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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1292

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AUTOMOBILE, TRUCK, TRUCK-TRACTOR, TRAILER, AND MOTOR COACH WIRING

[This SAE Recommended Practice combines, revises, and replaces two previous recommended practices: SAE J555a and SAE J556.]

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. Scope—This SAE Recommended Practice covers the application of primary wiring distribution system harnesses to automotive, truck, and similar type vehicles. This is written principally for new vehicles but is also applicable to rewiring and service. It covers the areas of performance, operating integrity, efficiency, economy, uniformity, facility of manufacturing and service. This practice applies to wiring systems of less than 50 V.

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 version of SAE publications shall apply.

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

SAE J156—Fusible Links
SAE J163—Low Tension Wiring and Cable Terminals and Splice Clips
SAE J258—Circuit Breaker—Internal Mounted—Automatic Reset
SAE J541—Voltage Drop for Starting Motor Circuits
SAE J553—Circuit Breakers
SAE J554—Electric Fuses (Cartridge Type)
SAE J560—Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable
SAE J561—Electrical Terminals—Eyelet and Spade Type
SAE J573—Miniature Lamp Bulbs
SAE J575—Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width
SAE J858—Electrical Terminals—Blade Type
SAE J895—Five Conductor Electrical Connectors for Automotive Type Trailers
SAE J928—Electrical Terminals—Pin and Receptacle Type
SAE J1067—Seven Conductor Jacketed Cable for Truck Trailer Connections
SAE J1127—Battery Cable
SAE J1128—Low-Tension Primary Cable

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

ASTM D 573—Test Method for Rubber—Deterioration in an Air Oven

3. General Section

3.1 Definition—The systems of installation known as two wire or single wire are to be designated respectively as insulated-return and ground-return systems. Installations in which the frame and/or body of the vehicle are used as part of the return circuit are considered as ground-return systems.

3.2 Insulated Cable—All insulated cable shall conform to SAE Standards J1127 and J1128.

3.2.1 CONDUCTORS

3.2.1.1 All conductors are to be constructed in accordance with SAE J1127 and J1128 except when good engineering practice dictates special strand constructions.

3.2.1.2 Conductor materials and stranding other than copper can be used if all applicable requirements for physical, electrical, and environmental conditions are met as dictated by the end application.

3.2.2 CONDUCTOR INSULATION—Physical and dimensional values of conductor insulation are to be in conformance with the requirements of SAE J1127 or J1128 except when good engineering practice dictates special conductor insulations.

3.3 Insulated Cable Application

3.3.1 Select cable insulation in accordance with the vehicle's working environment. Consideration is given to physical and environmental factors such as flexing, heat, cold, bend, oil and fuel contact, dielectric, abrasion, short circuit, and pinch resistance among others.

Note: Most vehicle working environments permit the use of a thermoplastic insulated, SAE type GPT, general purpose cable. A cable of this type is generally used in static (non-flexing) applications when nominal abrasion, heat, cold, oil, dielectric, short circuit, and pinch resistance properties are desired.

3.3.2 Where vehicle working environments for cable require additional physical and environmental characteristics, upgraded insulations such as SAE types HDT, GPB, HDB, STS, HTS, and SXL shall be used as the severity of the applications dictate.

3.3.3 Specific continuous duty temperature limitations for each SAE cable type shall be observed. The total of the ambient temperature plus cable temperature rise, due to current flow, should not exceed the continuous duty guideline temperatures as shown in Table 1, unless extensive testing and/or evaluation has indicated that higher temperatures can be tolerated.

In addition, the maximum continuous duty temperature rating for any wire insulation shall be determined by an accelerated aging test conducted in accordance with ASTM D 573, with the samples of insulation being removed from the finished wire and aged 168 h. The test temperature shall be 30 °C above the intended rated temperature. Tensile strength after aging shall be not less than 80% of the original tensile strength. The elongation after aging shall be at least 50% of the original elongation.

Note: Heavier conductors may be required to protect the carrying of current in wire bundles when all conductors are carrying maximum current. Temperature rise tests of the conductor bundle shall be run to determine the proper conductor size and insulation.

Resistance wire low tension cable may be used to limit the voltage applied to electrical devices. Since the nature of the wire is to limit the voltage applied to electrical devices, the distance of the device from the power source and the current demand of the device will determine the materials used. Because every application is different, no materials, conducting or insulating, can be specifically described as standard; thus the conductor and insulating materials must be carefully chosen for each application by the design engineer. It is desirable to identify resistance wire by printing the words resistance wire on the conductor.

Extreme care shall be used by the design engineer in choosing resistance wire as a conducting material to satisfy the current demand of the device and not create a temperature rise in the conductor that would deteriorate the insulating material even though the device is left on continuously.

Circuits using resistance wire shall be carefully placed in the vehicle so that their temperature rise will not create a hazard to, or malfunction of, any part of the vehicle. A general design guide would be that the conductor will be required to dissipate no more than 5 W per insulated conductor foot.

TABLE 1—

SAE Cable (Ref. SAE J1128)	Temperature[1]
Type GPT, HDT, GPD, HDB	194 °F (90 °C)
Type STS, HTS	221 °F (105 °C)
Type SXL	275 °F (135 °C)

1. Recommended maximum continuous duty temperature (ambient plus rise).

3.3.4 FUSIBLE LINKS—A special section of low tension cable designed to open circuit when subjected to an extreme current overload shall conform to SAE J156.

3.3.5 It is desirable to color code each conductor in an electrical circuit to facilitate manufacture and service of a wire assembly. It is further desirable for all motor vehicle manufacturers to assign and use similar color code information for commonly used electrical circuits to promote ease of circuit analysis in service among the various manufacturers.

3.3.5.1 When feasible each circuit shall conform to a recommended color code by category of equipment as shown in Table 2. Otherwise, the color code may be a solid color (basic) and/or a basic color with secondary color stripes, dots, or hashes.

TABLE 2—CIRCUIT COLOR CODE - BASIC CIRCUITS (AUTOMOTIVE ONLY)

Function	Color
Left rear stop and turn	Yellow
Right rear stop and turn	Dark green
Auxiliary	Blue
Tail, side marker, license	Brown
Ground	White

NOTE—The above code is identical to the color code adopted for automotive type trailers - SAE J895.

3.3.5.2 Secondary color markings to be applied as to be visible throughout the entire length of the wire, or at each end of a lead.

3.3.5.3 Color combinations for special circuits not shown on Table 2 are to be selected by the user. As special circuit functions become standard with manufacturers, they shall be added to the recommended Color Code by category and shown in Table 2.

NOTE—It is desirable for the wire of any one circuit to be of uniform color code throughout the circuit regardless of the number of connections. A circuit is assumed to be continuous until it can be interrupted by a relay or switch contacts, or when it reaches a load (such as bulbs, motors, etc.). Fusible links may differ in color from the circuits they are protecting as it could be advantageous to identify fusible link wire gauge size by insulation color.

3.3.5.4 Each circuit in the same wire assembly shall be distinguished from one another in some manner such as color code, or some substantial difference in insulation diameter (that is, two or more gauge sizes).

3.4 Conductor Termination

3.4.1 All stranded conductor stripped ends are to be fitted with terminals (exception-splices). Solid, precisely shaped conductors whose ends are the termination shall not have this fitting.

3.4.2 All terminal attachments to conductors shall conform with the physical and electrical performance requirements of SAE J163.

3.4.3 As a general practice, all terminations have integral and functional insulation grips, except where other secondary applications preclude their use. Special applications without insulation grips may be employed where other means of relieving strain are provided.

3.4.4 A terminal shall be attached to a conductor by a simple mechanical crimp-type process that will conform to the intent of paragraph 3.4.2. For maximum reliability and surety of connection, the crimp may also be soldered, swagged, brazed, or welded in a workmanlike manner. Care shall be taken to minimize wicking of solder in a stranded wire to avoid impairment of the strain relief or cable flexing.

3.4.5 CIRCUIT GROUNDING—Ground terminal lugs shall be solder dipped, cadmium, tin, or zinc plated. Ground terminals shall be accessible for service. A serrated paint cutting terminal may be utilized to make proper contact on painted surfaces. Ground terminal devices shall be cadmium, tin, or zinc plated. In special cases, plating may not be required for lugs and/or attaching devices.

Ground return connections shall be made to the vehicle structure, frame, or engine. In cases where the engine or body is mounted on rubber or other insulation, proper ground shall be provided.

3.4.6 Terminations used shall comply with the requirements of SAE J561, ring and spade types; SAE J858, blade type; and SAE J928, pin and receptacle type. Secondary applications will dictate the use of special terminations for special use or application.

NOTE—Terminations may be plated with a conductive and corrosion resistant material such as tin or silver to upgrade the current carrying capacity and to improve their resistance to corrosion.

3.5 Conductor Splicing

3.5.1 Conductors shall be mechanically crimped, soldered, swagged, brazed, or welded with other conductors to form a wire splice. All wire splices shall conform with the electrical specifications for splices per SAE J163.

3.5.2 Splices shall be mechanically secure to withstand all fabrication installation and vehicle environment abuse. The splice must be insulated.

3.6 Terminal and Connector Function

3.6.1 Single terminations shall be used only where there is no possibility of misconnections in assembly or service except when special applications may require otherwise.

3.6.2 Multiple terminal connect-disconnect connector bodies shall be used at all points where two or more conductors are terminated and where there is a possibility of misconnection in fabrication, assembly, or service; secondary applications may require a deviation from this practice.

3.6.3 All connections shall be designed to maintain surety of connections while subjected to vibration, shock, and the extreme temperatures that are normal environmental conditions for motor vehicles. Surety may be accomplished by employing the use of integral-molded lock devices, terminal to terminal interferences (detents), secondary locking clips, or attaching devices.

3.6.4 All multiple connect-disconnect connector bodies shall be polarized to prevent incorrect assembly unless circuitry permits use of a nonpolarized connector.

3.6.5 Connections shall be located in clean, dry areas when possible. Connections shall be designed to maintain circuit integrity regardless of environmental conditions (such as high humidity, road splash, rain, drainage, earth particles, fuels, lubricants, high and low temperatures, and solvent).

3.7 Conductor Grouping

3.7.1 Conductors are to be grouped together into multiple conductor assemblies whenever possible.

3.7.2 The number of wiring assemblies and electrical connections per vehicle shall be kept to a minimum with overlay or option wiring used only when justified by the economics of fabrication, vehicle installation, and service.

3.8 Wire Assembly Construction

3.8.1 Conductors are to be grouped, where practical, in cable or harness form.

NOTE—Suitable material such as braided cotton, braided paper and cotton, braided vinyl/nylon, flexible plastic conduit, friction or thermoplastic tape, extruded rubber and thermoplastic jackets, or woven loom may be used to form the assembly.

3.8.2 Wiring harness covering shall be adequate to protect the harness in the vehicle routing environment and shall furnish protection during all phases of vehicle assembly and operation.

NOTE—A general guideline to be used in the selection of coverings is specified in Table 3.

3.9 Wire Assembly Installation and Protection

3.9.1 Wiring and related devices shall be installed in a workmanlike manner, mechanically and electrically secure. Devices, lamps, and so forth requiring periodic service shall be serviceable and accessible by providing wire length sufficient to reasonably accomplish this.

3.9.2 In general, wire routing shall be such that maximum protection is provided by the vehicle sheet metal and structural components. Smooth protective channels especially designed for wiring and built into the vehicle body structure should be used when practicable. Avoid areas of excessive heat, vibration, and abrasion.

NOTE—Extra protection (such as braid, loom, conduit, etc.) should be provided when these areas cannot be avoided (Ref. Table. 3).

TABLE 3—

Type	Wire Harness Covering	General Application
1	Vinyl Plastic Tape - 0.007 in (0.18 mm)	Primarily used for grouping cables into wire harnesses. Wiring not subject to damage from scuffing or scrubbing on rough metal edges.
2	Friction Tape, Cotton and Kraft Paper Braid	Generally optional; improved scuff and scrub resistance.
3	Vinyl/Nylon Braid	Improved abrasion resistance.
4	Non-Metallic Loom (Woven Asphalt, Impregnated Loom, Extruded Vinyl Plastic, or Elastomeric Tubing)	Improved scuff and abrasion resistance.
5	Rigid and Flexible Conduit	For maximum abrasion resistance and/or positive positioning for clearance to moving or heated vehicle components.

3.9.3 All parts of the electrical system shall be adequately protected against corrosion.

3.9.4 If significant vibration levels exist, the edges of all metal members through which cables and harnesses pass shall be deburred, flanged, rolled, or bushed with suitable grommets. Suitable tubing or conduit over cables may be substituted for grommets if properly secured. Clips for retaining cables and harnesses shall be securely attached to body or frame member and cable or harness. Clips also assist in locating and routing at assembly.

3.9.5 Wiring shall be located to afford protection from road splash, stones, abrasion, grease, oil, and fuel. Wiring exposed to such conditions shall be further protected by either, or a combination of, the use of heavy wall thermoplastic insulated cable, (see SAE Standard J1128, Low Tension Primary Cable) additional tape application, plastic sleeving or conduit, nonmetallic loom, or metallic or other suitable shielding or covering.

3.9.6 Where cables must flex between moving parts, the last supporting clip shall be securely mounted and secure the cable in a permanent manner.

3.9.7 Wiring fasteners shall be non-conductive unless the wiring or fastener involved is provided with extra heavy outer covering such as nonmetallic conduit, tape, or dip.

NOTE—Overlay or option wiring should be routed in the same fasteners with standard wiring where practical, or should be fastened to the standard wiring with plastic straps or other mechanical means.

3.9.8 Electrical apparatus with integral wiring shall be supplied with grommets or other suitable mechanical fasteners for strain relief.

3.10 Wiring Overload Protective Devices

3.10.1 The current to all low-tension circuits, except starting motor and ignition circuits, shall pass through short circuit protective devices connected to the battery feed side of switches. Headlight systems shall be independently protected. Circuit protection shall be accomplished by utilizing fuses, circuit breakers, or fusible links which conform to SAE Standards.

3.10.2 The protective device shall be selected to prevent wire damage when subjected to extreme current overload.

3.10.2.1 Fuses—Fuse sizes shall be selected using guidelines presented in SAE J554, Electric Fuses.

3.10.2.2 Circuit Breakers—Fail-safe automatic reset circuit breakers shall be employed when it is necessary to quickly re-establish circuit continuity when that portion of the wiring has been subjected to an overload condition. Non-cycling type circuit breakers will not reset until the overload is removed, (unless they are the non-cycling manual-reset type). Circuit breakers shall conform to SAE J553 and SAE J258.

3.10.2.3 Fusible links shall be employed when heavy feed circuits exceed the continuous working limits of the fuses or circuit breakers. The link of wire, acting like a fuse, shall conform to the guidelines presented in SAE J156, Fusible Links.

4. Truck, Truck-tractor Section

4.1 The following SAE Recommended Practice relates to wiring for exterior lamps, exclusive of head lamps, of commercial vehicles 80 in (203 cm) or more in width. Except as noted, the wiring system shall conform to the guidelines of Section 3.

4.1.1 LAMP—A lamp is a complete lighting unit. All lamps shall meet the requirements of SAE Standard J575, Lighting Equipment for Motor Vehicles. Lamps with pigtails not in excess of 12 in (30 cm) long shall have a minimum of 16-gauge wire; pigtails in excess of 12 in (30 cm) long shall have wire gauge conforming to the wiring requirements of the vehicle.

4.1.2 WIRE SIZE—To minimize voltage drops, the feed wire size for all circuits shall be a minimum of 12-gauge; branches or taps not in excess of 50 ft (15.2 m) in length shall be 14-gauge. The ground wire for insulated-return systems shall be equal to the respective feed wire. The main ground wire shall be a minimum of 10-gauge.

NOTE—In many cases 4 or 6 gauge may be required.

4.1.3 DESIGN VOLTAGE OF LAMPS—Reference SAE Standard J573, Lamp Bulb and Sealed Units for design voltage values applicable to various bulbs.

4.1.4 Truck-tractors shall conform to Section 3 and the following:

4.1.4.1 *Circuit Identification*—It is desirable to follow the SAE Recommended Practice J1067, Seven Conductor Jacketed Cable for Truck and Trailer Connections, for coding of truck-tractor jumper cable throughout the circuit. Where impractical, the coding is to be followed to a junction block or harness terminating point where visual inspection will identify the circuit coding change. The coding may also be numbers and/or letters printed on the wire insulation. Whatever coding system is chosen, the system shall facilitate in harness manufacturing and in service.

4.1.4.2 *Circuit Termination*—Wiring for trailer circuits shall terminate in:

a. A connector socket conforming to SAE Recommended Practice J560, Seven-Conductor Electrical Connector for Truck-Trailer Jumper Cable, or
b. A jumper cable with cable plug conforming to SAE J560.

5. Trailer Section

5.1 Trailers shall conform to Section 3 and the following:

5.1.1 WIRING—All wiring shall be installed in:

a. Suitable conduit and boxes,
b. Structure of the trailer, and
c. Housings and/or raceways which provide equal protection.

Wiring shall be protected from stones, excess dirt, ice, moisture, chafing, and so forth, that will result in harmful effects.

All wiring for legally required lights shall be serviceable in a manner permitting removal and reinstallation from outside the trailer.

5.1.2 GROUNDING—The trailer shall be grounded to the tractor through the jumper cable.

NOTE—Contact of the trailer king pin or apron plate with the lower coupler or grounding through the coupler is not to be considered as providing a tractor-to-trailer ground.

5.1.3 MARKING—The voltage of the lighting system shall be permanently or semi-permanently marked in a legible manner on a mounting surface, in proximity to the electrical connector receptacle. Preferably, the marking shall be in amber reflective letters.

5.1.4 TRAILER CONNECTOR SOCKET—The trailer connector socket for receiving the jumper cable plug shall conform to SAE J560.

5.1.5 CIRCUIT PROTECTION—Circuit protection independent of truck-tractor system shall be provided. Trailer circuit protective devices shall conform to SAE Standard J554, Electric Fuses or SAE Recommended Practice J553, Circuit Breakers and shall be located near the trailer wiring connector socket and be readily accessible for service.

6. Motor Coach Section

6.1 Motor coaches shall conform to Section 3 and the following:

6.1.1 WIRING—Where practical, wiring is to be located within the structure of the coach where it will not be subjected to damage by road splash, stones, grease, oil, fuel, or abrasion.

Wiring so located that it will be subjected to more than normal wear or hard usage shall be equipped with a means of disconnecting from the main harness and be easily removable for replacement or repair.

Wiring connections to lights mounted on the coach body shall be accessible from outside, with the light removed or through an access door in an interior trim panel.

7. Storage Battery Cables

7.1 Definition—Battery cables provide the link between the battery(s) and the balance of the starting/charging circuit. Items that dictate the design are:

7.1.1 ROUTING—Routing shall be established with the following guidelines:

7.1.1.1 Areas of excessive heat, abrasion, and vibration are to be avoided. Extra protection (such as loom, conduit, tubing, heat shield, etc.) shall be provided when these areas cannot be avoided.

7.1.1.2 Grommets or ferrules and nipples shall be provided when routed through holes in the frame or sheet metal.

7.1.1.3 Support at intervals of approximately 24 in (61 cm). Insulated or nonconductive supports shall be used.

7.1.1.4 Provide strain relief for the battery and starter motor terminals as close to terminals as practical.

7.1.1.5 Tailor such that the cables are not too loose nor too tight, considering engine rocking due to torque changes.