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## DESIGN DIRECTIVE

**To:** Distribution

**From:** Erik Stoothoff, P.E. *EJS*  
Chief Engineer

**Date:** August 27, 2021

**RE:** Bonded Insulated Joints for Transit Trackwork

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When insulated joints are required by design, they shall be bonded insulated joints designed in accordance with the MBTA Maintenance of Way Book of Standard Trackwork Plans, Drawing No. 325. Transit track projects shall incorporate the following minimum bonded insulated joints requirements into the project specifications for track construction. All submittals shall be approved by the MBTA E&M Maintenance of Way and Signals & Communications Maintenance departments. In the event that conditions warrant deviation from this directive, a design waiver signed by the Chief Engineer is required.

### MINIMUM REQUIREMENTS

#### 1. SUBMITTALS

- A. Submit complete bonded insulated joint plug rail shop drawings.
- B. Submit calibration certificates for all testing equipment used to perform tests on insulated joints.
- C. Submit working drawings showing the proposed method and equipment for handling and installing bonded insulated joint plug rails, locations of field welds in CWR, and lengths of bonded insulated joint plug rails for review and acceptance prior to the commencement of work.

#### 2. QUALITY ASSURANCE

- A. Electrical Resistance Test: Rail joints shall be assembled in accordance with manufacturer's recommendations and supported on non-conducting material. With 500 VDC applied to the rail across the insulated joint for a duration of three minutes, the current flow through the joint should be measured to the nearest 0.01 microampere. The minimum acceptance resistance for the test shall be 10 megaohms. With 50 VAC applied to the rail across the insulated joint for duration of three minutes, the impedance shall be measured with an accuracy of plus or minus 2%. This test shall be repeated three times: once with a frequency in the range from 20 Hz to 100 Hz; again with a frequency in the

range from 200 Hz to 1 kHz; and again in the range from 2 kHz to 10 kHz. The minimum acceptable impedance for any of these tests shall be 10,000 ohms.

- B. Rolling Load Test: The rail joint used in the Electrical Resistance Test shall be mounted on a 33-inch stroke rolling load test machine supported on 36-inch centers with the joint centered between the supports. Apply a 44,400-pound wheel load on the rail for 2,000,000 cycles and measure and record, to the nearest 0.001-inch, the deflection of the rail at the centerline of the joint. The deflection at the ends of the joint shall also be measured at every 500,000 cycles. The wheel path shall travel from a point 6 inches from the center of the joint to a point 9 inches outside the opposite end of the joint. The total range of deflection of the joint shall not exceed 0.065 inches during the test and the joint shall show no evidence of failure by bending. The electrical resistance test shall then be repeated, and the test results shall be within the acceptance criteria specified.
- C. Longitudinal Compression Test: The assembled joint shall be sawn in half where the rails are joined together in a manner which will prevent overheating or damage to the epoxy bond. The cut shall be perpendicular to the centerline of the top of rail. A fixture or device shall be used so that the reaction at the sawn ends occurs only on the face of the joint bars when a load is applied to the centroid of the rail at the opposite end. The load shall be applied in increments of 25,000 pounds, maintaining each load increment until the deflection of the rail stops before increasing the load. The load shall be increased to 650,000 pounds, and a record of loading and differential movement of the rail measure to 0.00 inches shall be measured for each increment. The joint shall show no indication of slippage prior to reaching a compressive load of 650,000 pounds and the movement shall be less than 0.125-inch in any direction. The relative position of the rail and joint bar shall be within 0.031-inch of its original value when the load is removed.
- D. The Contractor shall submit certification and test results that an insulated joint has passed the qualification testing specified herein.

### 3. PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Bonded insulated joint plug rails shall be protected from damage throughout delivery, storage, and handling. Damage to bonded insulated joint plug rails resulting from improper handling by the Contractor shall require the Contractor to replace all damaged material with new material at no additional cost to the Contract.

### 4. MATERIALS

- A. Provide bonded insulated joints shop fabricated into 115-pound RE plug rails for installation into CWR. Plug rails shall be 39 feet in length and as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 325.
- B. All rail furnished for plug rails shall be head hardened.

- C. Fabricate joint bars from quenched carbon steel conforming to AREMA Manual, Chapter 4, Part 3, Section 3.4.
- D. Provide 36-inch full-face contact joint bars conforming to the configuration of the rail, as required. Joint bars shall be smooth and straight. The inside face of the joint bars shall have insulating material pre-bonded and shall be smooth with no branding or stamping.
- E. Fabrication Tolerances:
  - 1. Finishing Height. Within plus or minus 1/64 inch of the dimension shown on the approved shop drawings.
  - 2. Straightness. All portions of the joint bars adjacent to the rail shall be straight within a tolerance of plus or minus 1/32 inch, measured with a 36-inch straight edge.
  - 3. Length. Within plus or minus 1/8 inch of the dimension shown on the approved shop drawings.
- F. Insulating Materials:
  - 4. All insulating materials shall be of high pressure, laminated design, wrapped in Kevlar, impervious to oil, grease and water, and shall have electrical resistance characteristics equal to or greater than fiber insulation meeting the requirements of the AREMA, Signal Manual Part 8.5.3. End posts shall project 1/4 inch, plus or minus 1/16 inch below base of rail and shall be 3/8 inch thick.
  - 5. Bonded insulated joint to be cemented together with adhesive and bolted together with six high strength, 1-inch diameter bolts. Provide bolts, nuts and flat washers conforming to the chemical and mechanical requirements of ASTM Designation A490, Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints, and having Class 2A and 2B thread fit. Provide a positive means for maintaining the tension in the bolts through in-service vibrations by a prevailing lock nut complying with Industrial Fastener Institute Standard IFI-100 and IFI-101, or approved equivalent. Locate and size the bolt holes in conformance to the drilling as specified in AREMA Specifications. Flat washers, if required, shall be hardened A-325 or A-490 and tempered carbon steel.

## 5. INSTALLATION

- A. The Contractor shall install bonded insulated joint plug rails at the required locations as shown on the Contract Drawings.
- B. Bonded insulated joints shall be installed as suspended joints and existing cross ties shall be re-spaced as necessary to achieve this requirement.
- C. Joints created by installation of the insulated joint plug rails shall be field welded by an approved thermite process.
- D. Bonded insulated joints at rail fasteners shall be secured with the modified “e” clips.