SAE International™

SURFACE VEHICLE STANDARD

SAE J560

REV. APR2004

Issued 1951-07
Revised 2004-04

Superseding J560 JUL1998

(R) Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable

1. Scope

This SAE Standard provides the minimum requirements for Primary and Auxiliary jumper cable plug and receptacle for the truck-trailer and converter dolly jumper cable systems. 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 J2222—Coiled Electrical Cable
SAE J2394—Seven Conductor Cable for ABS Power

2.1.2 ASTM PUBLICATION

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

ASTM B 117-94—Standard Method of Salt Spray (Fog) Testing
ASTM G 153—Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G 154—Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

2.1.3 ISO PUBLICATIONS

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 1185:1997—Electrical connections between towing and towed vehicles with 24 V systems – 7 pole connector type 24 N (normal).
ISO 1724:1997—Electrical connections between towing and towed vehicles with 12 V systems – 7 pole connector type 12 N (normal).
ISO 3731:1997—Road Vehicles – Electrical connections between towing and towed vehicles with 24 V systems – 7 pole connector type 24 S (supplementary).
ISO 3732:1997—Road Vehicles – Electrical connections between towing and towed vehicles with 12 V systems – 7 pole connector type 12 S (supplementary).

2.1.4 TRUCK TRAILER MANUFACTURERS ASSOCIATION (TTMA)

1020 Princes Street, Alexandria, VA 22314

TTMA Technical Bulletin #65—Wiring Diagram for Truck Trailers
TTMA Technical Bulletin #119—Electrical Interface for Truck-Trailer Interconnection

2.1.5 FMVSS

Available from the Superintendent of documents, U.S. Government Printing Office, Washington, D.C. 20402-001

Code of Federal Regulations Title 49 Part 571.108—Lamps, Reflective devices, and Associated Equipment
Code of Federal Regulations Title 49 Part 121—Air Brake Systems

3. Definitions

3.1 Auxiliary Connector

As used in this standard refers to the receptacle and cable plug that provides power to the auxiliary devices on the trailer, but does not provide power to safety lighting and the Antilock Braking System (ABS) as required by FMVSS 108 and/or FMVSS 121.

3.2 Cable Plug

The cable plug is part of the jumper cable assembly.

3.3 Coupling Cycle

Coupling and uncoupling the plug and receptacle is one coupling cycle.

3.4 Primary Connector

As used in this standard refers to the receptacle and cable plug that provides power to safety lighting and the ABS as required by FMVSS 108 and FMVSS 121.

3.5 Receptacle

The receptacle consists of the connector socket, its housing, and a cover which latches the cable plug in place.

3.6 Serviceable

A serviceable part is one that can be removed with reasonable force and reinstalled without visible damage.

4. Identification Code Designation

4.1 Manufacturer Identification

Devices conforming to this document shall be identified with the manufacturer's identification. The device may include the model or part number.

4.2 SAE Designation

Devices conforming to this document shall be visually differentiated by connector type,

4.2.1 SAE J560

Primary connectors are used to supply power to devices regulated by FMVSS 108 and FMVSS 121. See table 4 for wiring functions.

4.2.2 SAE J560 AUX

Auxiliary connectors are used to supply power and control to auxiliary devices (i.e. lift gates, refrigeration power units, dome lamps, etc.). The connector shall be identified either by the color yellow and/or permanently marked with “AUX”. See table 4 for wiring functions

4.3 The revision (month and year) of the document to which the device conforms.

4.4 Example –

XYZ Corp.
SAE J560
Mo/Yr

5. Test Equipment and Instrumentation

5.1 The Power Supply

The power supply shall be capable of supplying the continuous current required to perform all tests.

5.2 Voltmeter

A direct current (DC) 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.

5.3 Ammeter

A DC ammeter shall be used for current measurements. The meter range resolution shall be 0.1 A.

5.4 Milliammeter

A DC ammeter shall be used for current measurements. The meter range resolution shall be 1.0 mA.

5.5 Hipot

Capable of detecting leakage currents of 0.5 mA at 500 VAC.

6. Test Procedures

6.1 Electrical

6.1.1 VOLTAGE DROP

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

6.1.1.1 Connect a 1000 to 2000 mm long SAE J2394 type cable to the receptacle terminals and another 1000 to 2000 mm long SAE J2394 type cable to the cable plug terminals.

6.1.1.2 Mate the cable plug and receptacle.

6.1.1.3 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 diameter terminal and 70 A to the circuit having a 6.35 mm diameter terminal.

6.1.1.4 Turn on power supply and wait 5 min for the circuits to stabilize.

6.1.1.5 Measure the voltage drop across each circuit of the assembly at a convenient point on the wire at least 25 mm from the terminal.

6.1.1.6 Connectors with active or passive electrical components may be tested by installing low-resistance shunts across the device.

6.1.2 ISOLATION RESISTANCE

This test is to be performed with the connector unmated with a hi-pot 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
#8 Shell to all other terminals

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

6.1.3 VIBRATION

6.1.3.1 Mounting

Connectors (Cable plug and receptacle mated) under test are to be mounted to the vibrating plane with the SAE J2394 wire harness end fixed to a stationary 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.

6.1.3.2 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).

6.1.3.3 Test Duration

Test to last a total of 12 h.. The connector shall be tested in each axis (X, Y and Z) for 4 h.. Monitor for discontinuity in excess of 100 ms at 100 mA during the last hour of vibration in each axis.

6.2 Mechanical

6.2.1 COUPLING FORCE

Mount the assembled cable plug and receptacle on a suitable fixture. Measure and record the peak force to fully mate the receptacle and cable plug until the receptacle's cover latch feature has engaged.

6.2.2 UNCOUPLING FORCE

Mount the assembled cable plug and receptacle on a suitable fixture. The force in the following tests shall be applied parallel to the axis of the connector.

6.2.2.1 Unlatched

Measure and record the peak force to disconnect the cable plug after manually disengaging the receptacle's cover latch feature.

6.2.2.2 Latched

Measure and record the peak force to disconnect the cable plug with the cover latch engaged.

6.2.3 ANGULAR PULL FORCE

Mount the cable plug and SAE J2394 cable assembly and receptacle on a suitable fixture. A pull force of 667 N shall be exerted on the cable at an angle 60°, on the plugs horizontal axis, for a duration of 24 h at 25 ± 5 °C. Continuity of the wiring circuits shall be monitored during the test.

6.2.4 STRAIGHT PULL (CABLE PLUG)

A cable plug and SAE J2394 cable assembly shall be securely mounted in a suitable fixture. A pull force of 667 N shall be exerted on the cable along the axis of the cable plug for a duration of 24 h at 25 ± 5 °C. Continuity of the wiring circuits should be measured before and after completion of the 24 hrs. duration.

6.2.5 TERMINAL WIRE RETENTION

This test pertains to the mechanical connection between the connector terminals and the 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. All samples are to be pulled to destruction.

6.2.6 TERMINAL RETENTION FORCE

Both the receptacle and cable plug terminals shall be subjected to a direct pull and push force of 175 N for 1 min. The force is to be exerted on each terminal without sudden or jerking forces during the test.

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

6.2.7 CYCLE COVER SPRING

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

6.2.8 COUPLING CYCLE TEST

The cable plug and SAE J2394 cable assembly and receptacle shall be engaged and disengaged at a rate not to exceed 300 cycles per hour for 5000 cycles.

6.3 Environmental

6.3.1 FLUID RESISTANCE

A sample of an assembled plug and an assembled receptacle shall be prepared for each fluid to be tested. A separate sample shall be immersed in each of the fluids shown in Table 1 for a period of 20 h. After removal from the fluid, remove excess fluid from the sample and then condition the sample for 4 h at room temperature.

TABLE 1 – TEST FLUIDS

Fluid	Concentration (%)	Fluid Specification	Test Temp (ºC)
Diesel Fuel #2	90 – 100	IRM-903/T-Xylene	60 ± 3
Engine Coolant	50/50	ASTM D 471, Service Fluid 104	85 ± 3
Engine Oil 30 wt	100	ASTM D 471, IRM-902	85 ± 3
Gear Oil	100	ASTM STP 512, API GL-5	85 ± 3

6.3.2 SALT SPRAY

6.3.2.1 Coupled

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 120h salt spray test per ASTM B 117.

6.3.2.2 Uncoupled

Subject the test sample from 6.3.2.1 in the uncoupled state to a 120 h salt spray test per ASTM B 117. Mount the receptacle in a normal vehicle position with the cover closed, and the cable plug with the mating end down.

6.3.3 THERMAL SHOCK

The mated connectors shall be subjected to 10 cycles of thermal shock. One cycle shall consist of 2 hrs at –40 °C ± 3 °C, followed by 2 hrs at 85 °C ± 3 °C with a transition time of 2 min maximum.

6.3.4 ULTRAVIOLET EFFECTS

Test the mated connectors for 1000 hrs per ASTM G 154 or ASTM G 153 with 20 hrs UV and 4 hrs of condensation for each cycle.

6.4 Test Sequences

Each test sequence is to be performed on six different production level connector assemblies in the order listed in Table 2. No supplemental lubrication or other cleaning of the terminal pins prior or during the test sequence is permitted.

TABLE 2 – TEST SEQUENCES

Test Order	Durability Test		Mechanical Test		Environmental Test	
1	Voltage Drop	6.1.1	Voltage Drop	6.1.1	Voltage Drop	6.1.1
2	Isolation Resistance	6.1.2	Isolation Resistance	6.1.2	Isolation Resistance	6.1.2
3	Thermal Shock	6.3.3	Thermal Shock	6.3.3	Thermal Shock	6.3.3
4	Coupling Force	6.2.1	Vibration	6.1.3	Salt Spray	6.3.2
5	Uncoupling Force	6.2.2	Straight Pull	6.2.4	Fluid Resistance	6.3.1
6	Angular Pull Force	6.2.3			Ultraviolet Effects	6.3.5
7	Cycle Cover Spring	6.2.7	Terminal Pin Retention		Voltage Drop	6.1.1
8	Coupling Cycle Test	6.2.8	Voltage Drop	6.1.1	Isolation Resistance	6.1.2
9	Voltage Drop	6.1.1	Isolation Resistance	6.1.2		
10	Isolation Resistance	6.1.2	Terminal Crimp Strength			

7. Performance Requirements

7.1 Electrical

7.1.1 VOLTAGE DROP

The voltage drop for each circuit shall not exceed 3 mV/A.

7.1.2 ISOLATION RESISTANCE

The leakage current between each circuit and the other six circuits shall not exceed 0.5 mA.

7.1.3 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.

7.2 Mechanical

7.2.1 COUPLING FORCE

The unlatched coupling force shall not exceed 223 N in accordance with 6.2.1.

7.2.2 UNCOUPLING FORCE

The uncoupling force test requirements are as follows:

7.2.2.1 Unlatched

The unlatched uncoupling force shall not exceed 223 N in accordance with 6.2.2.1.

7.2.2.2 Latched

The latched uncoupling force shall not be less than 178 N in accordance with 6.2.2.2.

7.2.3 ANGULAR PULL FORCE

The cable plug and SAE J2394 cable assembly and receptacle shall not show any visual damage or loss of electrical continuity in accordance with 6.2.3.

7.2.4 STRAIGHT PULL

An assembled cable plug and trailer jumper cable shall not be damaged when tested in accordance with 6.2.4.

7.2.5 TERMINAL/WIRE INTERFACE STRENGTH

This is a destructive test. The tensile test of paragraph 6.2.5 performed on the terminal/wire interface shall meet the requirements of Table 3

TABLE 3 – MINIMUM TENSILE STRENGTH FOR TERMINAL/WIRE INTERFACE CONNECTIONS

Cable Size (mm^2)	Cable Size (AWG)	Minimum Tensile Strength (N)
8.0	8	445
5.0	10	375
3.0	12	335

7.2.6 TERMINAL RETENTION FORCE

The terminal shall maintain its original position in the connector after testing in accordance with 6.2.6.

7.2.7 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 when tested in accordance with 6.2.7.

7.2.8 COUPLING CYCLE TEST

The cable plug and SAE J2394 cable assembly and receptacle shall still function properly at the end of the cycles specified in 6.2.8.

7.3 Environmental

7.3.1 FLUID RESISTANCE

Upon completion of the tests conducted in accordance with 6.3.1, the connectors must remain serviceable. A visible inspection shall reveal no cracks, splits, or other damage to the items used in the construction of the assembly.

7.3.2 SALT SPRAY

The connector materials may show evidence of corrosion as long as it is not detrimental to the normal operation of the connector in accordance with 6.3.2.

7.3.3 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 6.3.3.

7.3.4 ULTRAVIOLET EFFECTS

After testing in accordance with 6.3.4, conduct a visual examination of the connector. damaged seals, cracked plastic, or anything that could affect the performance and serviceability of the connector shall constitute a failure.

7.4 Test Sequences

The samples shall comply with all the tests in the sequence. Failure of one test during the sequence constitutes a failure of the sample.

8. Design Requirements

8.1 Interchangeability

The cable plug and receptacle shall be designed to conform to the performance requirements of this document.

8.2 Latchability

The cable plug shall be designed to mate and latch to any receptacle designed to conform to this document except that primary connectors shall not be compatible with Auxiliary connectors. The latch mechanism shall be constructed to latch and release without interference.

8.3 Indexing

The cable plug and receptacle shall be designed with an indexing feature. Indexing is required to insure proper electrical mating.

8.4 Wiring Circuits

The function and color code of each circuit is shown in Table 4. 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 and SAE J2394. The receptacle and cable plug shall be constructed so that the "WHT" terminal shall accommodate at least an 8.0 mm^2 size wire and all other terminals at least a 5.0 mm^2 size wire.

TABLE 4 – WIRING CIRCUITS (REFERENCE TTMA TB #65 & #119)

Conductor Identification Terminal Number	Conductor Identification Wire Color	Lamp and Signal Circuit
Primary		
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 Braking System (ABS) (Secondary Power)
5	Grn (Green)	Right turn signal and hazard lamps
6	Brn (Brown)	Tail and license plate, clearance and/or side marker lamps
7	Blu (Blue)	Continuous ABS primary power/auxiliary devices
Auxiliary		
8	Wht (White)	Ground return to towing vehicle
9	Blk (Black)	Cab switched auxiliary power
10	Yel (Yellow)	ABS malfunction signal to cab
11	Red (Red)	Constant or ignition auxiliary power
12	Grn (Green)	Unassigned
13	Brn (Brown)	Unassigned
14	Blu (Blue)	Unassigned

8.5 Receptacle

Figure 1 shows receptacle dimensions and design requirements. Figure 2 shows alternate construction features. An integral cover with a weather-tight 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.

8.6 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.

8.7 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.

8.8 Latching Means

Receptacle cover shall be provided with a latching means that engages with the cable plug.

9. Guidelines

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

9.2 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.

9.3 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.

10. Notes

10.1 Marginal Indicia

The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

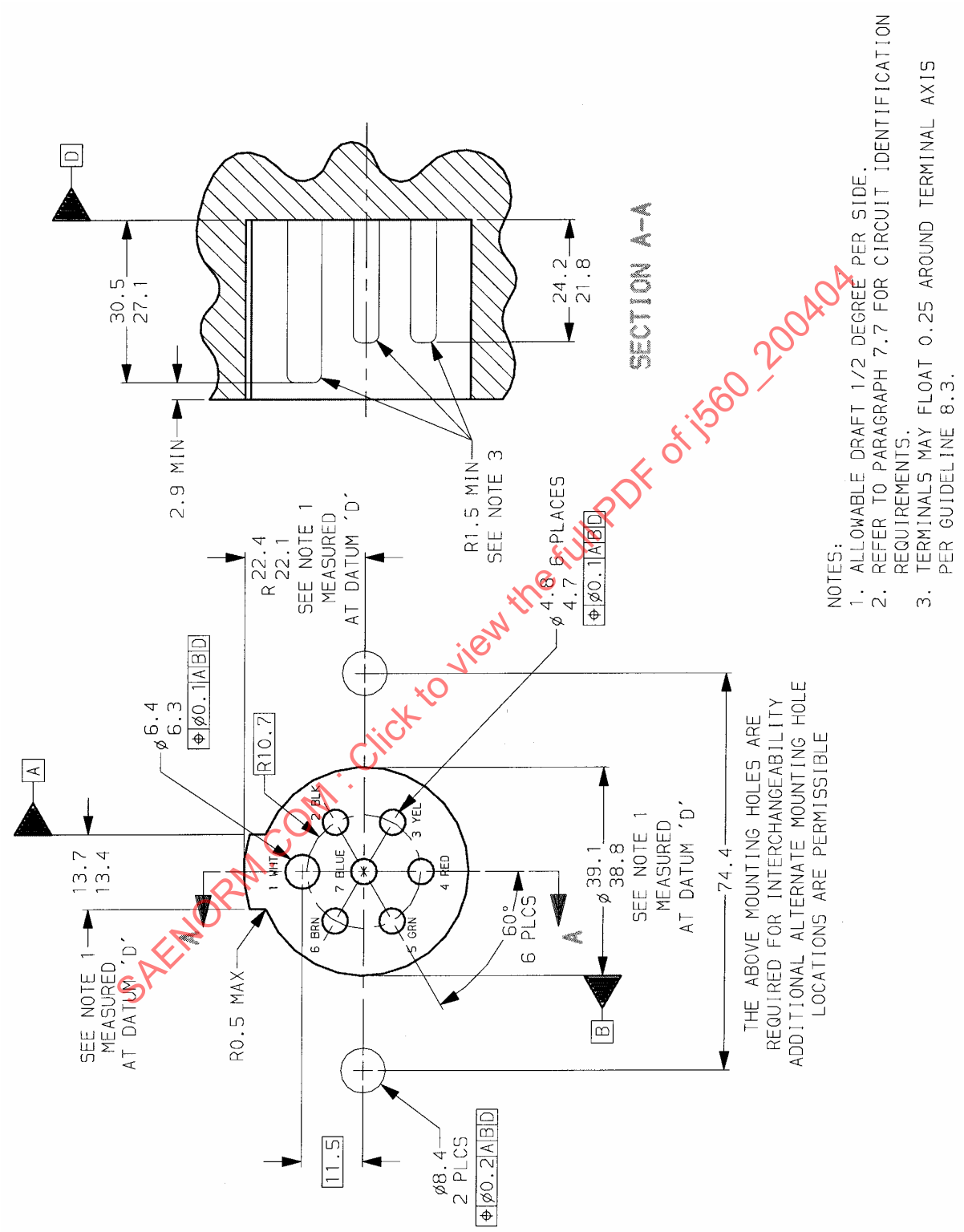

FIGURE 1—PRIMARY RECEPTACLE SOCKET

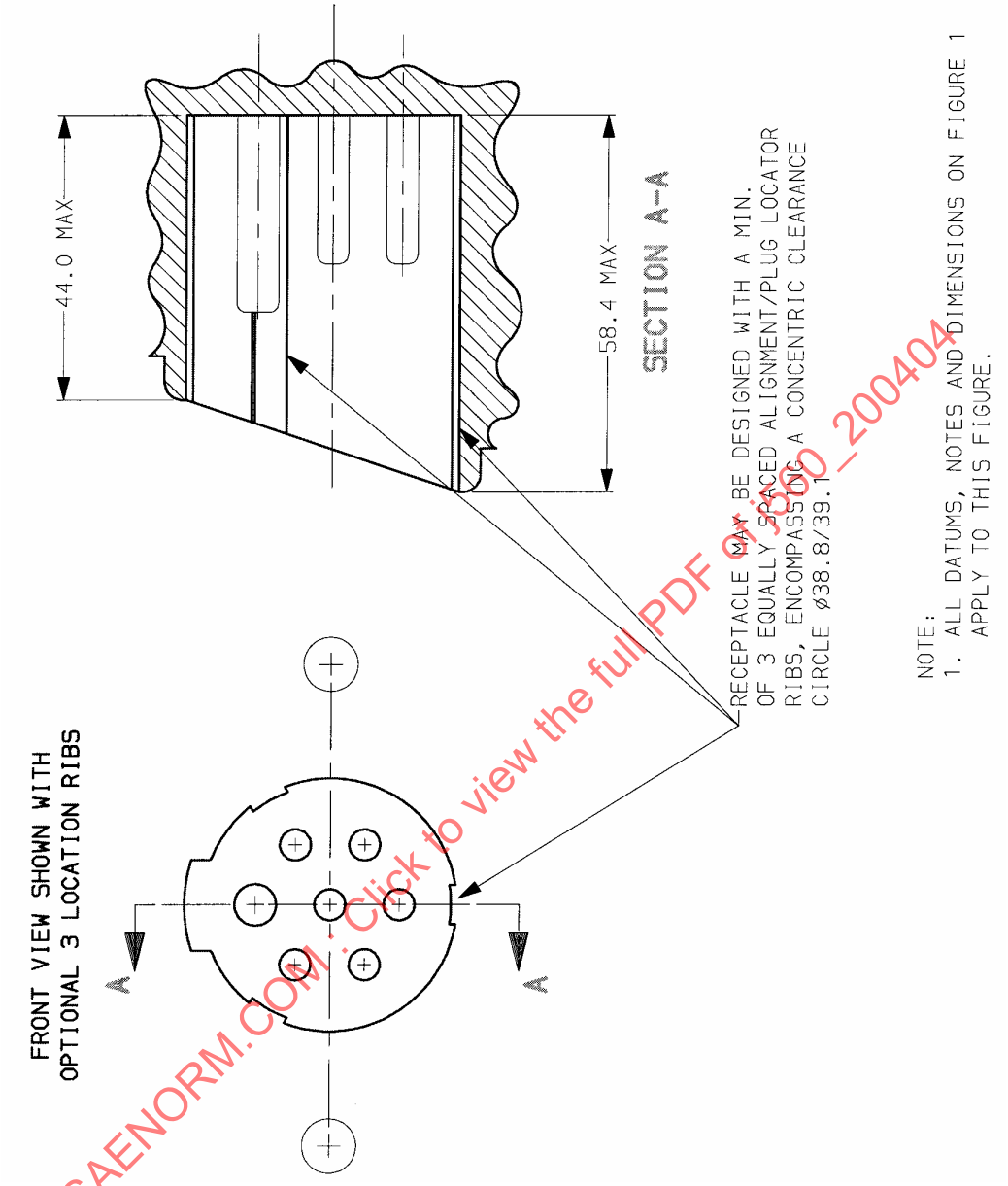

FIGURE 2—PRIMARY ALTERNATE CONSTRUCTION RECEPTACLE SOCKET

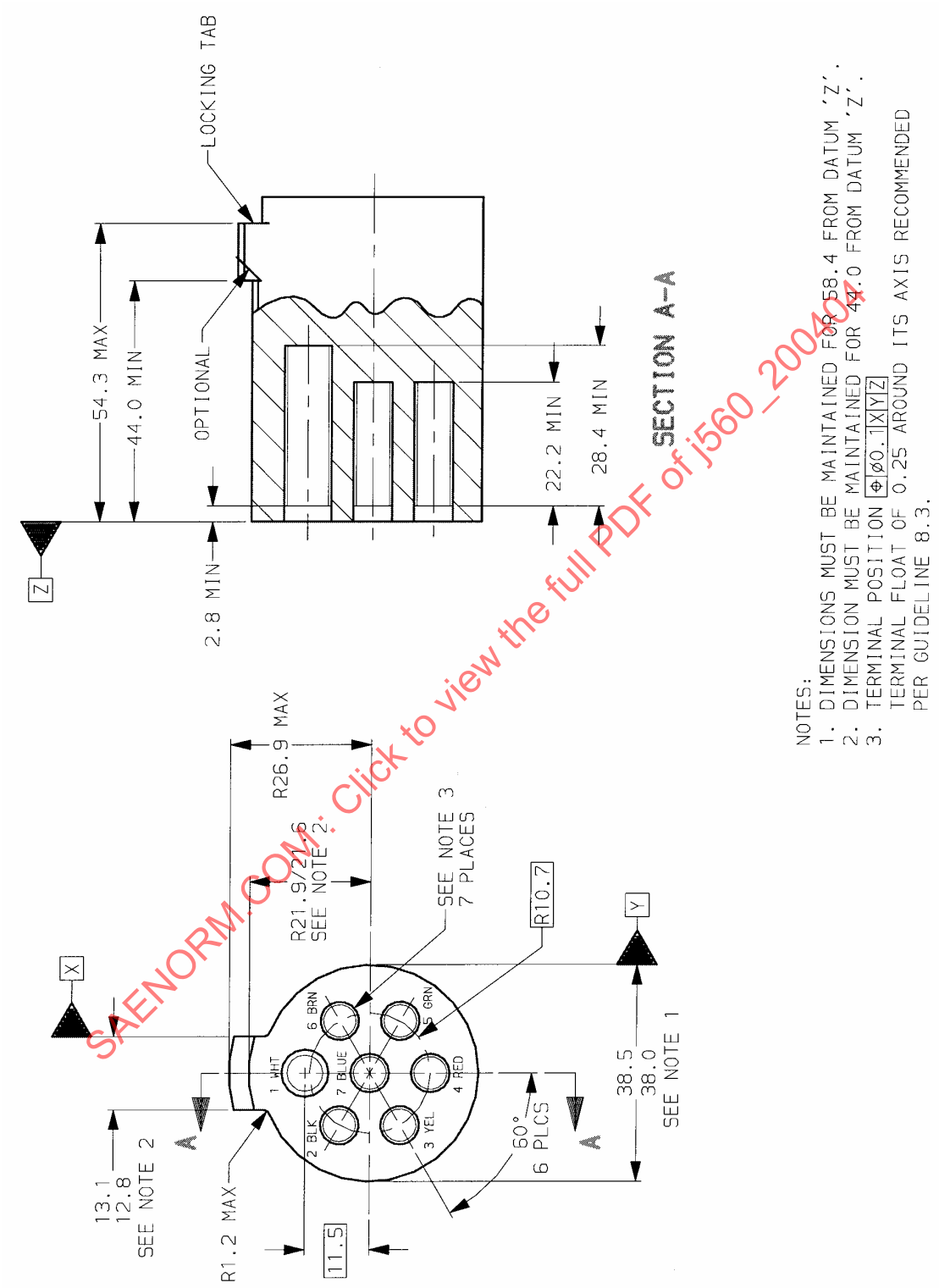

FIGURE 3—PRIMARY CABLE PLUG

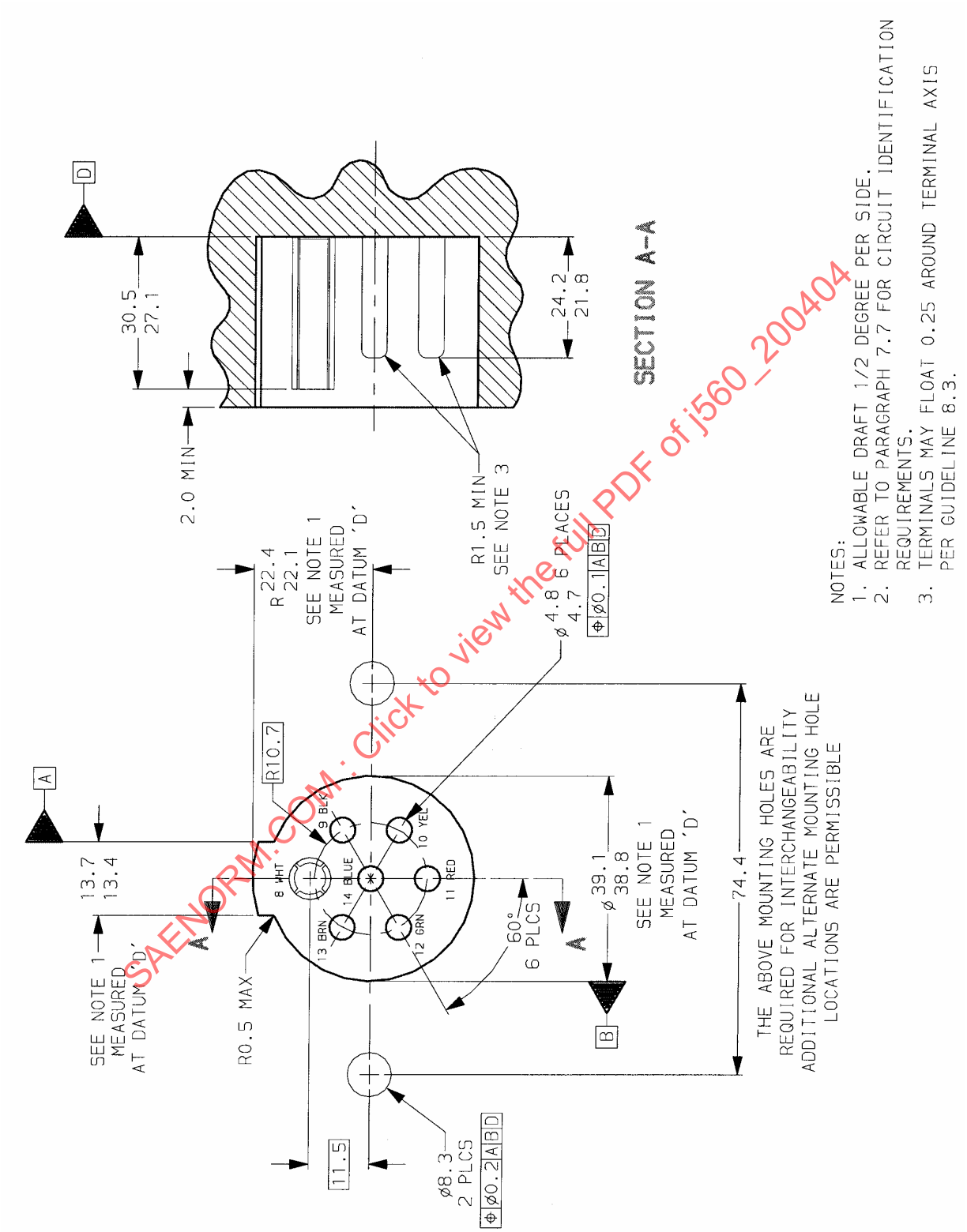

FIGURE 4—AUXILIARY RECEPTACLE SOCKET