyamine Novolac Epoxy Primer with Polyamine Novolac Epoxy Top Coat.
   a. Prime coat:
      1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) P1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.
   b. Finish coat:
      1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
2) F1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.

17. HPIC SYSTEM #17 - Epoxy Modified Surfacer/Filler with Polyamine Novolac Epoxy Top Coats.
   a. Filler/surfacer coat:
      1) Filler = 1 coat, 0.0625 IN thick, Series 218 Mortar Clad.
   b. Prime coat:
      1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) P1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.
   c. Finish coat:
      1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) F1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.

18. SYSTEM #18 - Touch-up of galvanized surfaces not requiring a top coat.
   a. Refer to Specification Section 34 80 52.

19. SYSTEM # 19 - Epoxy Paint.
   a. Finish coat:
      1) F1 = 1 coat, 8 mils dry film thickness (10 mils wet film thickness), Chemical-Mastic CM-15, Metallic Aluminum color.

PART 3 - EXECUTION

3.01 ITEMS TO BE PAINTED

A. Exposed Surfaces indicated on Drawings.

1. Conduit, device boxes, junction boxes and covers, pull boxes and covers and supports when attached to a surface required to be painted or to a prefinished surface.

2. Miscellaneous ferrous metal surfaces.

3.02 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article unless specifically noted in the Contract Documents to be painted.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical Equipment:
   1. Do not field paint electrical equipment except where painting is specifically stated elsewhere in these Contract Documents, or where the equipment is subject to a corrosive environment and is specifically noted to be painted.

D. When not in a corrosive or highly corrosive area, do not paint the following hidden surfaces:
   1. Concrete and/or concrete masonry units.
   2. Conduit.
   4. Note: Manufacturer’s standard coatings, if any, may remain.

E. Other Items:
   1. Stainless steel surfaces except:
      a. Piping where specifically noted to be painted.
      b. Banding as required to identify piping.
   2. Code labels and equipment identification and rating plates.
   3. Concealed surfaces of precolored masonry.
   4. Steel deck, unless specifically noted to be painted in the Contract Documents.
   5. Contact surfaces of friction-type connections.
   6. Metal soffit.
   7. Galvanized steel items, unless specifically noted to be painted.
3.03 SCHEDULE OF ITEMS TO BE PAINTED AND PAINTING SYSTEMS

A. Concrete:

B. Concrete Masonry Units:
   1. Exterior smooth faced standard (heavy) weight: SYSTEM #12.
   2. Exterior rough faced standard (heavy) weight: SYSTEM #9.

C. Steel:
   1. Structural:
      a. Exposed portion of pile plate, piling between the pile plates and concrete collars or ground line, angle bracing and any other non-galvanized exposed steel: SYSTEM #19.
      b. Immersion or non-immersion surfaces subject to highly corrosive environment: SYSTEM #16.
      c. Non-immersion surfaces subject to corrosive environment: SYSTEM #1.
      d. All other surfaces (non-corrosive dry environment): SYSTEM #5.

D. Miscellaneous ferrous metals (non-corrosive dry environment): SYSTEM #1.
   1. Not for coating galvanized steel and products with approved factory finishes.

E. Galvanized Metals:
   1. Field touch-up where top coat is required: SYSTEM #2, prime and first finish coat only.
      a. Prime paint only the damaged area.
   2. Assembled galvanized steel items: SYSTEM #2.
   3. Field touch-up of galvanized surfaces not requiring a finish top coat: SYSTEM #18.
      a. Paint only damaged areas.

F. Non-ferrous metals (except galvanized): SYSTEM #2.
   1. Includes copper, brass, aluminum and aluminum flashing specifically indicated on the Drawings to be painted.
G. Electrical Conduit:
   2. PVC coated: SYSTEM #2.

H. Aluminum buried in concrete, between dissimilar metals and dissimilar materials: SYSTEM #10.

I. Aluminum colored pipe thread touch-up, and aluminum colored finish where top coat is not required: SYSTEM #11.
   1. Not for coating aluminum material.

3.04 PREPARATION

A. General:
   1. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.
      a. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
         1) Provide temporary dehumidification equipment properly sized to maintain humidity levels required by paint manufacturer.
         2) Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 hours basis.
         3) No exhaust gases (no direct fired heating equipment) shall be allowed to vent into the space being painted or any adjacent space.
   2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
      a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
   3. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
4. Adhere to manufacturer's recoat time surface preparation requirements.
   a. Paint manufacturer's recommended recoat time surface preparation requirements will be strictly enforced.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
   1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations.
   2. Complete fabrication, welding or burning before beginning surface preparation.
      a. Chip or grind off flux, spatter, slag or other laminations left from welding.
      b. Remove mill scale.
      c. Grind smooth rough welds and other sharp projections.
   3. Solvent or water jet and detergent clean in accordance with SSPC SP 1 or SSPC SP 12/NACE No. 5 all surfaces scheduled to receive additional SSPC surface preparation.
   4. Surfaces subject to corrosive or highly corrosive environment and all surfaces subject to immersion service:
      a. Near-white blast clean in accordance with SSPC SP 10/NACE No. 2.
   5. All interior and exterior structural steel not included in corrosive, highly corrosive or immersion service surfaces:
      a. Minimum commercial blast clean in accordance with SSPC SP 6/NACE No. 3.
   6. Steel surfaces scheduled to receive SYSTEM #16:
      a. White metal blast clean in accordance with SSPC SP 5/NACE No. 1.
      b. Provide 2-1/2 to 3 mil anchor profile.
7. All fusion bonded epoxy coated surfaces identified to be field painted:
   a. Remove all traces of gloss finish by sanding or by abrasive brush blasting.
   b. Clean surface after removing gloss finish to remove sanding or blasting residue.

8. Restore surface of field welds and adjacent areas to original surface preparation.

E. Hollow Metal:
   1. Clean in accordance with SSPC SP 1 or SSPC SP 12/NACE No. 5 and in accordance with hollow metal manufacturer.

F. Galvanized Metal:
   1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 7/NACE No. 4 to uniform profiled surface removing zinc oxide and other foreign contaminants.
      a. Provide 1 mil profile.

G. Concrete:
   1. Cure for minimum of 28 days.
   2. Verify that concrete surfaces have been cleaned and that voids have been patched in accordance with Specification Section 34 80 41 or Section 34 80 43.
      a. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
   3. Mechanically abrade concrete surfaces in accordance with ASTM D4259 as recommended by coating manufacturer.
   4. Abrasive blast concrete surfaces in accordance with SSPC SP 13/NACE No. 6 to provide profile recommended by coatings manufacturer.
   5. Test pH of surface to be painted in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer’s required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
      b. Retest pH until acceptable results are obtained.
6. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
   a. Test moisture content of surface to be coated in accordance with ASTM D4263.
   b. After remedial measures have been taken to lower or raise moisture content, retest surface until acceptable results are obtained.

H. Concrete Masonry Unit:

1. Cure for minimum of 28 days.
2. Remove all mortar spatters and protrusions.
3. Verify that concrete unit masonry surfaces have been cleaned in accordance with ASTM D4261.
4. Test pH of surface to be painted in accordance with ASTM D4262.
   a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable limits.
   b. Retest pH until acceptable results are obtained.
5. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
   a. Test moisture content of surface to be coated in accordance with ASTM D4263.
   b. After remedial measures have been taken to lower or raise moisture content, retest surface until acceptable range is obtained.

I. Preparation by Abrasive Blasting:

1. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
   a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
2. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
3. Perform additional blasting and cleaning as required to achieve surface preparation required.
   a. Prior to painting, reblast surfaces allowed to set overnight and surfaces that show rust bloom.
   b. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be reinspected prior to paint application.

4. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.

5. Provide compressed air for blasting that is free of water and oil.
   a. Provide accessible separators and traps.

6. Confine blast abrasives to area being blasted.
   a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
   b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.

7. Protect nameplates and other items that may be damaged from blasting.

8. Reblast surfaces not meeting requirements of these Specifications.

9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.

10. Properly dispose of blasting material contaminated with debris from blasting operation not scheduled to be reused.

J. All Non-Ferrous Surfaces Except Galvanized Steel:

1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.05 APPLICATION

A. General:

1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
   a. Application equipment must be inspected and approved in writing by coating manufacturer.
   b. Hollow metal shall be spray applied only.
2. Temperature and weather conditions:
   a. Do not paint surfaces when surface temperature is below 50° F unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
   b. Avoid painting surfaces exposed to hot sun.
   c. Do not paint on damp surfaces.

3. Immediately after surface has been inspected apply structural steel and miscellaneous steel prime coat in the factory.
   a. Finish coats shall be applied in the field.
   b. Prime coat referred to here is prime coat as indicated in this Specification.
      1) Structural steel and miscellaneous steel prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.

4. Provide complete coverage to mil thickness specified.
   a. Thickness specified is dry mil thickness.
   b. All paint systems are "to cover." In situations of discrepancy between manufacturer’s square footage coverage rates and mil thickness, mil thickness requirements govern.
   c. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.

5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.

6. Apply materials under adequate illumination.

7. Evenly spread to provide full, smooth coverage.

8. Work each application of material into corners, crevices, joints, and other difficult to work areas.

9. Avoid degradation and contamination of blasted surfaces and avoid intercoat contamination.
   a. Clean contaminated surfaces before applying next coat.

10. Smooth out runs or sags immediately, or remove and recoat entire surface.
11. Allow preceding coats to dry before recoating.
   a. Recoat within time limits specified by coating manufacturer.
   b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.

12. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.

13. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.

14. Backroll concrete and masonry surfaces with a roller if paint coatings are spray applied.

B. Prime Coat Application:

1. Prime all surfaces indicated to be painted.
   a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.

2. Ensure field-applied coatings are compatible with factory-applied coatings.
   a. Employ services of coating manufacturer's qualified technical representative.
      1) Certify through material data sheets.
      2) Perform test patch.
   b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
   c. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in Article 2.02 - MATERIALS, Paragraph D. Paint Systems.
      1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to SCRRRA.

3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.

4. Apply zinc-rich primers while under continuous agitation.
5. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.

6. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.

7. Touch up damaged primer coats prior to applying finish coats.
   a. Restore primed surface equal to surface before damage.

C. Finish Coat Application:
   1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
      a. Prepare damaged area in accordance with Article 3.04 - PREPARATION.

3.06 GRAFFITI-RESISTANT COATING

A. All accessible concrete, masonry, and porous surfaces from finish grade to 10 feet above finish grade shall be painted with clear graffiti-resistant coating.

B. Surface Preparation:
   1. Prepare surfaces to receive the coating in compliance with the coating manufacturer's written instructions.

C. Coating Preparations:
   1. Only open containers required for use.
      a. Mix coating in designated areas.
      b. If mixing areas are not designated, Contractor must propose mix area to the Engineer for Engineer's acceptance.
   2. Thoroughly stir and agitate coating to uniformly smooth consistency suitable for proper application.
   3. Do not reduce, change or use materials except in compliance with manufacturers written instructions.
   4. In all cases, prepare and handle coating to prevent deterioration and inclusion of foreign matter.
D. Application:

1. Test coating on each type of substrate for compatibility and desired results before proceeding further.

2. Apply coating only under conditions that will ensure finishes free from blemishes and defects.

3. Remove spillage and splatters on adjacent surfaces so as not to damage the surface being cleaned.

4. Completed work shall match approved samples, as determined by the Engineer.

3.07 FIELD QUALITY CONTROL

A. Contractor to provide protection for surfaces painted with epoxy coatings to prevent chalking.

1. Surfaces showing chalking will not be accepted regardless of condition of paint film.

B. Maintain Daily Records:

1. Provide the following information during application of each coat of paint applied:

   a. Date, starting time, end time, and all breaks taken by painters.

   b. For exterior painting:

      1) Sky condition.

      2) Wind speed and direction.

   c. Air temperature.

   d. Relative humidity.

   e. Moisture content of substrate prior to each coat.

   f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.

   g. Surface temperature of substrate to which paint is being applied.
2. Provide the following information daily for the paint manufacturer's recommended curing period:
   a. Start date of cure period for each item or area.
   b. For exterior painting:
      1) Sky conditions.
      2) Wind speed and direction.
   c. Air temperature, each day.
   d. Relative humidity, each day.
   e. Dew point temperature, each day.
   f. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.

3. Format for daily record to be computer generated.

C. Measure wet coating with wet film thickness gages.

D. Measure coating dry film thickness in accordance with SSPC PA 2 using Mikrotest gage calibrated against NBS "Certified Coating Thickness Calibration Standards."
   1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

E. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

F. Measure substrate humidity with humidity gage specifically designed for such.

3.08 CLEANING

A. Clean paint spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION