ECP CABLE-BASED BRAKE SYSTEM CABLE, CONNECTORS, AND JUNCTION BOXES—PERFORMANCE SPECIFICATION

Standard
S-4210

Version 1.1

Adopted: 1999; Revised 2002

1.0 PURPOSE

To establish the qualification test procedure for an electric brake train line connector, cable, and end-of-car junction box. The qualification test procedure is intended to verify that the designed components have high reliability, will withstand harsh environmental conditions, and have a minimum of an 8-year operating life.

2.0 SCOPE

This standard applies to ECP brake system power and signal cable intended for use on interchange freight cars and locomotives equipped with AAR-approved ECP brake systems.

2.1 Referenced Documents

ASTM B-8	Standard Specification for Concentric Stranded Copper for Electrical Conductors
ASTM B-33	Tinned Soft or Annealed Copper Wires
ASTM B-172	Standard Specification for Rope Lay Stranded Copper Conductors Having Bunch-Stranded Members for Electrical Conductors
ASTM B298	Standard Specification for Silver-Coated Soft or Annealed Copper Wires
ASTM B355	Standard Specification for Nickel-Coated Soft or Annealed Copper Wires
ASTM D4566	Standard Test Methods for Electrical Properties of Insulation and Jackets for Telecommunications Wire and Cable
CSA C22.2 No. 0.3-92	Test Methods for Electrical Wires and Cables
ICEA S-66-524	Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA T-22-294	Test Procedures for Extended Time Testing for Wire and Cable Insulation for Service in Wet Locations
ICEA T-28-562	Hot Creep
MIL-C-13777	Cables, Special Purpose, Electrical
MIL-C-24643	General Specification for Cables and Cords, Electrical, Low Smoke, for Shipboard Use
MIL-F-13927A	Electrical, Fungus Resistance Tests
UL 1581	Reference Standard for Electrical Wires, Cables, and Flexible Cords
MIL-STD-1344A	Test Methods for Electrical Connectors
MIL-STD-202F	Sand and Dust
NEMA 4	Plugs, Receptacles, and Cable Connectors
AAR *MSRP* S-4006	Performance Testing of Air Brake End Hose Supports
AAR *MSRP* S-471	Brake Pipe Restriction Test

2.2 Temperature Tolerances

All test temperatures stated in this document have a +2 °C tolerance.

3.0 GENERAL SERVICE INTER-CAR CABLE

3.1 General Characteristics

The cable shall consist of two #8 AWG conductors and a shield. The conductors must have a minimum of two twists per foot. The cable shall be rated to 600 V and a have a characteristic impedance of 50 Ω ±10%. The operating temperature range is –46 °C to 66 °C. The overall outside diameter must be 0.700 in. minimum to 0.750 in. maximum. The dimensional tolerance for any given cable outside diameter is ±0.025 in.

3.2 Conductors

3.2.1 Conductors shall be #8 AWG and consist of annealed tinned copper per ASTM B-33 and shall have rope stranding sufficient to meet flexibility requirements.

3.2.2 The cross-sectional area of the conductors shall be not less than 98% of the cross-sectional area specified. Resistance values shall be in accordance with ICEA S-66-524.

3.3 Insulation—General Requirements

3.3.1 The insulated wire and cable shall be suitable for electrically controlled freight brake systems for the railroad industry, and all requirements and parameters specified herein must be met.

3.3.2 The insulation shall be tight fitting over the stranded conductors and be clean stripping without damage to strands.

3.3.3 The insulation shall be fungus resistant and shall be tested in accordance with MIL-F-13927A. After 30 days, the material must remain fungus inert.

3.3.4 The insulation thickness at any point shall be not less than 90% of the nominal average wall thickness to meet the requirements of paragraph 3.1.

3.3.5 The insulation shall have a continuous temperature rating of 90 °C as determined by test temperatures used and temperature-related parameters established herein. This cable is not certified for use within locomotive engine rooms. If cable is routed through locomotive engine rooms, the cable insulation must be rated at 125 °C.

3.4 Insulation—Properties and Tests

Unless otherwise stated, all testing in paragraph 3.4 will be done on samples removed from completed cable.

3.4.1 Unaged Tensile and Elongation

When tested in accordance with ICEA S-66-524, the minimum values measured on insulation samples that have been removed from the conductor shall be as follows:

Tensile Strength	Elongation
750 psi	200%

3.4.2 Aged Tensile and Elongation

When tested as above, insulation that has been aged in a circulating air oven for 168 hours at 121 °C shall have the following minimum values:

Tensile Strength	Elongation
75% of unaged value	75% of unaged value

3.4.3 Dielectric Proof Test

Insulated conductors shall withstand test voltages as specified in ICEA S-66-524 for 5 minutes after a 6-hour immersion in water. The water shall be normal tap water (conductive) and at room temperature. The sample shall be wound in a coil with a diameter 20 times the insulated diameter. The required test voltage shall be 6.0 kVac (rms) and 18 kVdc.

3.4.4 Impulse Dielectric or Spark Test

100% of all wire made to this specification shall withstand either the dielectric proof test (paragraph 3.4.3) or a 100% impulse dielectric test of 18.0 kV.

3.4.5 Insulation Resistance in 25 °C Water

The center 20-ft section of a 25-ft length of insulated conductor shall be immersed in normal tap water that is maintained at 25 °C for 24 hours. Following this conditioning period, the sample shall pass the dielectric proof test (paragraph 3.4.3), and the insulation resistance shall be measured per ICEA procedures. The minimum acceptable insulation resistance value shall be calculated using the insulation resistance constant value *K* at 10,000. Resistance is calculated as follows:

$$R = K \times \log\left(\frac{OD}{ID}\right)$$

where

K = insulation resistance constant = 10,000

3.4.6 Long-Term Insulation Resistance

A sample shall be immersed for 26 weeks in a water bath maintained at 90 °C and with 600 V rms applied continuously. Insulation resistance measurements shall be taken weekly. The minimum acceptable insulation resistance value shall be not less than 10 MΩ based on 1000 ft after the 26-week test.

3.4.7 Long-Term Direct Current Service Test

Insulation shall be evaluated for suitability for service in wet locations using the test specimens and procedure described in ICEA T-22-294. The water temperature shall be maintained at 90 °C with a continuous test voltage of 600 Vdc negative applied to the conductor. The test shall be conducted for a minimum of 16 weeks. The minimum acceptable measured dissipation factor (power factor) shall not exceed 0.05.

3.4.8 Cold Bend Test

3.4.8.1 The cold bend test shall be run per UL-1581, paragraph 580, except the conditioning temperatures shall be –46 °C, the sample shall not be removed from the cooling chamber when performing the test, and the mandrel size, tension weights, and number of turns shall be as indicated below:

Mandrel size	5/8 in.
Tension weights	10 lb
Number of turns	6

3.4.8.2 The insulation shall not exhibit visible cracks, and after bending, must pass the dielectric proof test (paragraph 3.4.3).

3.4.9 Cold Impact Test

The cold impact test shall be run per UL-1581, paragraph 590, or per CSA C22.2 No.0.3-92, except the conditioning and actual test temperature shall be –45 °C.

3.4.10 Cold Shock (Unwind) Test

3.4.10.1 A sample shall be prepared with a length not to exceed 2 ft. The mandrel, tension weights, and number of turns shall be as indicated below:

Mandrel Size	5/8 in.
Tension Weights	10 lb
Number of Turns	6

3.4.10.2 The assembly shall then be conditioned at –46 °C for a minimum of 1 hour. While still at –46 °C, the sample shall be unwrapped within the cold box at a speed of 15 rpm. The insulation shall not exhibit visible cracks and shall pass the dielectric proof test (paragraph 3.4.3).

3.4.11 Insulation Shrinkage Test

A 24-in. sample of completed wire shall be cut flush and straight at both ends. The sample shall be placed in a loose coil and conditioned in a circulating air oven for 168 hours at 121 °C. Following the conditioning period, the sample shall be removed from the oven and allowed to cool for at least 1 hour at room temperature. The sample shall then be wrapped around a 3/8-in. mandrel for six turns, and insulation shrinkage at both ends shall be measured. The maximum allowable shrinkage shall be 1/8 in. on either end.

3.4.12 Aged Insulation Resistance

A 25-ft sample coil of finished insulated wire shall be conditioned in a circulating air oven for 168 hours at 121 °C. Following the conditioning period, the sample shall be removed from the oven and allowed to cool at room temperature for at least 1 hour. The sample must pass the dielectric proof test (paragraph 3.4.3) and shall pass the insulation resistance test in 25 °C water test (paragraph 3.4.5).

3.4.13 Aged Cold Shock Test

A sample of finished insulated wire shall be conditioned in a circulating air oven for 168 hours at 121 °C. The sample shall then pass the cold shock (unwind) test (paragraph 3.4.10).

3.4.14 Penetration Test

A sample of the insulated conductor, jig, and plunger/chisel shall be conditioned for a minimum of 1 hour at 121 °C. The plunger/chisel shall consist of a metal plunger having a sharp chisel knife edge, (approximately 0.001-in. radius or less), with a provision for adding weight. The plunger/chisel shall be positioned in a suitable metal jig with a 750-g total weight. The sample shall be placed under, and at a right angle to, the plunger/chisel cutting edge. After preconditioning, the weighted plunger shall be gently lowered into contact with the cable surface. A 6-V buzzer circuit between the conductor and the plunger/chisel shall be used to indicate a test failure. The weighted plunger/chisel shall then be raised, the wire sample rotated 120° in the radial plane, and the test repeated. The process shall be repeated a third time, again rotating the sample 120° in the radial plane. The sample shall not indicate a short circuit in 10 minutes or less in any of the three trials.

3.4.15 Crush Resistance Test

Finished samples of wire shall be placed between two flat steel plates (2 1/4 in. × 2 1/4 in. × 1/4 in.), with corners and edges rounded to 1/8-in. radius, mounted parallel and in a horizontal plane. The plates shall be closed at a rate of 0.2 in. per minute until the conductor is grounded to either of the steel plates as indicated by a low-voltage (6 Vdc) buzzer circuit. The crush resistance shall be the average of 10 trials, all conducted at room temperature. The insulated conductor shall exhibit a crush resistance of at least 2,500 lb.

3.4.16 Hot Creep Test

Test according to ICEA T-28-562 at 175 °C. At the conclusion of the test, the samples shall have the following minimum values:

Max. Elongation	Set
100%	5%

3.5 Fillers

Cables shall include fillers as necessary to ensure that the finished cable diameter is as specified in paragraph 3.1. Fillers used must be nonwicking and compatible with other cable components.

3.6 Binder

Cables may include a binder over the cable core, under the overall jacket. Additional binders may be used as necessary dependent on cable construction and manufacturing techniques. Binders used must be compatible with other components.

3.7 Shield

The shield shall be designed to significantly reduce the effects of electromagnetic and radio frequency interference (EMI/RFI) by shielding the cable core with a tinned copper braided shield. To ensure that the shield can effectively reduce EMI/RFI, the maximum shield resistance shall be 3 Ω/1000 ft (10 mΩ per meter) at 25 °C. Minimum shield coverage is 85%.

3.8 Shield Drain Wire

The cable shall incorporate a drain wire for the shield. The drain wire shall be a minimum wire size of #22 AWG.

3.9 Jacket

A heavy duty, flexible, low temperature material such as polychloroprene shall be used, shall have reinforcing served thread(s) located at approximately the middle of the jacket wall, and shall meet the following requirements.

3.9.1 Unaged Tensile and Elongation

When tested in accordance with ICEA S-66-524, the minimum values measured on jacket samples that have been removed from the cable shall be as follows:

Tensile Strength	Elongation	Modulus at 200%	Set
1,850 psi	200%	850 psi	20% maximum

3.9.2 Aged Tensile and Elongation

When tested as described in paragraph 3.9.1, a jacket that has been aged in a circulation air oven for 168 hours at 100 °C shall retain the following minimum values:

Tensile Strength	Elongation
80% retention of unaged value	80% retention of unaged value

3.9.3 Oil-Aged Tensile and Elongation

When tested as described in paragraph 3.9.1, a jacket that has been aged in ASTM #2 oil or equivalent for 18 hours at 120 °C shall retain the following minimum values:

Tensile Strength	Elongation
80% retention of unaged value	80% retention of unaged value

3.9.4 Sunlight Exposure

Test according to UL 1581, section 1200, Sunlight Resistance. After 300 hours of exposure, the cable shall retain the following minimum values:

Tensile Strength	Elongation
85% retention of unaged value	85% retention of unaged value

3.10 Completed Cable

Unless otherwise stated, all tests in paragraph 3.10 will be done on samples of completed cable.

3.10.1 Abrasion Resistance Test

Test according to MIL-C-24643, except the test apparatus shall be set up to test between the overall shield and the abrasion tool. The sample shall be in contact with the wheel for a minimum of 90°. The weight used shall be 2 lb. The minimum acceptable cycles is 500.

3.10.2 Cold Bend Test

The cold bend test shall be run according to paragraph 3.4.8, except that the mandrel size shall be 10 times the finished jacketed diameter.

3.10.3 Cold Impact Test

The cold impact test shall be run according to paragraph 3.4.9.

3.10.4 Flex Test

Test a sample of completed cable according to MIL-C-13777. The bend test shall use a 5/8-in.-diameter mandrel and a 50-lb weight. At the conclusion of the test, subject the cable to an insulation resistance test (paragraph 3.4.5).

3.10.5 Crush Test

Test according to paragraph 3.4.15.

3.10.6 Cable Identification

The cable shall be marked throughout its length at regular intervals on the surface of the jacket or on a marker tape pulled in directly under the jacket with the following information:

AAR Specification Number
Manufacturers Name
2/C 8 AWG, 600 V
Unique Part Number
Quarter and Year of Manufacture

3.10.7 Final Electrical Testing

3.10.7.1 Dielectric Proof Test

Measure the dielectric withstand voltage from conductor to conductor and conductor to shield. The required test voltage shall be 6.0 kVac (rms) and 18 kVdc.

3.10.7.2 Insulation Resistance

Measure insulation resistance conductor to conductor and conductor to shield at 500 Vdc. The minimum insulation resistance shall be as follows:

$$R = K \times \log\left(\frac{OD}{ID}\right)$$

where

K = insulation resistance constant = 10,000

3.10.7.3 Conductor Direct Current Resistance

Minimum requirements shall be as described in paragraph 3.2.

3.10.7.4 Shield Resistance

Shield resistance shall be measured in accordance to ICEA S-66-524, Section 2. Minimum requirements shall be as described in paragraph 3.7.

3.10.7.5 Cable Characteristic Impedance

Test according to ASTM D4566, Method 2, Option 1, at 250 KHz.

4.0 GENERAL SERVICE UNDER CAR CABLE

This cable shall meet all requirements of section 3.0 with the following exceptions.

4.1 A metal conduit, flexible conduit, cable armor, or equivalent that can accommodate this cable may be used at the option of the end user.

5.0 HIGH TEMPERATURE UNDER CAR CABLE

This cable is intended to be thermally insulated. A cable that meets all of the requirements of paragraph 3.0 but with insulation rated at higher than 90 °C may be required to meet the individual requirements of the railroad or car owner depending on car design and thaw shed characteristics.

6.0 INTERCAR CONNECTORS

6.1 Electrical Qualification Test Procedure

6.1.1 Insulation Resistance Test

With a mated pair of connector assemblies, measure the insulation resistance conductor to conductor and conductor to shield at 500 Vdc. The measurements shall be made after the test voltage has been applied for 1 minute. The minimum insulation resistance shall be as follows:

$$R = K \times \log\left(\frac{OD}{ID}\right)$$

where

K = insulation resistance constant = 10,000

Note that since the shield is terminated at the intercar connector, the conductor-to-shield insulation resistance measurement shall be made separately for each member of the pair.

6.1.2 High Potential Test

With a mated pair of connector assemblies, conduct a high potential test with a test voltage of 2200 Vdc. The test voltage shall be held for a minimum of 1 minute. During the test, the maximum allowable current leakage is 5 mA.

6.1.3 Wet Mate Test

Immerse two connector assemblies in tap water for a minimum of 5 minutes. Remove connectors from water and immediately mate the connector pair in the horizontal position. Perform an insulation resistance test (paragraph 6.1.1).

6.2 Environmental

6.2.1 Salt Spray

Subject two unmated connectors to a salt spray per MIL-STD-1344A, Method 1001.1, Test Condition A. Mate connectors, perform a voltage drop test (paragraph 7.2.2) at room temperature, and perform an insulation resistance test (paragraph 6.1.1).

6.2.2 Humidity/Temperature Test

Test a pair of mated connectors per MIL-STD-1344, Method 1002, Test Procedure Type III. Immediately after completion of the last test cycle, conduct a voltage drop test (paragraph 7.2.2) at room temperature and an insulation resistance test (paragraph 6.1.1). Then remove the connectors from the test chamber, un-mate, and let sit at ambient conditions. Within 1 to 2 hours after removing the connectors from the chamber, re-mate and repeat the voltage drop test (7.2.2) and the insulation resistance test (paragraph 6.1.1).

7.0 CONNECTOR ASSEMBLIES

A connector assembly is defined as an intercar connector, cable, and car body junction box plug connector as described in paragraph 8.1. The assembly may or may not be integrated with an air hose coupling.

7.1 Strength Member

7.1.1 The strength member will be external to the cable. It must support the connector such that the lowest point of the connector is 4 in. to 5 in. above the top of rail with the car fully loaded. The strength member must bear the pull-apart forces.

7.1.2 The strength member must be capable of sustaining 200% of the maximum pull-apart force.

7.1.3 The forces exerted during any disconnection must not result in damage to the portion of the connector on the car body junction box or to the permanent wiring on the car, even in the event of complete lanyard failure.

7.2 Mechanical Qualification Test Procedures

7.2.1 Definitions

For purposes of this specification, the following definitions pertain:

Table 7.1 General definitions

7.2.1.1 Un-mate	Uncoupling the connectors manually without uncoupling the cars themselves.
7.2.1.2 Pull-apart	Uncoupling the connectors by uncoupling the cars. Pull-apart forces must be through the external strength member.

7.2.2 Voltage Drop Test

Mated pair, 20 A current, made at 66 °C, room temperature, and –46 °C. Apply current and measure the voltage drop. The maximum allowable post-test voltage drop of the assembled pair is 400 mV from end sill connector to end sill connector.

7.2.3 Durability

Run a pair of connector assemblies through 1000 mate/pull-apart cycles. Measure voltage drop before the test and after cycle numbers 1, 250, 500, 750, and 1000. Voltage drop must not exceed the criteria defined in paragraph 7.2.2 performed at room temperature. Perform an insulation resistance test (paragraph 6.1.1) as a final test. The pull-apart forces must be measured at cycle numbers 250, 500, 750, and 1000. The pull-apart forces must meet the test criteria in paragraph 7.2.5. The mate forces must never increase to the point that a normal human being has difficulty coupling the connectors.

7.2.4 Connector assemblies must be capable of being coupled/uncoupled under current industry railcar couplers, i.e., rotary dump, bottom shelf, angle cock and traveling hose carrier designs. Coupling/uncoupling must be performed with a metal support strap meeting appropriate sections of the current AAR *Manual of Standards and Recommended Practices*, Standard S-4006.

7.2.5 Pull-Apart Forces

Measure the pull-apart forces at room temperature, at –46 °C, and at 66 °C. Rate of separation should be at least 2 ft/sec (1.4 mph) along the centerline of the cable assemblies. Connector assemblies should be soaked at the high and low test temperatures for a sufficient time to ensure that the connector assemblies reach the required temperature. The pull-apart forces must be no less than 30 lb and no more than 500 lb. Strength member shall be attached to the eyebolt of the intercar connector. The eyebolt must be capable of withstanding 500 lb force when pulled at a strength member angle of 0° and 45° from the centerline of the eyebolt. Bending of the eyebolt is not a cause for failure. The mate forces must never increase to the point that a normal human being has difficulty coupling the connectors. It must never be necessary to use tools to couple connectors.

7.2.6 Thermal Shock

Cycle mated connectors between –46 °C and 66 °C for five cycles. Connectors must be soaked at –46 °C in one temperature chamber then immediately placed in a second temperature chamber and soaked at 66 °C. Connectors must be soaked at the high and low test temperatures for a sufficient time to ensure that the connectors reach the required temperature. One cycle is defined as raising the temperature of the connector, then lowering the temperature in the reverse order. Examine for physical damage, loose fasteners, etc. At the completion of the five cycles, after reaching room temperature, conduct an insulation resistance test (paragraph 6.1.1), a wet mate test (paragraph 6.1.3), and a pull-apart test (paragraph 7.2.5, at room temperature only).

7.2.7 Physical Shock

Measure the initial mate/unmate forces (see paragraph 7.2.5) and voltage drop. Suspend a mated pair of connectors from a 12-ft-long rope or cable so that the connection point of the connector assemblies just comes in contact with a concrete wall or steel beam. Pull the connectors out from the wall until the connection point is raised 6 ft, then release. The mated connector assemblies should impact while in a vertical position. The connectors must be impacted on the bottom and one side. A suggested test fixture is shown in Fig. 7.1. Impact a total of eight times per axis. Conduct this test at room temperature, –46 °C, and 66 °C. For the tests at the temperature extremes, conduct the tests within 1 minute from removing the connectors from the temperature chamber. Connectors must be soaked at the high and low test temperatures for a sufficient time to ensure that the connectors reach the required temperature. The mate/unmate forces must meet the test criteria in paragraph 7.2.5. Voltage drop must not exceed that defined in paragraph 7.2.2 at room temperature. Conduct an insulation resistance test (paragraph 6.1.1). Repeat the physical shock test with a single unmated connector.

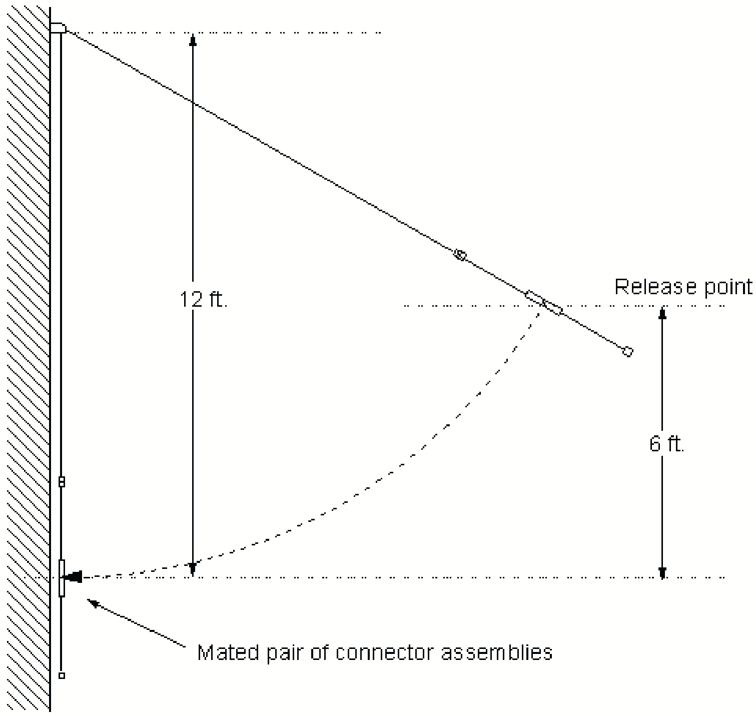

Fig. 7.1 Physical shock test set-up

7.2.8 Extreme Temperature Pull-Apart

Pull a mated pair of connector assemblies apart. Rate of separation should be at least 2 ft/sec (1.4 mph). Prepare the cable assemblies by cooling them in a temperature chamber at –46 °C and coat with a minimum of 1/2 in. of ice. Measure the force required to separate the connectors. Repeat by recoupling the connector assemblies, putting them back in the temperature chamber, and reestablishing the 1/2-in.-thick ice coating. Repeat for a total of 25 uncouplings. Make an insulation resistance test (paragraph 6.1.1), a pull-apart test (paragraph 7.2.5) at room temperature only, and a voltage drop test (paragraph 7.2.2) before the first test and after the 25th uncoupling. Repeat this test with a pair of connectors heated to 66 °C for 30 minutes minimum between each of 25 uncouplings.

7.2.9 Frozen Connector Mate Test

Prepare a pair of cable assemblies by cooling them in a temperature chamber at –46 °C. Remove them from the chamber and immediately couple the connectors together. The mate forces must never increase to the point that a normal human being has difficulty coupling the connectors. It must never be necessary to use tools to couple connectors. It is permissible to knock the two connectors together to remove any ice before mating the connectors.

7.3 Environmental

7.3.1 Fluid Resistance

Test the connector samples according to MIL-STD-1344, Method 1016 (one sample per fluid). The test fluids will be diesel fuel, lubricating oil (fluid type D), isopropyl alcohol (fluid type I), and sulfuric acid (0.5% concentration). The connectors must be tested unmated. Following the fluid immersion cycles, the connectors must be mated without being wiped off, then given the pull-apart test at room temperature only (paragraph 7.2.5), an insulation resistance test (paragraph 6.1.1), and a voltage drop test (paragraph 7.2.2).

7.3.2 Sunlight Exposure

Perform a test on mated connectors according to paragraph 3.9.4 and inspect for cracks or physical damage.

7.3.3 Sand/Dust Exposure

Mated connectors will be tested according to MIL-STD-202, Method 110. Following the sand immersion cycles, the connectors must be given the pull-apart test at room temperature only (paragraph 7.2.5), a wet mate test (paragraph 6.1.3), and a voltage drop test (paragraph 7.2.2).

7.4 Life Test

7.4.1 Pre-Test

Perform an insulation resistance test (paragraph 6.1.1) and voltage drop test (paragraph 7.2.2).

7.4.2 Aging

Place a mated pair of connector assemblies at two times the rated voltage in a temperature chamber. Age the mated pair at 107 °C for 168 hours.

7.4.3 Post-Test

Perform an insulation resistance test (paragraph 6.1.1), voltage drop test (paragraph 7.2.2), and pull-apart test paragraph 7.2.5) at room temperature only.

8.0 CAR BODY CONNECTIONS

8.1 Connectors

All connectors used between the end-of-car cable and car body connection will meet the appropriate requirements of this specification. The connector shall be designed so that the plug on the end of the cable shall form the “weak link” in the connection so that the receptacle portion, attached to the junction box or conduit extension (see paragraph 8.3.1), shall not be damaged if the cable is snagged by track debris.

8.2 Junction Box

The assembled junction box or enclosure at the end sill of the car and at the split to the CCD shall not be sealed and must have a drain hole in the bottom of the box or enclosure. The junction box removable covers shall be secured with captive screws/fasteners to prevent loss of these items during inspection and repairs.

8.3 Car Body Connector Mounting Envelope

The car body connection must be within a 15-in. radius sphere centered on the angle cock to hose connection.

8.3.1 As an alternate to the junction box, the car body connector may be fitted to a conduit or other suitable rigid conduit fitting. The end of the conduit must be solidly supported at the end of the car within 12 in. of the car body connector.

8.4 Cable Length

The length of the entire connector assembly must be 40 in. ± 1 in. for conventional cars and 51 in. ± 1 in. for rotary dump cars. This length is the total length as measured between the mating face of the car-to-car connector and the mating face of the junction box plug on the other end of the connector/cable assembly.

8.4.1 Cars with sliding center sills or end-of-car trolley arrangements will require an intermediate cable between the car body connection of the connector assembly and the car body itself. All wiring connections on the intermediate cable will use ring terminals or an AAR-approved alternate.

8.5 Car Body Wiring Connections

8.5.1 Connection Types

All wiring connections on the car itself, for example from the main cable to the CCD, will use low-resistance ring terminals and crimped connections or an AAR-approved alternate. The ring terminals shall be bolted to suitably sized terminal posts with locknuts and plain washers or plain nuts with shake-proof washers, capable of withstanding a vibration level of ±5 g over a frequency range of 20–80 Hz.

8.5.2 Connection Resistance

The electrical resistance of bolted and crimped connections shall not exceed 10 mΩ.

8.5.3 Cable Shield Grounding

The cable shield shall be grounded to the car body at the junction box containing the live connections to the CCD using ring terminals crimped to the drain wire bolted to terminal posts as specified in paragraph 8.5.1 or an AAR-approved alternate.

9.0 CRIMP STRENGTH

9.1 Crimp Tensile Pull Test

The sample contact shall be attached to the specified #8 AWG wire and placed in a standard tensile-testing machine. Sufficient force shall be applied to pull the wire out of the sample contact or break the wire or the sample. The travel speed of the head shall be 1 in. per minute. The clamping surfaces may be serrated to provide sufficient clamping force. During the pull test, the sample contact shall not break or separate from the wire before the minimum tensile strength of 150 lb is reached.

10.0 PRODUCTION REQUIREMENTS

All connector assemblies must be subjected to a dielectric proof test as described in paragraph 3.10.7.1 prior to shipment.

11.0 APPROVAL PROCEDURE

11.1 The manufacturer will apply in writing to the Chief—Technical Standards, Transportation Technology Center, Inc., P.O. Box 11130, 55500 DOT Road, Pueblo, CO 81001, to initiate the approval process. This application for approval will include a description of the product and its intended use.

11.2 The manufacturer will, at no expense to the AAR, provide a sample of each cable and/or connector to each member of the Braking Systems Committee.

11.3 The manufacturer will supply at least 500 ft of production cable, or 50 production connector assemblies, from which an AAR representative will select the necessary test samples.

11.4 The manufacturer will provide test data and certify that the cable and/or connector meets all requirements of this standard. Testing must be performed or witnessed by the AAR Research and Test Department, or be conducted by a certified outside laboratory. The AAR may, at its discretion, require further testing at any time to ensure continued compliance.

11.5 After the Braking Systems Committee has examined the cable and supporting information, it will notify the manufacturer or supplier as to whether the product has been given a conditional approval or has been disapproved.