1. **SCOPE**

1.1 This specification covers the components that make up the 85 lb. composite electrical contact rail used on the MBTA’s rapid transit system. The components covered under this specification include the 85 lb. ASCE steel base contact rail, 85 lb. ASCE steel base rail clad with aluminum extrusions on each side of the web, contact rail inclines fabricated from 85 lb. ASCE steel base rail, aluminum splice plates, and pin and collar fasteners.

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7. Additional Information for Potential Bidders
3. REFERENCED DOCUMENTS

3.1 The following documents make up a part of this specification as referenced herein, the current revision at the time of Invitation for Bid shall apply.

3.1.1 Industrial Standards:

American Railway Engineers & Maintenance-of-Way Association (AREMA),
Manual for Railway Engineering,
- Chapter 4, Part 2
- Plan No. 100, Section M11
Department of Defense
- MIL-P-23469- General Specification for Pin-Rivet, Grooved and Collar,
  Grooved Pin-Rivet, Swage-Locked (Lockpin)
American Welding Society (AWS)
- AWS D15.2- Recommended Practices for the Welding of Rails and Related Rail Components for Use by Rail Vehicles.
American Society of Mechanical Engineers (ASME)
- ASME B1.1 - Unified Inch Screw Threads (UN & UNR Thread Form)

4. DETAILED REQUIREMENTS

4.1 85 LB.- STEEL BASE CONTACT RAIL

4.1.1 All steel base rail shall be new 85 lb. ASCE sections conforming to the following requirements.

4.1.2 The steel base rail shall be manufactured in accordance with AREMA Chapter 4, Part 2, Section 2.1 - "Specification for Steel Rails" except as amended herein.

4.1.3 The chemical composition shall be in conformance with AISI 1012 steel as modified below:

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<thead>
<tr>
<th>Constituents</th>
<th>Percent by Weight</th>
</tr>
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<tbody>
<tr>
<td>Carbon</td>
<td>0.10-0.15</td>
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<td>Manganese</td>
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<tr>
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<tr>
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<td>0.20-0.40</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.15-0.30 (max.)</td>
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</tbody>
</table>
4.1.4 Physical Properties:  
- Tensile Strength: 43,000 psi, min.  
- Yield Strength: 24,000 psi, min.  
- Elongation in 2": 25%, min.

4.1.5 The contact rail shall have a minimum Brinell Hardness of 90.

4.1.6 Cross sectional dimensions of the rail shall be in accordance with MBTA Drawing 85C-RAIL, TRACK STANDARD, 85C THIRD RAIL.

4.1.7 Each length of rail shall be thirty-nine feet (39'-0") when measured at a temperature of 80 °F with a tolerance of ±7/16 of an inch. Shorts may be used to manufacture inclines.

4.1.8 The drilling of the rail shall be in accordance with section 4.5 of this specification. The rail ends shall NOT be chamfered.

4.1.9 The contact rails shall NOT be branded and stamped during manufacture per AREMA requirements. The rail webs shall be smooth to ensure proper contact of the aluminum extrusion specified in section 4.3 of this specification.

4.1.10 The contact rail shall NOT be subject to non-destructive ultrasonic inspection for internal defects. The interior condition of the head, web and base shall be defined as in the AREMA Chapter 4, Part 2, Section 2.1, Article 2.1.9 as a guideline. Macro-etch evaluation shall allow for an additional 15 percent of deviation from conditions as described herein. Sample macro-etch, frequency, preparation and evaluation methods shall comply with AREMA requirements.

4.2 RAIL WORKMANSHIP AND MATERIAL QUALITY

4.2.1 End Straightness- For all end deviations, i.e., upsweep, droop and side sweep, shall not exceed 0.040 of an inch in the end three feet (3'-0").

4.2.2 Surface Imperfections -Singular or localized surface imperfections shall not exceed 1/8 of an inch deep in the head and web and 3/16 of an inch deep in the base. Surface imperfections of any size occurring in a number deemed excessive by the MBTA Engineer, or appointed representative, shall be considered unacceptable. Contact rail with unacceptable surface imperfections shall be rejected.

4.2.3 The contact rails shall be straight in line and surface in both planes without waves and kinks except as otherwise noted and without twists exceeding 1.5 degrees in thirty-nine feet (39'-0") or 0.090 of an inch (ref: AREMA Chapter 4, Part 2, Section 2.1.13). The supports for the rails in straightening presses shall have flat surface and be free of hollows, bends, or crooks and shall be spaced not less than 60 inches. Auxiliary supports at less than 60 inches may be used for straightening the ends of the rails.
4.2.4 All contact rails shall be sawed at the ends. A variation of not more than 1/32 of an inch from squareness shall be allowed. Rough burrs shall be removed and made smooth.

4.3 **85 LB. ALUMINUM CLAD CONTACT RAIL**

4.3.1 **FABRICATION OF ALUMINUM CLAD CONTACT RAIL** - The aluminum clad contact rail shall consist of 85 lb. ASCE steel base rail (refer to section 4.1 herein) with aluminum extrusions (refer to section 4.3.2 herein) on both sides of the web, fastened at intervals by means of 5/8 inch diameter compression type pin rivets with flanged collars manufactured by Huck International Inc. or MBTA approved equal (refer to section 4.11 herein), at intervals not to exceed 18 inches, flat or spring washers shall NOT be used. The heads of the fasteners shall be on the gage side of the contact rail assembly.

4.3.1.1 Prior to final assembly of the aluminum to the steel base rail, the surfaces of the steel base rail and aluminum extrusions shall be cleaned of all grease, oil, chips and matter of any description. The steel base rail shall then be sand or shot blasted to remove all mill scale. The aluminum extrusions shall be free of aluminum oxide prior to application of oxide inhibiting paste.

4.3.1.2 Following the cleaning process, all interface surfaces shall be coated with an oxide inhibiting paste. The paste shall be applied on the web of the rail as well as on the aluminum. Average thickness of the paste applied shall be ten thousandths of an inch (1/1000 inch).

4.3.1.3 Immediately after cleaning and the application of the oxide inhibitor paste, the aluminum extrusions shall be affixed permanently to the steel rail with the specified fasteners. The fasteners shall also be coated with the oxide inhibitor. The fastening system shall maintain the aluminum extrusions and the steel rail in intimate, stable electrical contact over a temperature range of -25°F to 220°F. Thermal expansion or contraction within this temperature range shall not exceed yield points of any of the contact rail components.

Any excess oxide paste not intended for inhibiting protection and remaining on the aluminum cladding and rail surfaces after fabrication shall be cleaned by scraping and/or wiping prior to final inspection and shipment.

4.3.1.4 Both ends of the contact rail shall be trimmed or ground, when necessary, so that aluminum extrusions and the steel rail are flush, square and of even length. The aluminum extrusions shall not extend beyond the end of the steel rail.
4.3.1.5 Each piece of contact rail shall have the Contractor's identification and date of manufacture (month and year) permanently die stamped on the outer identification face of the aluminum extrusion (outside of the splice joint area). In addition, the manufacturer shall legibly mark the face of the aluminum extrusion with a unique sequence number, and a distinctive code identifying what third of the batch the assembly came from (e.g.: 1/3, 2/3, & 3/3). Sequence number and code shall be marked using a paint stick or permanent ink marker that contrasts with the aluminum surface.

4.3.1.6 Special Contact Rail Adjoining Inclines: The first section of contact rail adjoining inclines shall have one end specially prepared for the attachment of the incline. When facing the gauge side of the contact rail assembly, left hand specials shall have the specially prepared end of the left end of the special contact rail assembly. Right hand specials shall have the specially prepared end of the right end of the special contact rail assembly.

4.3.2 ALUMINUM EXTRUSION

4.3.2.1 The aluminum extrusions shall be fabricated from an aluminum alloy that meets the Aluminum Association alloy and hardness designated 6101-T6.

4.3.2.2 The extrusions shall exhibit high mechanical strength and electrical conductivity.

4.3.2.3 The extrusions shall be formed to permit intimate contact with the web or with the fillets of the head and the base of the steel rail to assure a positive electrical connection for current flow between the steel and the aluminum, and minimize ingress of water into the interface between the aluminum and the steel rail.

4.3.2.4 The extrusions shall be formed to permit rail tongs to grasp the head of the steel rail for lifting the contact rail without damage to the aluminum extrusion.

4.3.2.5 The extrusions shall be formed to provide for future installation of a heater tape.

4.3.2.6 The extrusions shall be of adequate cross sectional area to meet the electrical requirements of section 4.6 herein.

4.3.2.7 At each end of the contact rails, the extrusions external contour on the outer face shall be machined to mate with the internal contour of the aluminum splice plate (refer to section 4.3.3 herein) to assure proper alignment of the contact rail, both vertically and horizontally.

4.3.3 ALUMINUM SPLICE JOINT

4.3.3.1 Aluminum splice joints shall be used to join sections of aluminum clad contact rail.
4.3.3.2 One complete splice joint assembly shall consist of two (2) aluminum splice bar extrusions measuring 22 inches long, fabricated to the same requirements specified in section 4.3.2 herein, four (4) special galvanized Huck pin with flanged collars, Part Number C50LR-DBR28-88G or approved equal (refer to section 4.11 herein), and an oxide inhibiting compound.

4.3.3.2.1 Flat or spring washers shall NOT be used.

4.3.3.3 The splice joint extrusion shall meet the dimensions and tolerances shown on MBTA drawing 85C-RAIL, TRACK STANDARD, 85C THIRD RAIL. The internal contours of the splice joint extrusion shall conform to the external contours of the aluminum rail extrusion. Tolerances shall be sufficiently close to assure proper alignment of the contact rail, both vertically and horizontally, and assure an ample contact surface for the transfer of electrical current across the interface, with an overall assembled resistance no greater than that specified in section 4.6 herein. The splice plates shall be predrilled to match the two predrilled holes in the end of the contact rail. The splice plates shall be furnished separately with all specified fasteners, for field assembly by others.

4.3.3.4 The splice joint shall be so designed that when completely assembled, it shall withstand a 25,000 lb. longitudinal tension force across the joint without exceeding the yield point of any of the components.

4.4 CONTACT RAIL INCLINES

4.4.1 The contact rail inclines shall be fabricated from 85 lb. ASCE base rail and the ends drilled. Inclines dimensions per MBTA drawing 85C END.

4.4.2 Cutting and welding of the contact rail inclines shall be in accordance with AWS D15.2 Recommended Practices for the Welding of Rails and Related Rail Components for Use by Rail Vehicles, and shall be performed by certified welders who have been requalified within twelve months of performing this work. Contractor shall submit the welder certifications and welding procedures to the MBTA for approval prior to commencing fabrication.

4.5 REQUIREMENTS FOR DRILLING AND PUNCHING

4.5.1 The holes for splice bolts on both ends of the 85 lb. ASCE steel base rail and on both ends of the contact rail shall be drilled.
4.5.2 The holes in the steel base rail and aluminum extrusions except the splice holes at each end, may be drilled or punched. If the Contractor elects to punch these holes, the following conditions shall apply:

A. The Contractor shall demonstrate that the punching operation shall have no detrimental effect on aluminum to base rail contact resistance and shall cause no detrimental deformation of the aluminum at the interface with the base rail.

B. The Contractor shall demonstrate that the punching operation will cause no detrimental deformation which will interfere with proper functioning of any part of the cladding system nor encourage ingress of water.

4.5.3 The splice plate holes shall be drilled, NOT punched in the contact rail sections after assembly of the aluminum extrusions to the base rail, to assure exact registration of the holes in the aluminum extrusions and the steel base rail.

4.5.4 The splice holes at each end of each length of the base rail may be drilled prior to assembly only under the following conditions:

A. The Contractor shall demonstrate that his process is sufficiently accurate to assure exact registration of the holes in the aluminum extrusions and the base rail.

B. After assembly of each length of contact rail, the Contractor shall prove exact registration of the holes by pushing through each hole a mandrel whose diameter is no more than 0.005 of an inch smaller than the hole diameter and certifies that this test was successful on all rail sections shipped.

C. The Contractor shall further certify that all rail sections form a tight joint between base rail sections upon installation.

D. The Contractor shall be responsible for any extra costs incurred by Installing Contractors as a result of uneven end faces of rail sections and as a result of variations in hole locations for splice plates.

4.5.4.1 Punching of aluminum extrusion and base rail together as one operation shall NOT be permitted.

4.6 ELECTRICAL CHARACTERISTICS

4.6.1 The aluminum clad contact rail shall be a low resistance conductor with a resistance not greater than 0.002 Ω per thousand feet at 20°C. The current distribution between the steel and the aluminum shall be inversely proportional to their respective resistivities. The aluminum splice assembly, without the bonds, shall have an electrical efficiency of not less than 100% when compared by resistance to an equal length of contact rail.
4.6.2 The steel base rail shall have a resistance not greater than 0.0115 Ω per thousand feet at 20°C. Both base and clad rail shall be capable of withstanding 5000 amperes DC continuously without damage with a resulting rise in temperature not exceeding 40°C above 30°C ambient temperature in still air.

4.7 CONTACT RAIL RESISTANCE AND THERMAL CYCLE TEST

4.7.1 The Contractor shall devise a test procedure acceptable to the MBTA and shall test prior to shipment one section of the contact rail 120 inches in length to demonstrate adequacy and stability of electrical contact between the aluminum and the steel rail using the following criteria.

A. At a constant room temperature of 68°F ± 1°F, the resistance of the contact section shall be accurately measured per method described in 4.8.1.

B. The Contractor shall lower the rail temperature to -25°F ± 2°F and measure the resistance of the contact rail section. The rail temperature shall then be raised to 220°F ± 5°F and the resistance again measured. This procedure shall be repeated for a minimum of 12 cycles.

4.7.2 Any indication that continued cycling might cause the sample to fail to meet the resistivity and current distribution requirements of section 4.6 of this specification, shall be sufficient cause to continue the cycle test until the MBTA is satisfied that further cycling will not cause the sample to become noncompliant. The MBTA reserves the right to reject any design that when adjusted for temperature or current distribution, fails to maintain the resistivity specified in section 4.6 herein, after the extended cycle testing.

4.7.3 From the entire order of rail produced under this specification, the MBTA shall select three (3) pieces of thirty-nine (39) foot lengths of contact rail at random, one (1) piece from the first one-third (1/3) of the rail produced and one (1) piece from the final one-third (1/3) of the rail produced, for testing of the contact rail and joints to assure that the desired electrical characteristics are maintained during the entire production run. Each rail shall be cut up as follows for testing and inspection.

A. Two (2) pieces, 60 inches, to be joined together with a joint assembly for test and one (1) piece, 120 inches continuous length. The balance of each rail shall be disassembled for examination.
4.8 SPLICE RESISTANCE AND THERMAL CYCLE TEST

4.8.1 The Contractor shall devise a test procedure (acceptable to MBTA) and shall test prior to shipment two sections of contact rail, each 60 inches in length, which are joined together by splice plates as in a standard splice using the following criteria:

A. At a constant room temperature of 68°F ± 1°F, the resistance across the joint shall be measured and compared to an equal length of un-spliced contact rail. The resistance across the spliced rail shall not exceed the resistance of the equal length of un-spliced contact rail at the same temperature.

B. For all measurements, the resistance measuring probe shall be attached at a distance of 60 inches (30 inches from center in both directions) on the steel portion of the 120 inch length of spliced or un-spliced contact rail. A 100 amp current source (micro-ohm meter) shall be injected for 5 seconds on the steel portion of the contact rail at a distance of 120 inches. Attachments to steel rail can be by brazed or welded nibs, or by clamps. Method chosen must provide positive connection to steel rail.

C. Temperature measurements shall be monitored and recorded by three thermocouples evenly distributed and attached to the rail head. In addition, the ambient temperature of the environmental chamber shall be accurately monitored and recorded.

D. After measuring the resistance across the spliced rail at ambient temperature, the rail temperature shall be lowered to -25°F ± 2°F. And the resistance across the jointed rail measured. The rail temperature shall then be raised to 220°F ± 5°F and the resistance across the joint measured again. Electrical readings shall be made after the temperature has become stabilized (temperature within plus or minus tolerance for 2 hours).

4.8.2 This procedure shall be repeated for a minimum of 12 cycles. Any indication that continued cycling might cause the resistance of the joint to exceed the resistance of an equal length of un-spliced contact rail at the corresponding temperature shall cause the cycle test to be continued until MBTA is satisfied that further cycling shall not cause the resistance of the joint to exceed the specified value.

4.8.3 If at any time the resistance of the spliced rail exceeds the resistance of an equal length of un-spliced rail at the corresponding temperature, the joint design shall be rejected.
4.9 INSPECTION AND TEST RESULTS

4.9.1 Disassembled samples shall be inspected to confirm that the aluminum extrusion and steel rail was properly cleaned before assembled, properly coated with the approved oxide inhibiting paste, and that interface surfaces of the fastening system components were also properly coated with paste.

A. If the sample of rail taken from each one-third (1/3) of the production run of contact rail fails to pass testing for the required electrical characteristics and/or confirmation that the aluminum extrusion and steel rail were not properly cleaned and coated with oxide inhibiting paste before assembly, then two (2) additional 39 foot rail from the same one-third (1/3) of the production run as the failing sample shall be randomly selected and similarly tested and inspected. If these additional rails pass, the entire one-third (1/3) of the production run shall be considered as pass. If either of these two (2) additional rails fail, the entire one-third (1/3) of the production run shall be rejected unless the Contractor can provide proof to the MBTA that the remainder of the production run is acceptable.

B. MBTA representatives shall have free entry at all times to all parts of the manufacturer's work which concern the manufacture of the rails. The manufacturer shall afford the MBTA representatives, without charge, all reasonable facilities to permit them to determine that the rail is being furnished in accordance with this specification. Tests and inspections shall be made at the place of manufacture prior to shipment.

4.9.1.1 Measuring and Testing Equipment

A. All measuring and testing equipment and devices used in the manufacture of the rail shall be properly controlled and maintained. At prescribed intervals, or prior to use, the equipment shall be calibrated and adjusted against certified equipment having a known relationship to nationally recognized standards.

B. The Contractor shall maintain all certification and calibration documents and shall make them available to the MBTA upon request. The documents shall include, but be not limited to, equipment type, identification number, location, frequency of certification or check, description of check method, acceptance criteria and action to take when results are unsatisfactory.

C. All measuring and testing equipment shall be identified with a tag, sticker or other suitable indicator to show the most recent calibration and date, and also, the date of the next scheduled recalibration or test.
D. Any rail found to be tested with equipment that is not certified nor properly calibrated, shall be retested with certified equipment at the Contractor's expense to the satisfaction of the MBTA.

4.9.2.1 Five (5) certified copies of all tests including the original data calculations and interpretation of results shall be furnished to the MBTA. The Contractor shall notify the MBTA at least three (3) weeks in advance of the time and location of the specified tests. The Contractor shall permit representatives of the MBTA to observe the tests as outlined in this specification.

4.9.2.2 No material shall be shipped until inspection at the plant indicates that all material has been properly assembled and all tests have been satisfactorily completed to the satisfaction of the MBTA.

4.10 FASTENERS

4.10.1 COMPRESSION TYPE PIN RIVETS AND FLANGED COLLARS- The compression type pin rivets and flanged collars used in the fabrication of the aluminum clad rail and those provided to the MBTA for field splicing of the aluminum clad rails shall meet the requirements specified in the Department of Defense standard MIL-P-23469 General Specification for Pin-Rivet, Grooved and Collar, Grooved Pin-Rivet, Swage-Locked (Lockpin) for M23469/4 type II class 5 pins (round head, carbon steel; zinc plated) and M23469/1 type II class 5 collars (flanged, carbon steel zinc plated). Selection of the pin and collar grip range shall be such that when installed, the pin does not protrude beyond 3/8 inch of the top of the flanged collar.

4.10.1.1 A carbon steel round head compression type pin and flanged collar fastening system that has been approved by the MBTA for this application is the C50L fastening system (C50LR-DBR28-88G) manufactured by Huck International Inc.

4.10.1.2 A compression type pin used for splicing the aluminum clad rail system with the aluminum splice joint specified in 4.3.3, is specially manufactured for the MBTA, by Huck International Inc. a division of ALCOA, under their part number C50LR-BR28-88G.
1. **SCOPE**

1.1 This specification covers the components that make up the 85 lb. composite electrical contact rail used on the MBTA’s rapid transit system. The components covered under this specification include the 85 lb. ASCE steel base contact rail, 85 lb. ASCE steel base rail clad with aluminum extrusions on each side of the web, contact rail inclines fabricated from 85 lb. ASCE steel base rail, aluminum splice plates, and pin and collar fasteners.

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4. **DETAILED REQUIREMENTS**

4.1 **85 LB.-STEEL BASE CONTACT-RAIL**

4.1.1 All steel base rail shall be new 85 lb. ASCE sections conforming to the following requirements.

4.1.2 The steel base rail shall be manufactured in accordance with AREMA Chapter 4, Part 2, Section 2.1 -"Specification for Steel Rails" except as amended herein.

4.1.3 The chemical composition shall be in conformance with AISI 1012 steel as modified below:

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<tr>
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4.1.7 Each length of rail shall be thirty-nine feet (39'-0") when measured at a temperature of 80 °F with a tolerance of ±7/16 of an inch. Shorts may be used to manufacture inclines.  

4.1.8 The drilling of the rail shall be in accordance with section 4.5 of this specification. The rail ends shall NOT be chamfered.  

4.1.9 The contact rails shall NOT be branded and stamped during manufacture per AREMA requirements. The rail webs shall be smooth to ensure proper contact of the aluminum extrusion specified in section 4.3 of this specification.  

4.1.10 The contact rail shall NOT be subject to non-destructive ultrasonic inspection for internal defects. The interior condition of the head, web and base shall be defined as in the AREMA Chapter 4, Part 2, Section 2.1, Article 2.1.9 as a guideline. Macro-etch evaluation shall allow for an additional 15 percent of deviation from conditions as described herein. Sample macro-etch, frequency, preparation and evaluation methods shall comply with AREMA requirements.  

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4.2.1 End Straightness- For all end deviations, i.e., upsweep, droop and side sweep, shall not exceed 0.040 of an inch in the end three feet (3'-0").  

4.2.2 Surface Imperfections -Singular or localized surface imperfections shall not exceed 1/8 of an inch deep in the head and web and 3/16 of an inch deep in the base. Surface imperfections of any size occurring in a number deemed excessive by the MBTA Engineer, or appointed representative, shall be considered unacceptable. Contact rail with unacceptable surface imperfections shall be rejected.  

4.2.3 The contact rails shall be straight in line and surface in both planes without waves and kinks except as otherwise noted and without twists exceeding 1.5 degrees in thirty-nine feet (39'-0") or 0.090 of an inch (ref: AREMA Chapter 4, Part 2, Section 2.1.13). The supports for the rails in straightening presses shall have flat surface and be free of hollows, bends, or crooks and shall be spaced not less than 60 inches. Auxiliary supports at less than 60 inches may be used for straightening the ends of the rails.
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4.3 **85 LB. ALUMINUM CLAD CONTACT RAIL**

4.3.1 **FABRICATION OF ALUMINUM CLAD CONTACT RAIL** - The aluminum clad contact rail shall consist of 85 lb. ASCE steel base rail (refer to section 4.1 herein) with aluminum extrusions (refer to section 4.3.2 herein) on both sides of the web, fastened at intervals by means of 5/8 inch diameter compression type pin rivets with flanged collars manufactured by Huck International Inc. or MBTA approved equal (refer to section 4.11 herein), at intervals not to exceed 18 inches, flat or spring washers shall NOT be used. The heads of the fasteners shall be on the gage side of the contact rail assembly.

4.3.1.1 Prior to final assembly of the aluminum to the steel base rail, the surfaces of the steel base rail and aluminum extrusions shall be cleaned of all grease, oil, chips and matter of any description. The steel base rail shall then be sand or shot blasted to remove all mill scale. The aluminum extrusions shall be free of aluminum oxide prior to application of oxide inhibiting paste.

4.3.1.2 Following the cleaning process, all interface surfaces shall be coated with an oxide inhibiting paste. The paste shall be applied on the web of the rail as well as on the aluminum. Average thickness of the paste applied shall be ten thousandths of an inch (1/1000 inch).

4.3.1.3 Immediately after cleaning and the application of the oxide inhibitor paste, the aluminum extrusions shall be affixed permanently to the steel rail with the specified fasteners. The fasteners shall also be coated with the oxide inhibitor. The fastening system shall maintain the aluminum extrusions and the steel rail in intimate, stable electrical contact over a temperature range of -25°F to 220°F. Thermal expansion or contraction within this temperature range shall not exceed yield points of any of the contact rail components.

Any excess oxide paste not intended for inhibiting protection and remaining on the aluminum cladding and rail surfaces after fabrication shall be cleaned by scraping and/or wiping prior to final inspection and shipment.

4.3.1.4 Both ends of the contact rail shall be trimmed or ground, when necessary, so that aluminum extrusions and the steel rail are flush, square and of even length. The aluminum extrusions shall not extend beyond the end of the steel rail.
4.3.1.5 Each piece of contact rail shall have the Contractor's identification and date of manufacture (month and year) permanently die stamped on the outer identification face of the aluminum extrusion (outside of the splice joint area). In addition, the manufacturer shall legibly mark the face of the aluminum extrusion with a unique sequence number, and a distinctive code identifying what third of the batch the assembly came from (e.g.: 1/3, 2/3, & 3/3). Sequence number and code shall be marked using a paint stick or permanent ink marker that contrasts with the aluminum surface.

4.3.1.6 Special Contact Rail Adjoining Inclines: The first section of contact rail adjoining inclines shall have one end specially prepared for the attachment of the incline. When facing the gauge side of the contact rail assembly, left hand specials shall have the specially prepared end of the left end of the special contact rail assembly. Right hand specials shall have the specially prepared end of the right end of the special contact rail assembly.

4.3.2 ALUMINUM EXTRUSION

4.3.2.1 The aluminum extrusions shall be fabricated from an aluminum alloy that meets the Aluminum Association alloy and hardness designated 6101-T6.

4.3.2.2 The extrusions shall exhibit high mechanical strength and electrical conductivity.

4.3.2.3 The extrusions shall be formed to permit intimate contact with the web or with the fillets of the head and the base of the steel rail to assure a positive electrical connection for current flow between the steel and the aluminum, and minimize ingress of water into the interface between the aluminum and the steel rail.

4.3.2.4 The extrusions shall be formed to permit rail tongs to grasp the head of the steel rail for lifting the contact rail without damage to the aluminum extrusion

4.3.2.5 The extrusions shall be formed to provide for future installation of a heater tape.

4.3.2.6 The extrusions shall be of adequate cross sectional area to meet the electrical requirements of section 4.6 herein.

4.3.2.7 At each end of the contact rails, the extrusions external contour on the outer face shall be machined to mate with the internal contour of the aluminum splice plate (refer to section 4.3.3 herein) to assure proper alignment of the contact rail, both vertically and horizontally.

4.3.3 ALUMINUM SPLICE JOINT

4.3.3.1 Aluminum splice joints shall be used to join sections of aluminum clad contact rail.
4.3.3.2 One complete splice joint assembly shall consist of two (2) aluminum splice bar extrusions measuring 22 inches long, fabricated to the same requirements specified in section 4.3.2 herein, four (4) special galvanized Huck pin with flanged collars, Part Number C50LR-DBR28-88G or approved equal (refer to section 4.11 herein), and an oxide inhibiting compound.

4.3.3.2.1 Flat or spring washers shall NOT be used.

4.3.3.3 The splice joint extrusion shall meet the dimensions and tolerances shown on MBTA drawing 85C-RAIL, TRACK STANDARD, 85C THIRD RAIL. The internal contours of the splice joint extrusion shall conform to the external contours of the aluminum rail extrusion. Tolerances shall be sufficiently close to assure proper alignment of the contact rail, both vertically and horizontally, and assure ample contact surface for the transfer of electrical current across the interface, with an overall assembled resistance no greater than that specified in section 4.6 herein. The splice plates shall be predrilled to match the two predrilled holes in the end of the contact rail. The splice plates shall be furnished separately with all specified fasteners, for field assembly by others.

4.3.3.4 The splice joint shall be so designed that when completely assembled, it shall withstand a 25,000 lb. longitudinal tension force across the joint without exceeding the yield point of any of the components.

4.4 CONTACT RAIL INCLINES

4.4.1 The contact rail inclines shall be fabricated from 85 lb. ASCE base rail and the ends drilled. Inclines dimensions per MBTA drawing 85C END.

4.4.2 Cutting and welding of the contact rail inclines shall be in accordance with AWS D15.2 Recommended Practices for the Welding of Rails and Related Rail Components for Use by Rail Vehicles, and shall be performed by certified welders who have been requalified within twelve months of performing this work. Contractor shall submit the welder certifications and welding procedures to the MBTA for approval prior to commencing fabrication.

4.5 REQUIREMENTS FOR DRILLING AND PUNCHING

4.5.1 The holes for splice bolts on both ends of the 85 lb. ASCE steel base rail and on both ends of the contact rail shall be drilled.
4.5.2 The holes in the steel base rail and aluminum extrusions except the splice holes at each end, may be drilled or punched. If the Contractor elects to punch these holes, the following conditions shall apply:

A. The Contractor shall demonstrate that the punching operation shall have no detrimental effect on aluminum to base rail contact resistance and shall cause no detrimental deformation of the aluminum at the interface with the base rail.

B. The Contractor shall demonstrate that the punching operation will cause no detrimental deformation which will interfere with proper functioning of any part of the cladding system nor encourage ingress of water.

4.5.3 The splice plate holes shall be drilled, NOT punched in the contact rail sections after assembly of the aluminum extrusions to the base rail, to assure exact registration of the holes in the aluminum extrusions and the steel base rail.

4.5.4 The splice holes at each end of each length of the base rail may be drilled prior to assembly only under the following conditions:

A. The Contractor shall demonstrate that his process is sufficiently accurate to assure exact registration of the holes in the aluminum extrusions and the base rail.

B. After assembly of each length of contact rail, the Contractor shall prove exact registration of the holes by pushing through each hole a mandrel whose diameter is no more than 0.005 of an inch smaller than the hole diameter and certifies that this test was successful on all rail sections shipped.

C. The Contractor shall further certify that all rail sections form a tight joint between base rail sections upon installation.

D. The Contractor shall be responsible for any extra costs incurred by installing Contractors as a result of uneven end faces of rail sections and as a result of variations in hole locations for splice plates.

4.5.4.1 Punching of aluminum extrusion and base rail together as one operation shall NOT be permitted.

4.6 ELECTRICAL CHARACTERISTICS

4.6.1 The aluminum clad contact rail shall be a low resistance conductor with a resistance not greater than 0.002 Ω per thousand feet at 20°C. The current distribution between the steel and the aluminum shall be inversely proportional to their respective resistivities. The aluminum splice assembly, without the bonds, shall have an electrical efficiency of not less than 100% when compared by resistance to an equal length of contact rail.
4.6.2 The steel base rail shall have a resistance not greater than 0.0115 \( \Omega \) per thousand feet at 20°C. Both base and clad rail shall be capable of withstanding 5000 amperes DC continuously without damage with a resulting rise in temperature not exceeding 40°C above 30°C ambient temperature in still air.

4.7 CONTACT RAIL RESISTANCE AND THERMAL CYCLE TEST

4.7.1 The Contractor shall devise a test procedure acceptable to the MBTA and shall test prior to shipment one section of the contact rail120 inches in length to demonstrate adequacy and stability of electrical contact between the aluminum and the steel rail using the following criteria.

A. At a constant room temperature of 68°F ± 1°F, the resistance of the contact section shall be accurately measured per method described in 4.8.1.

B. The Contractor shall lower the rail temperature to -25°F ± 2°F and measure the resistance of the contact rail section. The rail temperature shall then be raised to 220°F ± 5°F and the resistance again measured. This procedure shall be repeated for a minimum of 12 cycles.

4.7.2 Any indication that continued cycling might cause the sample to fail to meet the resistivity and current distribution requirements of section 4.6 of this specification, shall be sufficient cause to continue the cycle test until the MBTA is satisfied that further cycling will not cause the sample to become noncompliant. The MBTA reserves the right to reject any design that when adjusted for temperature or current distribution, fails to maintain the resistivity specified in section 4.6 herein, after the extended cycle testing.

4.7.3 From the entire order of rail produced under this specification, the MBTA shall select three (3) pieces of thirty-nine (39) foot lengths of contact rail at random, one (1) piece from the first one-third (1/3) of the rail produced and one (1) piece from the final one-third (1/3) of the rail produced, for testing of the contact rail and joints to assure that the desired electrical characteristics are maintained during the entire production run. Each rail shall be cut up as follows for testing and inspection.

A. Two (2) pieces, 60 inches, to be joined together with a joint assembly for test and one (1) piece, 120 inches continuous length. The balance of each rail shall be disassembled for examination.
4.8 SPLICE RESISTANCE AND THERMAL CYCLE TEST

4.8.1 The Contractor shall devise a test procedure (acceptable to MBTA) and shall test prior to shipment two sections of contact rail, each 60 inches in length, which are joined together by splice plates as in a standard splice using the following criteria:

A. At a constant room temperature of 68°F ± 1°F, the resistance across the joint shall be measured and compared to an equal length of un-spliced contact rail. The resistance across the spliced rail shall not exceed the resistance of the equal length of un-spliced contact rail at the same temperature.

B. For all measurements, the resistance measuring probe shall be attached at a distance of 60 inches (30 inches from center in both directions) on the steel portion of the 120 inch length of spliced or un-spliced contact rail. A 100 amp current source (micro-ohm meter) shall be injected for 5 seconds on the steel portion of the contact rail at a distance of 120 inches. Attachments to steel rail can be by brazed or welded nibs, or by clamps. Method chosen must provide positive connection to steel rail.

C. Temperature measurements shall be monitored and recorded by three thermocouples evenly distributed and attached to the rail head. In addition, the ambient temperature of the environmental chamber shall be accurately monitored and recorded.

D. After measuring the resistance across the spliced rail at ambient temperature, the rail temperature shall be lowered to -25°F ± 2°F. And the resistance across the jointed rail measured. The rail temperature shall then be raised to 220°F ± 5°F and the resistance across the joint measured again. Electrical readings shall be made after the temperature has become stabilized (temperature within plus or minus tolerance for 2 hours).

4.8.2 This procedure shall be repeated for a minimum of 12 cycles. Any indication that continued cycling might cause the resistance of the joint to exceed the resistance of an equal length of un-spliced contact rail at the corresponding temperature shall cause the cycle test to be continued until MBTA is satisfied that further cycling shall not cause the resistance of the joint to exceed the specified value.

4.8.3 If at any time the resistance of the spliced rail exceeds the resistance of an equal length of un-spliced rail at the corresponding temperature, the joint design shall be rejected.
4.9 INSPECTION AND TEST RESULTS

4.9.1 Disassembled samples shall be inspected to confirm that the aluminum extrusion and steel rail was properly cleaned before assembled, properly coated with the approved oxide inhibiting paste, and that interface surfaces of the fastening system components were also properly coated with paste.

A. If the sample of rail taken from each one-third (1/3) of the production run of contact rail fails to pass testing for the required electrical characteristics and/or confirmation that the aluminum extrusion and steel rail were not properly cleaned and coated with oxide inhibiting paste before assembly, then two (2) additional 39 foot rail from the same one-third (1/3) of the production run as the failing sample shall be randomly selected and similarly tested and inspected. If these additional rails pass, the entire one-third (1/3) of the production run shall be considered as pass. If either of these two (2) additional rails fail, the entire one-third (1/3) of the production run shall be rejected unless the Contractor can provide proof to the MBTA that the remainder of the production run is acceptable.

B. MBTA representatives shall have free entry at all times to all parts of the manufacturer's work which concern the manufacture of the rails. The manufacturer shall afford the MBTA representatives, without charge, all reasonable facilities to permit them to determine that the rail is being furnished in accordance with this specification. Tests and inspections shall be made at the place of manufacture prior to shipment.

4.9.1.1 Measuring and Testing Equipment

A. All measuring and testing equipment and devices used in the manufacture of the rail shall be properly controlled and maintained. At prescribed intervals, or prior to use, the equipment shall be calibrated and adjusted against certified equipment having a known relationship to nationally recognized standards.

B. The Contractor shall maintain all certification and calibration documents and shall make them available to the MBTA upon request. The documents shall include, but be not limited to, equipment type, identification number, location, frequency of certification or check, description of check method, acceptance criteria and action to take when results are unsatisfactory.

C. All measuring and testing equipment shall be identified with a tag, sticker or other suitable indicator to show the most recent calibration and date, and also, the date of the next scheduled recalibration or test.
D. Any rail found to be tested with equipment that is not certified nor properly calibrated, shall be retested with certified equipment at the Contractor's expense to the satisfaction of the MBTA.

4.9.2.1 Five (5) certified copies of all tests including the original data calculations and interpretation of results shall be furnished to the MBTA. The Contractor shall notify the MBTA at least three (3) weeks in advance of the time and location of the specified tests. The Contractor shall permit representatives of the MBTA to observe the tests as outlined in this specification.

4.9.2.2 No material shall be shipped until inspection at the plant indicates that all material has been properly assembled and all tests have been satisfactorily completed to the satisfaction of the MBTA.

4.10 FASTENERS

4.10.1 COMPRESSION TYPE PIN RIVETS AND FLANGED COLLARS- The compression type pin rivets and flanged collars used in the fabrication of the aluminum clad rail and those provided to the MBTA for field splicing of the aluminum clad rails shall meet the requirements specified in the Department of Defense standard MIL-P-23469 General Specification for Pin-Rivet, Grooved and Collar, Grooved Pin-Rivet, Swage-Locked (Lockpin) for M23469/4 type II class 5 pins (round head, carbon steel, zinc plated) and M23469/1 type II class 5 collars (flanged, carbon steel zinc plated). Selection of the pin and collar grip range shall be such that when installed, the pin does not protrude beyond 3/8 inch of the top of the flanged collar.

4.10.1.1 A carbon steel round head compression type pin and flanged collar fastening system that has been approved by the MBTA for this application is the C50L fastening system (C50LR-DBR28-88G) manufactured by Huck International Inc.

4.10.1.2 A compression type pin used for splicing the aluminum clad rail system with the aluminum splice joint specified in 4.3.3, is specially manufactured for the MBTA, by Huck International Inc. a division of ALCOA, under their part number C50LR-BR28-88G.
5. **GENERAL REQUIREMENTS**

5.1 The Contractor shall submit to the MBTA all test records and test reports. The requirements shall in no way relieve the Contractor of the responsibility for determining the suitability or adequacy of the materials and procedures.

5.2 The Contractor shall describe methods of producing, fabricating, testing and shipping of steel base and aluminum clad contact rails. The operation Plan shall identify the Contractor's key personnel and inspectors assigned to this project.

5.3 Within 2 weeks after the Notice to Proceed, the Contractor shall submit detailed drawings to the MBTA for approval of all contact rail sections and assemblies. Once all detailed drawings have been approved, the Contractor shall provide to the MBTA one complete electronic record set of the approved drawings.

5.4 Please submit hard copies of all plans for approval to:

   **Gary Donaghey**
   **MBTA MOW Engineer**
   **Building 2**
   **21 Arlington Ave**
   **Charlestown MA 02129**

5.5 Please email copies of all plans for approval to: GDonaghey@mbta.com

5.5 The Contractor shall furnish to the MBTA mill chemical composition analysis and physical property test reports as required by this specification for all contact rail furnished.

6. **DELIVERY**

6.1 Material shall be delivered via road to:
   **MBTA Charlestown Rail shop**
   **21 Arlington Ave**
   **Charlestown, Massachusetts 02129**
   Notification of delivery is to be made two (2) business days in advance to Judy Sullivan, (617) 222-5290.
   To be accepted, all material specified herein shall conform to these Specifications in every respect. Material is at the supplier's risk until accepted at the specified delivery site by an authorized representative of the MBTA. Material rejected for non-compliance with these Specifications will be returned to the supplier wholly at the supplier's expense.
7. ADDITIONAL INFORMATION FOR POTENTIAL BIDDERS

7.1 Bidders requiring additional information shall contact the Procurement Administrator listed on the front page of the Contract Document. Potential Bidders requiring additional information from a person or persons listed in the Special Conditions must route their requests through the Procurement Administrator. Potential Bidders who contact any Authority personnel other than the Procurement Administrator will be considered in violation of the provisions of the Contract Document.
Standard 85C Composite Rail

Contact Rail

Section A-A

- 5.3/16
- 2 1/16
- 2 1/32
- 3.9/16
- 2 5/16
- 2 1/8
- 3/4" or approved equal (Per)

ASTM B317 Type B Splice Bar

4 - 7/8" dia. Hook Bolts and Collars

2 - 5/8" Splice Bar

Bill of Materials: Splice Assembly

Hook bolted as shown

Full assembled 39.0" 85C

Bill of Materials