4.4 Vibration

4.4.1 When tested in accordance with 3.2.7 and 3.2.7.1, there shall be no apparent loosening of the terminal in the connector or of the wire in the terminal. The millivolt drop shall not exceed the values listed in 4.1 for the wire size under evaluation. No mechanical or electrical damage or defects are allowed.

4.4.2 When tested in accordance with 3.2.7 and 3.2.7.2, there shall be no discontinuities observed.

4.5 Thermal Cycle—Upon completion of the thermal cycle exposure, there shall be no cracking, warping, or rupture of any of the components. The connectors shall remain serviceable.

4.6 Thermal Shock—There shall be no evidence of damage detrimental to the normal operation of the assembly.

4.7 Oil Absorption—Upon completion of the oil absorption tests, the connectors must remain serviceable. A serviceable part is one that can be removed with reasonable force and reinstalled without visible damage.

The wire, cable, or harness must conform to the requirements of 4.6 of SAE J1128 revised June 1988.

4.8 Insulation Resistance—The insulation resistance shall be in excess of 1 MΩ. The leakage current shall be less than 50 mA.

4.9 Salt Water Immersion—At the completion of the test, there shall be no evidence of corrosion residue on any of the electrical terminals and the terminals shall be intact in their original shape.

Allow the assembly to dry for 4 h after test and check each circuit for shorting between circuits and grounding to any conducting shell or conduit.

5. Design Requirements

5.1 All wire and cable shall conform to the requirements of SAE J1128.

Wherever possible, all conductors shall be grouped together in suitable conduit or jacket to protect it from environmental conditions detrimental to the material.

5.2 Wire sizes for the main and all branch circuits shall be sufficient to provide all electrical components with component design voltage or component manufacturer's recommended voltage.

5.3 Wire and cable assemblies shall be designed such that all uninsulated terminals are on the ground side of each connection. This applies to terminals which may be insulated in their connected state but which are uninsulated should a disconnect occur.

5.4 Noncorrosive flux must be used during any solder operation performed on any wire or cable assembly or component. Acid core solders or acid based fluxes must not be used.

5.5 If terminals are soldered to the wires, solder shall not wick under the insulation beyond the end of the terminal insulation support.

6. Installation Requirements

6.1 The edges of all metal members through which wire and cable passes, shall be deburred and rolled or covered with ridge rubber or split conduit. The cable shall be protected to prevent cutting, pinching, or abrasion at any point in the system.

6.2 Wire and cable shall be mechanically and electrically secure. When necessary, clips for retaining cables and wires shall be permanently attached to the body or frame members and shall hold the wire and cable permanently without cutting into the insulation.

6.3 Wire and cable shall be protected from road splash, stones, grease, oil, and fuels. Wire and cable exposed to such conditions shall be protected by the use of heavy wall insulation and/or additional tubing resistant to the hazards. Other methods which provide shielding are acceptable.

6.4 Electrical tape shall not be used externally for sealing or insulation.

6.5 Dielectric compound at terminals and connectors is not considered to be a primary sealing mechanism. All components intended for use with a sealed electrical distribution system for trailers shall have features which maintain the sealed characteristics of the system. If necessary an additional sealing material may be used to seal connections. This sealing material must provide a permanent seal and, also, be easily removed in the event service is necessary.

The electrical distribution system and its added-on components shall conform to the requirements of this document when subjected to the test procedures outlined in this document.

6.6 Use of dissimilar metals which can encourage galvanic corrosion must be avoided.

7. Guidelines

7.1 It is recommended that a crimp width and height requirement be generated for each terminal and wire assembly in addition to the tensile requirement for terminal retention.

(R) SEVEN CONDUCTOR ELECTRICAL CONNECTOR FOR TRUCK-TRAILER JUMPER CABLE—SAE J560 JUL98

SAE Standard

Report of the Electrical Equipment Committee approved January 1951 and revised September 1974. Completely revised by the SAE Truck and Bus Electrical and Electronics Committee June 1993 and July 1998. Rationale statement available.

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board format.

The seven conductor electrical connector is the electrical interface between highway tractors and trailers. The use of this connector makes it possible to pull any trailer with any tractor without the use of adapters.

This connector is comparable to only one unit currently being considered as an ISO Standard. In addition to the seven conductor unit, ISO is considering twelve, thirteen, and fifteen conductor units. All of these may be included in any ISO Standard which will require a number of adapters to achieve universal compatibility of tractors and trailers.

1. Scope—This SAE Standard provides the minimum requirements for the jumper cable plug and receptacle for the truck-trailer jumper cable system. It includes the test procedures, design, and performance requirements.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of the publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE J1067—Seven Conductor Jacketed Cable for Truck-Trailer Connections

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

ASTM B 117-94—Standard Method of Salt Spray (Fog) Testing

3. Definitions

3.1 Receptacle—The receptacle consists of the connector socket, its housing, and a cover which latches the cable plug in place. The socket contains the male contacts. See Figures 1 and 2.

3.2 Cable Plug—The cable plug is part of the jumper cable assembly. The cable plug contains the female contacts. See Figure 3.

3.3 Coupling Cycle—Coupling and uncoupling the plug and receptacle is one coupling cycle.

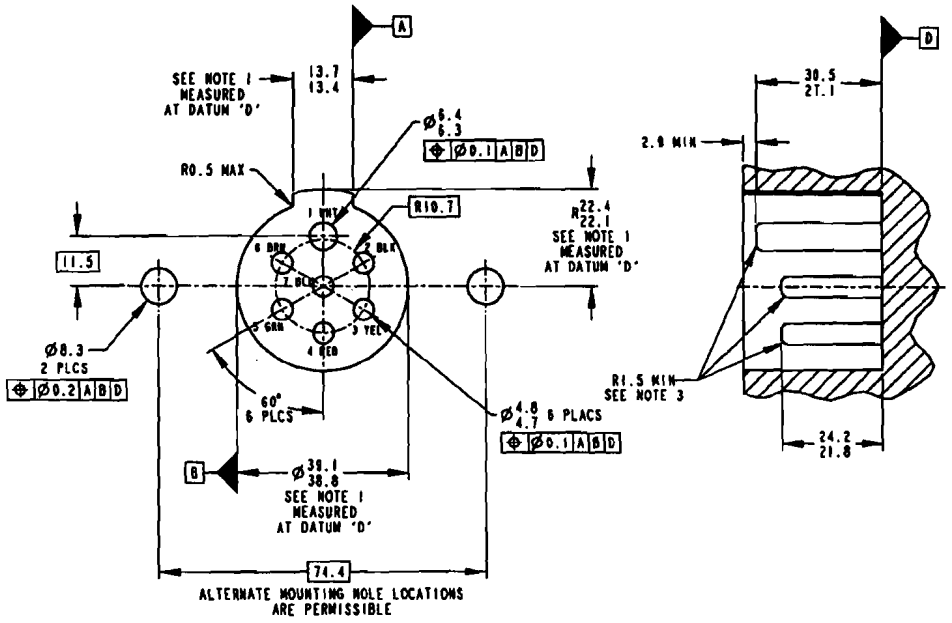
4. Identification Code Designation—Devices conforming to this document shall be identified with the manufacturer's identification, model or part number, and shall be identified with SAE J560 and the revision (month and year) of the document to which the device conforms. For example:

XYZ Corp.
9999
SAE J560
May 1998

5. Technical Requirements

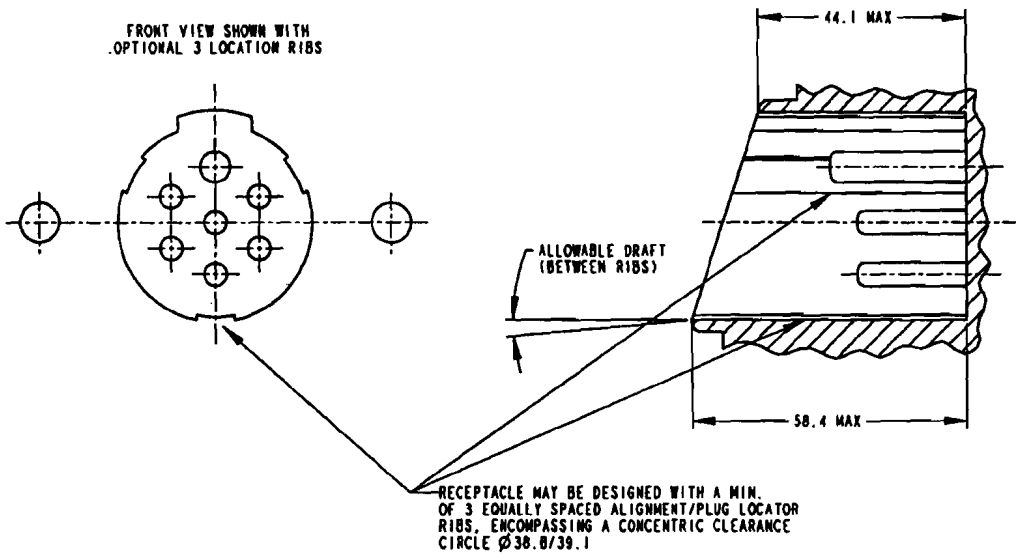
5.1 Test Equipment and Instrumentation

5.1.1 THE POWER SUPPLY—The power supply shall be capable of supplying the continuous current required to perform all tests.



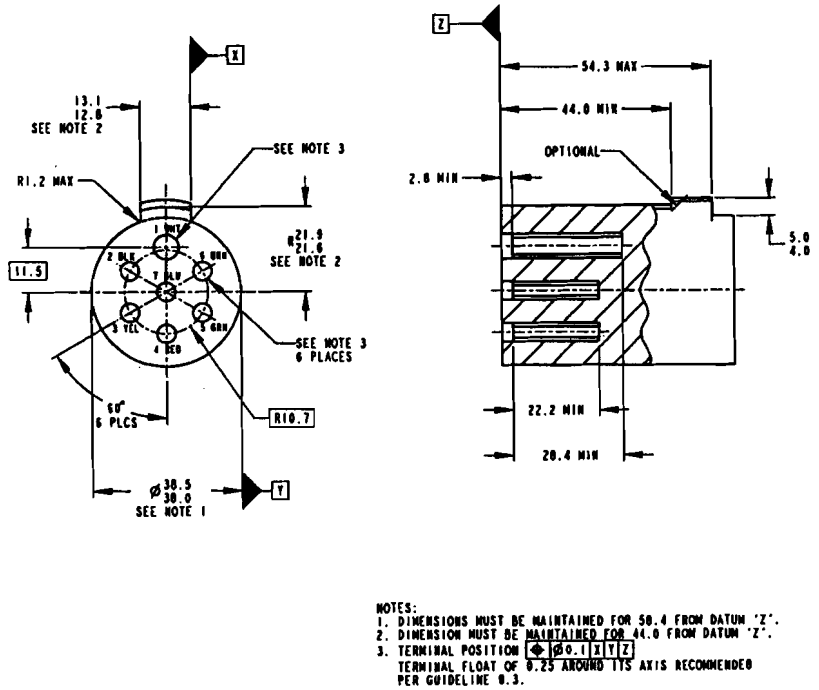
NOTES:
1. ALLOWABLE DRAFT 1/2 DEGREE PER SIDE.
2. REFER TO PARAGRAPH 7.7 FOR CIRCUIT IDENTIFICATION REQUIREMENTS.
3. TERMINALS MAY FLOAT 0.25 AROUND TERMINAL AXIS PER GUIDELINE 8.3.

FIGURE 1—RECEPTACLE SOCKET



ALL DATUMS, NOTES AND DIMENSIONS ON FIGURE 1 APPLY TO THIS FIGURE

FIGURE 2—ALTERNATE CONSTRUCTION RECEPTACLE SOCKET



NOTES:
1. DIMENSIONS MUST BE MAINTAINED FOR 50.4 FROM DATUM 'Z'.
2. DIMENSION MUST BE MAINTAINED FOR 44.0 FROM DATUM 'Z'.
3. TERMINAL POSITION ⌖ Ø0.1 X Y Z
TERMINAL FLOAT OF 0.25 AROUND ITS AXIS RECOMMENDED PER GUIDELINE 0.3.

FIGURE 3—CABLE PLUG

5.1.2 VOLTMETER—A d-c voltmeter with an input resistance greater than 1000 Ω/V and with a resolution of 0.1 V shall be used. To achieve this resolution, the full-scale deflection shall be appropriate to the voltage rating of the system being tested.

A digital meter having at least a 3-1/2-digit readout with an accuracy of ±1% plus one digit is recommended for millivolt readings.

5.1.3 AMMETER—A d-c ammeter shall be used for current measurements. The meter range resolution shall be 0.1 A.

5.1.4 MILLIAMMETER—A d-c ammeter shall be used for current measurements. The meter range resolution shall be 1.0 mA.

5.1.5 HIPOT—Capable of detecting leakage currents of 0.5 mA at 500 VAC.

5.2 Test Procedures

5.2.1 VOLTAGE DROP—The test is to be conducted in a draft-free room maintained at an ambient temperature of 25 °C ± 5 °C.

5.2.1.1 Connectors without Circuit Breakers

a. Connect a 1000 to 2000 mm long SAE J1067 type cable to the receptacle terminals and another 1000 to 2000 mm long SAE J1067 type cable to the cable plug terminals.
b. Mate the cable plug and receptacle.
c. Connect a power supply to the two cable ends in such a way that it applies 35 A to each circuit having a 4.75 mm (0.188 in) diameter terminal and 70 A to the circuit having a 6.35 mm (0.25 in) diameter terminal.
d. Turn on power supply and wait 5 min for the circuits to stabilize.
e. Measure the voltage drop across each circuit of the assembly at a convenient point on the wire at least 25 mm (1 in) from the terminal.

5.2.1.2 Connectors with Circuit Breakers

a. Same as in 5.2.1.1
b. Devices with circuit breakers may be certified using the noncircuit breaker version provided their construction is otherwise identical. If this is not possible, devices with circuit breakers may be tested by installing low-resistance shunts across their circuit breakers.

5.2.2 ISOLATION RESISTANCE—This test is to be performed with a hipot tester at 500 VAC with a leakage current setting of 0.5 mA. Connect the hipot tester from terminal "x" to all the other terminals in parallel for one minute and observe for failure (breakdown). Perform this test for the following terminal combinations:

#1 terminal to all other terminals
#2 terminal to all other terminals
#3 terminal to all other terminals
#4 terminal to all other terminals
#5 terminal to all other terminals
#6 terminal to all other terminals
#7 terminal to all other terminals

If applicable, this test should be performed after salt residue has been washed off and the parts have been dried.

5.2.3 COUPLING FORCE

5.2.3.1 Mounting—Mount the assembled cable plug and receptacle on a suitable fixture and measure with a 0 to 445 N (100 lb) force gage.

5.2.3.2 Measurement—Measure and record the peak force to fully mate the receptacle and cable plug until the receptacle's cover latch feature has engaged. Measure and record the peak force to disconnect the cable plug after manually disengaging the receptacle's cover latch feature.

5.2.4 STRAIGHT PULL - (CABLE PLUG)—A cable plug and SAE J1067 cable assembly shall be securely mounted in a suitable fixture. A pull force of 667 N (150 lb) shall be exerted on the J1067 cable along the axis of the cable plug for a duration of 24 h at 25 °C ± 5 °C.

5.2.5 SALT SPRAY

5.2.5.1 With the plug inserted into the receptacle and with the assembly mounted in normal truck-trailer position, subject the normally exposed portion of the assembly to a 48 h salt spray test per ASTM B 117.

5.2.5.2 Subject the uncoupled units to a 48 h salt spray test per ASTM B 117. Mount the receptacle in a normal vehicle position with the cover closed, and the cable plug protected by the docking device of 8.2 in normal vehicle position.

5.2.6 COUPLING CYCLE

5.2.6.1 25 °C ± 5 °C Test—Perform 2500 coupling cycles. Measure coupling and uncoupling force for informational purposes of the first cycle.

5.2.6.2 82 °C Test—Subject each assembly to a temperature of 82 °C ± 5 °C. After the assembly has stabilized at 82 °C, perform 250 coupling cycles. Measure coupling and uncoupling force for informational purposes of the first cycle.

5.2.6.3 –40 °C Test—Subject each assembly to a temperature of –40 °C ± 5 °C. After the assembly has stabilized at –40 °C, perform 250 coupling cycles. Measure coupling and uncoupling force for informational purposes of the first cycle.

5.2.7 VIBRATION

5.2.7.1 Mounting—Connectors (Cable plug and receptacle mated) under test are to be mounted to the vibrating plane with the SAE J1067 wire harness end fixed to a nonvibrating object no closer than 100 mm and not farther than 300 mm from the rear of the connector. *Connectors under test shall be wired in series and* connected to a DC power supply source, with a current flow of 10 A in each terminal.

5.2.7.2 Vibration Test Characteristics—Connectors under test shall be subjected to a sine motion sweep having an initial displacement of 1.78 mm double amplitude. The frequency shall be varied between limits of 15 to 2000 Hz. The entire frequency range (15 to 2000 back to 15 Hz) shall be traversed in 15 min. (Acceleration levels not to exceed 20 Gs).

5.2.7.3 Test Duration—Test to last a total of 12 h. X, Y, and Z axis are to be tested 4 h in each direction. Monitor for discontinuity in excess of 100 ms at 100 mA during the last hour of vibration in each axis.

5.2.8 THERMAL SHOCK—The mated connectors shall be subjected to 10 cycles of thermal shock. One cycle shall consist of 30 min at –40 °C ± 3 °C, followed by 30 min at 82 °C ± 3 °C with a transition time of 2 min maximum.

5.2.9 TERMINAL CRIMP STRENGTH—This test pertains to the mechanical connection between the connector pins and the SAE J1067 cable wires. (Usually a crimped, welded, or set screw design). The strength of the connection shall be tested by using a suitable apparatus at a constant speed within the range of 50 to 100 mm/min. If the terminal has a cable insulation crimp, it shall be rendered mechanically ineffective. Minimum acceptable values are shown in Table 1. All samples are to be pulled to destruction.

TABLE 1—MINIMUM TENSILE STRENGTH FOR CRIMPED CONNECTIONS

Cable Size mm^2	Minimum Tensile N
8.0	445
5.0	375
3.0	335

5.2.10 TERMINAL PIN RETENTION—Both the receptacle and cable plug pins shall be subjected to a direct pull and push force of 175 N for 1 min. The force is to be exerted on each pin without sudden or jerking forces during the test.

NOTE—Secondary lock devices should be utilized if part of the design.

5.2.11 CYCLE COVER SPRING—The cover spring integrity shall be tested to 5000 cycles by cycling the cover open/closed to the full extend of its motion. The torque to move the cover for the initial 10 degrees of motion shall be measured before and after test.

5.3 Durability Test Sequence—This test sequence is to be performed on six production level connector assemblies in the order listed as follows. No supplemental lubrication or other cleaning of the terminal pins prior or during the test sequence is permitted.

a. Coupling Force, Reference 5.2.3
b. Voltage Drop, Reference 5.2.1
c. Isolation Resistance, Reference 5.2.2
d. Room Temperature Coupling Cycles, Reference 5.2.6.1
e. 82 °C Coupling Cycles, Reference 5.2.6.2
f. Salt Spray, Reference 5.2.5.1
g. Voltage Drop, Reference 5.2.1
h. Isolation Resistance, Reference 5.2.2
i. Salt Spray, Reference 5.2.5.2
j. Room Temperature Coupling Cycles, Reference 5.2.6.1
k. –40 °C Coupling Cycles, Reference 5.2.6.3
l. Voltage Drop, Reference 5.2.1
m. Isolation Resistance, Reference 5.2.2
n. Coupling Force, Reference 5.2.3

5.4 Mechanical Test Sequence—This test sequence is to be performed on six production level connector assemblies in the order listed as follows. No supplemental lubrication or other cleaning of the terminal pins prior or during the test sequence is permitted.

a. Coupling Force, Reference 5.2.3
b. Straight Pull, Reference 5.2.4
c. Isolation Resistance, Reference 5.2.2
d. Terminal Retention, Reference 5.2.10
e. Terminal Crimp Strength, Reference 5.2.9
f. Cycle Cover Spring, Reference 5.2.11

5.5 Environment Test Sequence—This test sequence is to be performed on six production level connector assemblies in the order listed below. No supplemental lubrication or other cleaning of the terminal pins prior or during the test sequence is permitted.

a. Voltage Drop, Reference 5.2.1
b. Thermal Shock Test, Reference 5.2.8
c. Vibration Test, Reference 5.2.7
d. Voltage Drop, Reference 5.2.1
e. Isolation Resistance, Reference 5.2.2

6. Performance Requirements

6.1 Electrical

6.1.1 VOLTAGE DROP—The voltage drop for each circuit shall not exceed 3 mV/A when tested in accordance with 5.2.1.

6.1.2 ISOLATION RESISTANCE—The leakage current between each circuit and the other six circuits shall not exceed 0.5 mA, reference 5.2.2.

6.1.3 VIBRATION—The connector assembly under test shall show no signs of damage and shall not exceed 100 ms discontinuity when monitored during the last hour of test in each of the three axis in accordance with 5.2.7.

6.2 Mechanical

6.2.1 COUPLING FORCE —The unlatched coupling and uncoupling force shall not exceed 223 N (50 lbs) and the latched uncoupling force shall not be less than 110 N (25 lbs) in accordance with 5.2.3.

6.2.2 DURABILITY TEST—The connector assembly shall conform to the electrical and mechanical requirements outlined in 5.3 Durability Test Sequence.

6.2.3 STRAIGHT PULL—An assembled cable plug and trailer jumper cable shall not be damaged when tested in accordance with 5.2.4.

6.2.4 TERMINAL CRIMP STRENGTH—This is a destructive test. The tensile test shall meet Table 1 requirements in accordance with 5.2.9.

6.2.5 TERMINAL PIN RETENTION—The terminal shall maintain its original position in the connector when tested in accordance with 5.2.10.

6.2.6 CYCLE COVER SPRING—The torque to move the cover for the initial 10 degrees of motion after 5000 cycles shall be within 10% of the initial measurement as outlined in 5.2.11.

6.3 Environmental

6.3.1 SALT SPRAY—The connector materials shall show no evidence of corrosion or other damage detrimental to the normal operation of the connector. Connector shall conform to the electrical and mechanical requirements outlined in 5.3 Durability Test Sequence.

6.3.2 THERMAL SHOCK—The connectors under test shall show no evidence of cracking, chipping, or other damage detrimental to the normal operation of the connector. Insulating materials shall not fracture and shall not deform when tested in accordance with 5.2.8.

6.4 Extreme Temperature—Insulating materials shall not fracture and shall not deform when tested in accordance with 5.2.6.

6.5 Durability—Shall conform to the requirements of 6.1 during and after the test when tested in accordance with 5.2.7.

7. Design Requirements

7.1 Interchangeability—The cable plug shall be designed to conform to the performance requirements of this document with any receptacle which conforms to this document and vice versa.

7.2 Latchability—The cable plug shall be designed to mate and latch to any receptacle designed to conform to this document and vice versa. The latch mechanism shall be constructed to latch and release without interference.

7.3 Indexing—The cable plug shall be designed to provide indexing to any receptacle designed to this document and vice versa. Indexing is required to insure proper electrical mating.

7.4 Wiring Circuits—The function and color code of each circuit is shown in Table 2. The location of each circuit is shown in Figures 1 and 3. The wire color code refers to the color of the insulation on the conductors as specified in SAE J1067. The receptacle and cable plug shall be constructed so that the "WHT" terminal shall accommodate at least an 8.0 mm^2 size (8 AWG) wire and all other terminals at least a 5.0 mm^2 size (10 AWG) wire.

TABLE 2—WIRING CIRCUITS

Conductor Identification Terminal Number	Conductor Identification Wire Color	Lamp and Signal Circuit
1	Wht (white)	Ground return to towing vehicle
2	Blk (Black)	Clearance, side marker, and identification lamps
3	Yel (Yellow)	Left turn signal and hazard lamps
4	Red (Red)	Stop lamps and antilock device
5	Grn (Green)	Right turn signal and hazard lamps
6	Brn (Brown)	Tail and license plate lamps
7	Blu (Blue)	Continuous ABS power/Auxiliary

7.5 Receptacle—Figure 1 shows receptacle dimensions and design requirements. Figure 2 shows alternate construction features. A cover with a weathertight seal shall be provided to protect the male contacts when uncoupled. The male contacts shall not be split. Formed contacts are acceptable provided the seams are closed.

7.6 Cable Plug—Figure 3 shows plug dimensions and design requirements. The terminals in the plug shall be free floating for ease of alignment with the receptacle during coupling. Cable plug assemblies shall incorporate a strain relief to relieve the tension on the electrical connection between the plug contacts and the jumper cable conductors.

7.7 Circuit Identification—Circuit identification by color or numeric is mandatory on the wire connection side of the cable plug and receptacle. It is recommended that circuit identification be on both the front and back sides of each.

7.8 Latching Means—Receptacle cover shall be provided with a latching means that engages with the cable plug.

8. Guidelines

8.1 Electrical current-carrying parts should be copper or copper alloy. Protective coating or metallic plating is recommended to provide improved corrosion resistance.

8.2 A device should be provided to protect the plug in the uncoupled state. The device should be designed to prevent contaminated or corrosive liquid from entering the terminals.

8.3 For ease of alignment, receptacle contacts may be free floating within the dimensional boundaries of Figure 1. Cable plug contacts should have a minimum float of 0.25 mm from their true basic position.

COILED ELECTRICAL CABLE—SAE J2222 NOV93 SAE Draft Technical Report

Report of the Truck and Bus Wiring and Connector Subcommittee of the SAE Truck and Bus Electrical and Electronics Committee approved November 1993. Rationale statement available.

1. Scope—This Draft Technical Report covers the minimum performance and endurance requirements for coiled electrical cables to connect a tractor and trailer and/or trailer to trailer.

The purpose of this Draft Technical Report is to give the technical community the opportunity to review, comment on, and use the Draft Technical Report prior to its final approval by SAE. This document shall have a life span of no more than three years from approval which may not be renewed.

This Draft Technical Report represents the current thinking of the sponsoring Technical Committee. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringements arising therefrom, is the sole responsibility of the user.

Comments on this Draft are welcome and should be submitted in writing to Secretary, Technical Standards Board, SAE Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2. References

2.1 Applicable Documents—The following publications form a part of this Draft Technical Report to the extent specified herein. The latest revision of each SAE Document or version of material issued by other organizations shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J560—Electrical Connector for Truck-Trailer Jumper Cable

SAE J1067—Seven Conductor Cable

2.1.2 ASTM PUBLICATION—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 117—Standard for Salt Spray Testing

2.2 Definitions

2.2.1 The coiled electrical cable consists of seven-conductor jacketed cable, described by SAE J1067, that has been formed into a cylindrical helix. The electrical connector specified in SAE J560 may terminate each end of the cable.

2.2.2 Extended length is the length to which the coiled section of the electrical cable can be stretched without exceeding the elastic limit. Extended length applies only to the coiled section of the cable; it excludes lead lengths (see 2.2.3).

2.2.3 Lead length refers to the straight, noncoiled cable section, including connector plug assembly, that terminates either end of a coiled electrical cable. Each lead length shall exceed 200 mm, as shown in Figure 1.

2.2.4 Working length is the extended length of the coiled electrical cable, plus its two lead lengths.

2.2.5 Sag refers to the vertical drop measured from the horizontal centerline to the lowest coil outside diameter when cable is stretched to the extended length.

2.2.6 A coil flex cycle is defined as stretching the coiled cable section to the extended length, and then allowing contraction to 150% of relaxed length.

2.2.7 Relaxed length is the length of the coiled electrical cable when lying on a smooth horizontal surface, under no external force except gravity, and having