SAE International™

SURFACE VEHICLE STANDARD

SAE J2577

ISSUED SEP2005

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Heavy Duty Lamp Electrical Connector Standard

TABLE OF CONTENTS

1. Scope

This SAE Standard encompasses connectors that form the electrical interface(s) between the heavy duty lighting device(s) and the truck and truck/trailer wiring harness system. This document provides design and performance requirements based upon the mechanical, electrical and environmental conditions and covers applications of connectors for direct current electrical systems of 24 V nominal or less in heavy-duty signaling and marking devices. This standard excludes forward lighting devices (i.e. fog lamps) but includes the following list of lamps:

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- Stop Lamps
- Tail Lamps
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- Side Marker Lamps
- Clearance Lamps
- Identification Lamps
- Back Up Lamps
- Side-Turn Signal Lamps
- Work Lamps
- License Lamps
- Chassis Component Status (ABS) Lamps

1.1 Rationale

Not applicable.

2. References

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, or www.sae.org

SAE J163—Low Tension Wiring and Cable Terminals and Splice Clips
SAE J726—Air Cleaner Test Code Standard
SAE J1128—Low Tension Primary Cable
SAE J1455—Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design
SAE J1908—Electrical Grounding Practice
SAE J2030—Heavy Duty Electrical Connector Performance Standard
SAE J2139—Tests for Lighting Devices and Components Used on Vehicles 2032 mm or More in Overall Width
SAE J2174—Heavy Duty Wiring Systems for Trailers

2.1.2 MIL SPECIFICATION

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-1344A—Method 3002.1 Low-Signal Level Contact Resistance

2.1.3 ASTM PUBLICATION

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM G 154—Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, or www.sae.org.

SAE J821—Electrical Wiring Systems for Construction, Agricultural and Off-Road Machines
SAE J858—Electrical Terminals—Blade Type
SAE J1067—Seven Conductor Jacketed Cable for Truck Trailer Connections
SAE J1292—Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring
SAE J1614—Wiring Distribution Systems for Construction, Agricultural and Off-Road Work Machines
SAE J2202—Heavy-Duty Wiring Systems for On-Highway Trucks
SAE J2223—Connections for On-Board Road Vehicle Electrical Wiring Harnesses
SAE/USCAR-2—Performance Standard for Automotive Electrical Connector Systems

2.2.2 ISO Publication

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 8090—Road vehicles—Connections for on-board electrical harnesses

2.2.3 TMC Publications

Available from the Technology and Maintenance Council, American Trucking Associations, 2200 Mill Road, Alexandria, VA 22314.

TMC # RP-153(T)—Lamp-to-Connector Interface
TMC #RP-107—Seven Conductor Truck-Trailer and Converter Dolly Jumper Cable and Connector
TMC #RP 110A—Low Tension Cable for Heavy-Duty Truck-Trailer Wiring Systems
TMC #RP 112—Terminals for Heavy-Duty Truck-Trailer Primary Wiring Systems
TMC #RP 113—Electrical Systems Connectors
TMC #RP 120—Wiring System Identification
TMC #RP 121—Electrical Connector System for Auxiliary Starting and Off-Board Diagnostics
TMC #RP 129—Heavy-Duty Vehicle System Wiring Checks: 12-Volt Charging-12-Volt Cranking
TMC #RP 135—Multi-Pin Connector Repairs
TMC #RP 137—Antilock Electrical Supply from Tractors through the SAE J560 Seven-Pin Connector
TMC #RP 703A—Electrical and Gladhand Connector Placement
TMC #RP 704B—Heavy-Duty Lighting Systems for Trailers
TMC #RP 1201—Joint TMC/SAE Recommended Practice for Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications
TMC #RP 1203—Vehicle Electronics Glossary of Terms

3. Definitions

3.1 Connector

A coupling device which provides an electrical and/or mechanical junction between the heavy duty lighting device(s) and the vehicle harness system component. It can also provide for mechanical stability and geometric arrangement.

The male connector half is the portion of the connector that incorporates the blade terminals.

3.2 Terminal

An electrically conductive device attached to a conductor to facilitate connection to an electrical component.

3.3 Sealed

A system that creates a nonleaking union between mechanical elements when subjected to the water immersion, fluid immersion and pressure washing requirements as defined in the tests within this document.

3.4 Signal Level Circuit

A circuit in which open circuit voltages and currents are low, generally produces < 5 °C temperature rise over ambient and at the levels where the current is not able to break through the film of oxides, sulfides, or other films or contaminants which may build up on the contact surfaces.

3.5 Power Circuit

A system using two or more cables where current flows from the source to one or more electronic/electrical devices and back again to the source. The electrical energy is supplied at high levels of current at typical system voltage and generally produces greater than 10 °C temperature rise over ambient.

3.6 Independent Connector

Is a connector in which both halves are attached to wire leads or wire harnesses.

3.7 Integral Connector

Is a connector in which one-half is built into the lamp housing.

3.8 Secondary Lock

Is an auxiliary or additional piece that fits over the body of a connector half in order to retain seals and/or terminals.

4. Samples for Tests

4.1 Sample Preparation

Samples shall be made on the manufacturer's recommended connector tooling and checked for conformance to manufacturer's standards for connectors.

4.2 Assembly

All cavities shall be wired with minimum approved wire insulation size in lengths sufficient to accommodate testing. Wire insulation diameter shall be checked and be within the connector's manufacturing specification. Crimp characteristics (i.e., height, width, etc.) shall be checked. To prevent capillary action on sealed connectors, all loose wire ends and test points (i.e., millivolt test connection) shall be sealed with alcohol-base RTV silicone or equivalent. The wire gage is to be verified for correctness.

5. Test Sequence

Test samples shall be subjected to the tests in the order shown in Table 1.

TABLE 1—TEST SEQUENCES

Test Description	Test Para.	Test Group A Sample 6 Sequence	Test Group B Sample 6 Sequence	Test Group C Sample 6 Sequence	Test Group D Sample 6 Sequence	Test Group E Sample 6 Sequence	Test Group F Sample 6 Sequence	Acceptance Requirements Paragraph
Examination of Product	6.1	1	1	1	1	1	1	7.1
Insulation Resistance	6.2	2,7,9, 11,13, 15,17	2,7,9, 11,13,				2,6	7.2
Specified Rated Resistance	6.3				2,8	4,14, 16		7.3
Steam Cleaning/ Pressure Washing	6.22	16	12					7.22
Maintenance Aging	6.5				4			7.5
Temperature Life	6.6		4	5		5	3	7.6 & 7.21
Mating Forces	6.14.2			14	7			7.14.2
Unmating Forces	6.14.3			13	6			7.14.3
Durability	6.8		3	3	3	2		7.8 & 7.1
Corrosion	6.9	12	8					7.9
Thermal Shock	6.12	6		9		7		7.12 & 7.1
Fluid Immersion	6.11	14	10					7.11
Shock	6.13.1	4		12				7.13.1
Drop Test	6.13.2	5						7.13.2
Vibration	6.13.3	3	5	11		9		7.13.3
Terminal Retention	6.7				10			7.7
Water Submersion	6.10.1	10	6					7.10.1
Water Submersion	6.10.2						5	7.10.2
Connector Retention	6.14.1			16	9			7.14.1
Mismating	6.14.4							7.14.4
Side Load Force	6.14.5						4	7.14.5
Current Test	6.15					15		7.15/6.3/7.3
Temperature/ Humidity	6.18	8		7		11		7.18 (7.21)
Low-Voltage Resistance	6.16			2,4,6, 8, 10,15		3,6,8, 10,12		7.16
Current Cycling	6.19					13		7.19/6.3/7.3
Dust Test	6.20				5			7.20
Crimp Strength	6.4					18		7.4
Visual Examination	6.21	18	14	17	11	17	7	7.21

6. Test Methods

All tests shall be carried out at an ambient temperature of 25 °C ± 5 °C and a relative humidity between 20 and 90% unless otherwise stated. Not all test descriptions contained herein describe an acceptance criteria. Tests may be conducted for conditioning purposes only.

6.1 Examination of Product

Conduct a visual examination only for identification of potential defects in the product, torn seals, cracked plastic, flash, tarnished contacts, discoloration, corrosion, etc. It is recommended an untested control sample be retained for future reference to the tested sample(s).

6.2 Insulation Resistance

Using a 1000 Volt DC Megohmmeter, check each contact to all other contacts and a metal foil surrounding the housing. The metal foil shall be connected to earth.

6.3 Specified Rated Resistance

The measurement of specified rated resistance shall be per Figures 1 and 2. The resistance of a cable equal in length to that of the two measuring points shall be subtracted from the measured values. The cable used shall be from the same batch of cable as used for the connector wiring.

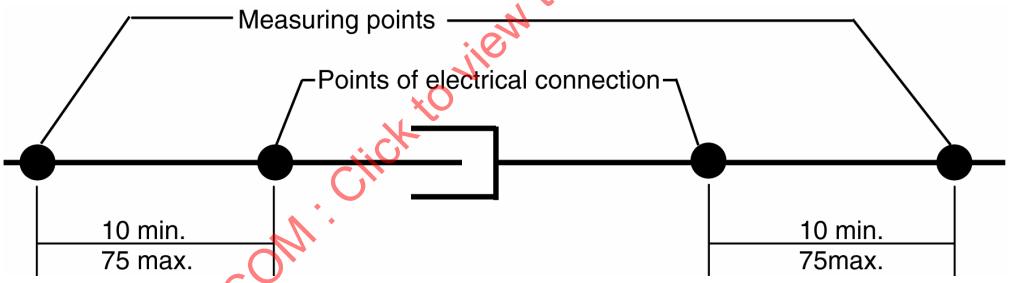

FIGURE 1—SPECIFIED RATED RESISTANCE, CABLE TO CABLE

NOTE—All dimensions are in millimeters.
Measuring points are on the wire.
Points of electrical connection (back of the crimp) are typically the joint of the wire to the terminal.

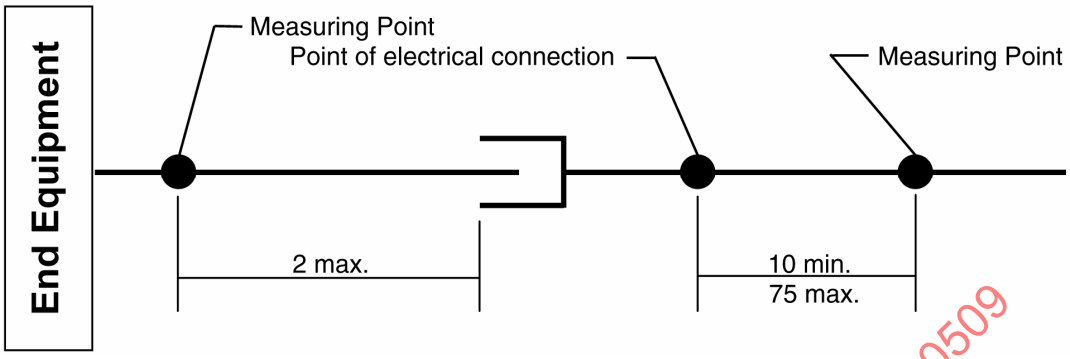

FIGURE 2—SPECIFIED RATED RESISTANCE, CABLE TO DEVICE

NOTE—All dimensions are in millimeters.
Measuring points are on the wire. NOTE—Subtract the wire resistance in Ohms.
Points of electrical connection are typically the joint of the wire to the terminal.

6.3.1 MEASUREMENTS AT SPECIFIED TEST CURRENT

Measurements shall be taken after thermal equilibrium at current levels as shown in Table 3 (Reference SAE J163, Table 2).

6.4 Terminal Crimp Strength (for Terminals Outside the Connector)

The tensile strength of the crimped connection shall be tested by using suitable apparatus at a constant speed within the range of 20 to 100 mm/min. If the terminal has a conductor insulation crimp it shall be rendered mechanically ineffective. Minimum acceptable values are shown in 7.4. All samples to be pulled to destruction.

6.5 Maintenance Aging

Subject at least 10% of the cavities to ten cycles of inserting and removing its respective contact. The ten cycles shall also include any disassembly required to remove the contacts. Insertion and removal to be performed using manufacturer's recommended practice.

6.6 Temperature Life

The wired-mated connectors shall be subject to 1008 h at 85 °C ± 3 °C without current flowing.

6.7 Terminal Retention in Connector

The contacts shall be subjected to a direct pull of 110 N for 1 minute minimum. The pull is to be exerted on the wire by means of a tension-testing machine or equivalent to prevent sudden or jerking force during test.

NOTE—Secondary lock devices should be utilized if available.

6.8 Durability

The connector shall be mated and unmated for a total of 25 complete cycles in a non-powered condition.

6.9 Corrosion

The connector shall be fully mated then tested per SAE J2139.

6.10 Water Submersion

6.10.1 STANDARD TEST

NOTE—This test applies to integral connectors.

The wired mated connectors shall be tested in accordance with SAE J2139 Water Submersion Moisture Test except the depth shall be 300 to 400 mm and the duration shall be 1 hour. The ends of the wire are to be sealed during this test. Observe for air bubbles. At least one connector shall be tested with wires exiting at 90° to the body of the connector.

6.10.2 WATER SUBMERSION UNDER LOAD

NOTE—This test applies to independent connectors.

6.10.2.1 Purpose

This test is an accelerated simulation of the "breathing" that may occur in a sealed connector system when it is heated and suddenly cooled by submersion in a cooler liquid and a means of determining if a side load force will cause an air leak in the seal after aging the seals in a heat chamber. The test is optional and should only be performed if the application requires a deviation from the TMC recommended practice for the lamp to connector guidelines. Salt water is used as the liquid to facilitate detection of any leakage into the connector. As a further aid to detecting any leakage that may occur, it is recommended that a suitable ultraviolet dye be added to the salt-water solution.

6.10.2.2 Procedure

6.10.2.2.1 Using the smallest conductor size and insulation type for the terminals to be used in the intended application, machine crimp samples until one meets the crimp height, crimp width, and tensile strength requirements of the applicable crimp specification or as required by the manufacturer of the terminal system being used for the test. Using that crimp setting, machine crimp enough samples of male and female terminals to assemble a minimum of 6 pairs of connector assemblies. Crimp both the conductor and insulation grips.

6.10.2.2.2 Assemble a minimum of 6 pairs of fully populated connectors using the terminals prepared in Step 1 above. Assembly must include all applicable wedges (TPAs, PLRs, etc.), Seals, etc.

6.10.2.2.3 Verify conformance of each mated sample connector assembly to the Insulation Resistance test. This establishes a reference for the concluding Insulation Resistance test.

6.10.2.2.4 Place the samples in the chamber such that there is no substantial obstruction to air flow across and around the samples, and the samples are not touching each other.

6.10.2.2.5 Set the chamber to 85ºC. Allow the chamber to stabilize before proceeding. Heat soak the samples at the elevated temperature of the chamber for 96 hours.

6.10.2.2.6 Prepare enough salt-water solution to completely submerse all samples to a depth of 30 to 40 cm below the surface. Use tap water and add 15 to 16 grams of table salt per liter. Then add 10 ml. of liquid dish washing soap per liter. Mix well before adding to test apparatus. This should result in a solution holding approximately 5% of the maximum weight of salt that each liter of water can dissolve at room temperature. Soap is added to approximate a 1% solution by volume. It is recommended that an appropriate ultraviolet dye be added to assist in visual inspection for any ingress of solution into the test samples.

6.10.2.2.7 Remove the samples from the chamber. Within 30 seconds, submerse them in the room temperature salt-water solution to a depth of 30 to 40 cm. The samples shall remain submersed at this depth for a period of 30 minutes.

6.10.2.2.8 After 5 minutes of the 30 minute submersion period apply 31 Newtons (N) force for 30 seconds to each wire 90° perpendicular to the back of the connector and against all four sides. This simulates a 90-degree wire stress under load in any of the four directions in which the wire may be dressed. Examine for any air bubbles while under tension, remove the samples from the salt-water solution, shake off the excess solution, and then carefully dry the exterior surfaces of the samples. Immediately perform the Insulation Resistance test (6.2).

6.10.2.2.9 At the conclusion of the test carefully open the samples and visually examine for any water ingress.

6.11 Fluid Immersion

Subject each connector to one fluid only in the wired and mated condition. Submerge the mated connector in fluid from Table 2 at the lab ambient temperature for 5 min., then remove and allow to air dry for 24 h. This completes one cycle. Each connector is to be subjected to a total of five cycles.

TABLE 2—FLUIDS

Fluid	Concentration	Classification
Motor oil 30 wt	100%	ASTM D 471, IRM-902
Brake fluid (disc type 1)	100%	SAE RM66-04
Diesel fuel #2	90/10%	IRM-903/T-Xylene
50/50 antifreeze mixture	50/50	ASTM D 471 Service Fluid 104
Gear oil 90 wt	100%	ASTM STP 512, API GL-5
Windshield Washer Fluid	100%	Methyl Alcohol Ref.: SAE J1944
Magnesium Chloride	5%	SAE J 2174(Ref)
Muratic Acid		Diluted 1:8 parts water by volume.
Calcium Chloride	5%	SAE J2174(Ref)
Cleaning Fluid		85% Mineral Spirits/15% Xylene Trisodium Phosphate – per manufacturer's recommendation

6.12 Thermal Shock

Test Per SAE J1455 – Thermal Shock Test, Fig. 2C.

6.13 Mechanical Tests

6.13.1 Operational Shock

10 cycles of ½ sine pulses. 50 g, 11ms duration, X, Y and Z axis to be tested. Monitor for discontinuity greater than 1 ms at 100 mA.

Connector under test to be fixed to the shock plane with the wire harness fixed to nonshocked objects no closer than 100 mm and not farther than 300 mm from the rear of the connector.

6.13.2 Drop Test

The free end of the cable, as used in the application which shall be approximately 2000 mm ± 25 mm long, shall be fixed to a wall at a height of 1000mm ± 25mm above a concrete floor, as shown in Figure 3. The specimen shall be held so that the cable is horizontal and allowed to fall to a concrete floor eight times. Rotate the specimen through approximately 45 degrees at its fixing each time.

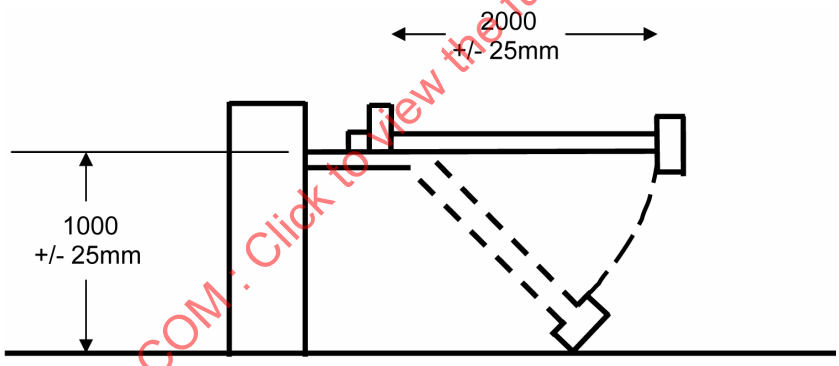

FIGURE 3—DROP TEST EQUIPMENT

6.13.3 Vibration Tests

The selection for performing a vibration test shall depend on the construction of the connector to lamp assembly.

6.13.3.1 Vibration Test for Connectors Built Integral to the Lamp Housing

In addition to the connector half in the lamp housing the mating half of the connector shall be assembled to it along with 300 mm of wiring cable of the size intended to power the lamp. The cable shall be anchored to a non-vibrating portion of the test fixture/equipment at 300 mm from the lamp. The test shall be conducted in accordance with SAE J2139. The test shall be performed in each of 3 perpendicular axes. Duration: 60 + 1, -0 minutes in each axis. The lamp shall be powered on at 12.0 volts and the current specified in Table 3.

6.13.3.2 Vibration Test for Connectors that are Independent of the Lamp Housing

Both connector halves shall be fully assembled with all component parts and assembled to each other.

Vibration Test per SAE J1455
Perform Test per Mechanical Vibration, Figure 11 – Chassis Vibration Data, PSD
Bobtail Vertical Rear Frame, Heavy Duty Truck
Section: Recommend Test Methods
Paragraph: Random Vibration Testing

Connectors under test are to be fixed to the vibrating plane with the wire harness fixed to non-vibrating objects no closer than 100 mm and not farther than 300 mm from the rear of the connector.

a. Duration of test to be 24 h
b. X, Y, and Z-axis to be tested 8 h each
c. Apply current as specified in Table 3 at 12.0 volts for the first 3 h in each axis

Monitor each circuit for discontinuity greater than 10Ω in excess of 1 microsecond at 100 mA during last hour of vibration in each axis.

NOTE—Table 3 is in J2577.

6.14 Connector Forces

6.14.1 CONNECTOR RETENTION

With the latch engaged apply a pulling force to the cable at 100mm distance from the back of the mated connector at 110 Newtons minimum. The load shall be applied for 60 s.

6.14.2 MATING FORCES

Test maximum required force to mate the plug and receptacle pair and engage the latching mechanism. The force is not to exceed 70 Newtons (16 lbf).

6.14.3 UNMATING FORCES

Test the maximum force required to separate the plug and receptacle with the latch mechanism fully disengaged. The force is not to exceed 70 Newtons (16 lbf).

6.14.4 MISMATING (REF. J2174 FOR COMPARISON)

Connectors with two or more contacts shall be keyed or of such a design that any intended polarization will not be defeated by improper assembly during installation. Polarization shall resist a minimum of 175 Newtons (40 lbf) axial force without damage.

6.14.5 SIDE LOAD FORCES

The connector shall be designed to withstand a side load of 65 Newtons minimum. The load shall be applied for 1 minute to both sides of the connector. A test sequence shall consist of 1 application to four sides of the connector for a total of 4 applications.

6.15 Current Test

Apply 7.5 amp current to all terminals. Ambient test temperature is to be 85 °C ± 3 °C for a 24 h period at the end of which the specified rated resistance is to be measured per 6.3.

6.16 Low-Voltage Resistance (Reference MIL-STD-1344A; Method 3002.1)

Test with applied voltage not exceeding 20 mV open circuit and the test current shall be limited to 100 mA. Utilize Figure 1.

6.17 Ultraviolet Effects

Materials used in the connector system shall meet ASTM G154a. 1008 hour test consisting of 20 hours UV and 4 hours of condensation per cycle.

6.18 Temperature/Humidity

Test samples to be placed in a temperature/humidity chamber and shall be subjected to 42 cycles described by the following profile, Figure 4.

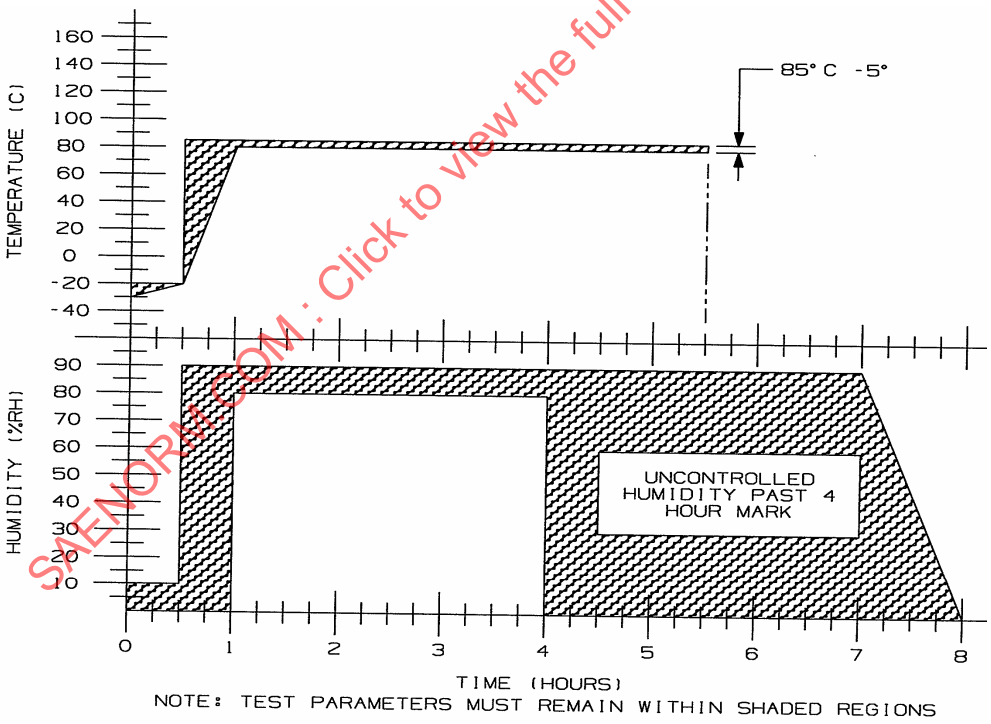

FIGURE 4—TEMPERATURE/HUMIDITY PROFILE

Relative humidity is not controlled unless it is specified. Samples will be tested for voltage resistance per 6.3 or 6.16 dependent upon power level of contacts and for insulation resistance per 6.2.

6.19 Current Cycling Test

This test is to determine the effects of crimp relaxation via current (thermal) cycling.

Subject samples to 500 cycles of current at 7.5 amps.

a. 200 off/on cycles, at ambient of 85 °C ± 3 °C, each cycle to consist of 45 min on, 15 min off.
b. 50 cycles of following: 20 min on at 85 °C ± 3 °C, 60 min. off including transition time at 21 °C ± 1 °C. Transition rate is to be 3 °C/min +3/-0 °C/min without current applied.
c. Repeat a. & b. to complete 500 cycles.

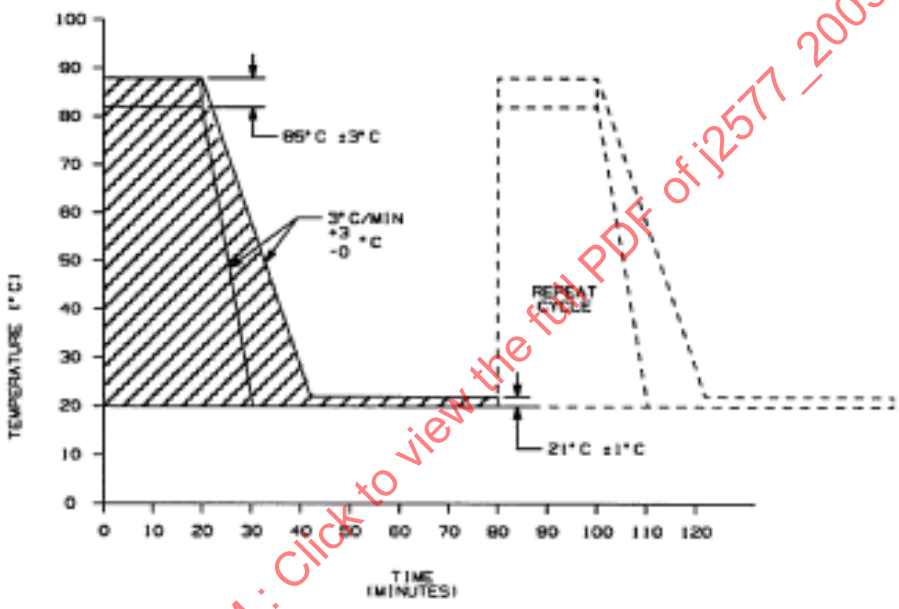

FIGURE 5—CURRENT CYCLING PROFILE

6.20 Dust Test

Test per SAE J2139 Dust Test.

6.21 Visual Examination

Conduct a visual examination for identification of product, torn seals, cracked plastic, evidence of fluid ingress, arcing, charing, finish deterioration, melting, or anything that could affect the performance of the product, etc.

6.22 Steam Cleaning and Pressure Washing

6.22.1 Effects on Performance

The intense heat from cleaning sprays and the caustic nature of chemical agents used in washing solutions create a severe environment for devices and associated wiring and connectors mounted in the engine, chassis, and exterior areas. This exposure can cause a degradation of insulation and seals as well as cracking of vinyl connectors and component packaging. High pressure wash-down may produce results similar to salt spray in many truck and truck trailer applications.

6.22.2 Recommended Test Method

The connector under test shall be mounted in its normal operating position with drain holes, if used, open. If an integral connector is used, it shall be mated. The test apparatus should be designed to provide 100% coverage of the exposed surface of the electronic component using flat fan spray nozzles located 20 to 30 cm (7.9 to 11.8 in) away. This apparatus should provide a source pressure of approximately 7000 kPa gage (1020 lbf/in^2 gage) with a flow rate of 9460 cm^3 /min (150gal/h). The test item should be exposed to the spray for 3 s of a 6 s period for a total of 375 cycles.

6.22.3 Pressure/Steam Cleaning

For regular pressure washing the water temperature is to be at 40 °C (104 °F) with water/detergent mixture. For steam cleaning the water temperature is to be at 93 °C (200 °F) with the source pressure of approximately 1400 kPa (203 lbf/in^2 gage) with a flow rate of 9460 cm^3/min (150 gal/h).

7. Test Requirements

7.1 Examination of Product

All tested samples must be free of defects that could affect the electrical or mechanical performance of the part or degrade the long-term performance of the part.

7.2 Insulation Resistance

The insulation resistance shall be greater than 20 Megohms.

7.3 Specified Rated Resistance

When tested according to 6.3 the specified rated resistance shall meet the requirements of Table 3.

TABLE 3—MEASUREMENTS AT SPECIFIED TEST CURRENT

Conductor Size mm^2	Test Current Amps	Maximum Resistance mΩ
0.8	10	20
1	15	20
2	20	15

7.4 Terminal Crimp Strength

The results of tests in 6.4 shall meet the requirements of Table 4.

TABLE 4—MINIMUM TENSILE STRENGTH FOR CRIMPED CONNECTIONS

Conductor Size mm^2	Minimum Tensile N
0.8	90
1	120
2	200

7.5 Maintenance Aging

At the completion of the test the retention force shall still meet the requirements of the terminal retention test for new terminals/connectors.

7.6 Temperature Life

Evidence of cracking, warping, distortion, discoloration or detrimental damage, shall constitute a failure.

7.7 Terminal Retention in Connector

The terminal shall maintain its original position in the connector throughout the test. Dislocation from the original position shall constitute a failure.

7.8 Durability

Visual defects shall constitute a failure.

7.9 Corrosion

The connector(s) shall be visually examined for corrosion which could affect the performance of the connector(s). If corrosion is found, other tests in this document shall be repeated to determine compliance with those requirements. If those requirements are not met, the corrosion shall constitute a failure.

7.10 Water Submersion

7.10.1 Integral connectors must meet the water submersion test requirements of J 2139.

7.10.2 Evidence of any water ingress shall constitute a failure.

7.11 Fluid Immersion

There shall be no evidence of cracking, warping, discoloration, corrosion or other damage which would be detrimental to normal operation of the connector.

7.12 Thermal Shock

There shall be no evidence of cracking, warping or other damage detrimental to the normal operation of the connector.

7.13 Mechanical Tests

7.13.1 Operational Shock Test

After this test the connector and its components shall not become detached or loosened or cracked which would impair the operation of the connector. These defects shall constitute a failure. Small chips and dents that would not adversely affect the operation or function of the connector shall be disregarded.

7.13.2 Drop Test

After this test the connector and its components shall not become detached or loosened or cracked which would impair the operation of the connector. These defects shall constitute a failure. Small chips and dents that would not adversely affect the operation or function of the connector shall be disregarded.

7.13.3 Vibration Tests

Detachment or loosened connector halves, terminals, seals or similar defects which would adversely affect the operation or function of the connector shall constitute a failure. Intermittent contact during testing shall constitute a failure.

7.14 Connector Forces

7.14.1 Connector Retention

Any damage to the connector or release of the latch shall constitute a failure of the test.

7.14.2 Mating Forces

A force exceeding 70 Newtons shall constitute a failure.

7.14.3 Unmating Forces

A force exceeding 70 Newtons shall constitute a failure.

7.14.4 Mismating Forces

Any damage or engagement of the electrical terminals shall constitute a failure.

7.14.5 Side Load Forces

Any damage or permanent distortion of the connector or its components shall constitute a failure. Leakage around the seals shall constitute failure.