



AEROSPACE STANDARD

AS60491™**REV. A**

Issued 2015-12
Revised 2019-10
Reaffirmed 2026-05

Superseding AS60491

Sleeve, Protection, for Cable and Harness Protection

RATIONALE

AS60491A adds missing water repellency requirement and test method.

AS60491A has been reaffirmed to comply with the SAE Five-Year Review policy.

A reaffirmed status is given to technical reports that have been reviewed by the technical committee and deemed to be current with no need for immediate revision. No changes have been made to this document as a result of this review.

1. SCOPE (SEE 6.1)

Procurement specification is principally for defining protection sleeves on a cable or group of electrical/fiber optic wires (wiring bundle). Single wire protection depends on the minimum diameter of the wire. Sleeve may be used to protect a wire bundle for a platform installation or for repair of installed damaged jacket or jacket/shielded wire bundles. Refer to AS50881 for aerospace wire bundle protection installations.

1.1 Temperature Operation Range

The sleeve temperature range is -60 to +175 °C/+200 °C/+240 °C/+260 °C depending on material and is defined in the detail specification. Mechanical properties may be reduced with increasing temperature.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1424	Deicing/Anti-Icing Fluid, Aircraft SAE Type 1
AIR1351	Manufacturers' Identification of Aerospace Electrical and Electronic Wiring Devices and Accessories
AS4373	Test Methods for Insulated Electric Wire
AS9100	Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations

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SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

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SAE WEB ADDRESS:

Full document details: [SAE AS60491A](http://www.sae.org/standards/content/AS60491A/)

For more information on this standard, visit
<https://www.sae.org/standards/content/AS60491A/>

Documents

Standard, visit Sharing Hub

AS50881	Wiring Aerospace Vehicle
AS60491/1*	Sleeve, Chafe-protection, Wrap-Around, Self-closing (-55 to +200 °C)
AS60491/2*	Sleeve, Chafe-protection, Wrap-Around, Self-closing, High Temp (-55 to +260 °C)
AS60491/3*	Sleeve, Chafe-protection, Expandable (-55 to +200 °C)
AS60491/4*	Sleeve, Chafe-protection, High Abrasion, Expandable (-55 to +200 °C)
AS60491/5*	Sleeve, Chafe-protection, Expandable (-55 to +240 °C)
EIA-557	Statistical Process Control Systems
SAE J2192	Recommended Testing Methods for Physical Protection of Wiring Harnesses

*AS60491 detail specification

2.1.2 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83133	Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-434), NATO F-35, and JP-8+100 (NATO F-37)
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordinance
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Numbers: O-152, O-154, O-156, and O-167
MIL-PRF-87937	Cleaning Compound, Aerospace Equipment
SD-6	Provisions Governing Qualification

2.1.3 National Conference of Standards Laboratory (NCSL)

Available from NCSL International, 2995 Wilderness Place, Suite 107, Boulder, CO 80301, Tel: 303-440-3339, www.ncsli.org.

NCSL Z540.3	Requirements for the Calibration of Measuring and Test Equipment
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2.1.4 ASQ Publications

Available from American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203, Tel: 800-248-1946 (United States or Canada), 001-800-514-1564 (Mexico) or +1-414-272-8575 (all other locations), www.asq.org.

ANSI/ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
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2.1.5 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A686	Standard Specification for Tool Steel, Carbon
ASTM B355	Standard Specification for Nickel-Coated Soft or Annealed Copper Wire
ASTM D3032	Standard Test Methods for Hookup Wire Insulation

2.1.6 NEMA Publications

Available from National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, VA 22209, Tel: 703-841-3200, www.nema.org.

WC 27500	Standard for Aerospace and Industrial Electric Cable
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2.1.7 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 61000-4-21	Testing and measurement techniques – Reverberation chamber test methods
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2.2 Other Government Documents

The following other government document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issue shall be the one in effect on the date of the solicitation.

2.2.1 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

2.2.1.1 Airworthiness Standards

Part 25	Transport Category Aircraft
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2.2.1.2 Defense Logistics Agency

H4/H8	Catalog of Commercial and Government Entities (CAGE)
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(Copies of specifications, standards, and other government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

3. REQUIREMENTS

3.1 Detail Specification (see 2.1)

The product requirements shall be as specified herein and in accordance with the applicable detail specification. In the event of any conflict between the requirements of this specification and the detail specification, the latter shall govern. Metric units shall be shown in parentheses.

3.2 Qualification

The components shall be a product that has been tested and has passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable Qualified Products List (see 6.3).

3.3 Materials (see 5.1.1)

Materials shall be specified and listed in the detail specification in accordance with a material specification. Materials shall be certified by the supplier. Additives are permitted by the supplier, but shall be strictly controlled by engineering and manufacturing process control procedures. The procedure control numbers with the latest revision and a generic title shall be available to the Qualifying Activity upon request (see 6.3). Only mold resistance materials shall be used and shall be certified by supplier.

3.4 Component Design and Construction

3.4.1 Design (see 6.2)

3.4.1.1 Sleeve Design

Sleeve shall be designed to expand or wrap-around a cable or wire bundle to provide protection against chaffing. Unless otherwise specified in the detail specification, each sleeve shall be built-up of groups of monofilament or multifilament fibers made from the same material or combinations of materials.

3.4.1.1.1 Expandable Sleeve

Expandable sleeve shall be a tubular braid construction capable of expanding to fit different cable or wire bundle shapes and sizes. The range of sizes shall be specified in the detailed specification. The sleeve is a tubular braid which may require the removal of the cable or bundle from which it is installed.

3.4.1.1.2 Wrap-Around Sleeve

Sleeve shall be designed to wrap around a cable or wire bundle without complete removal of the cable or bundle from the equipment in which it is installed. The sleeve shall be self-closing or the closing system shall have a locking device (i.e., lacing tape). The self-closing sleeve shall have tracer line which acts as a maximum diameter indicator. The tracer line should not be visible along the leading edge when wrapped on the largest diameter cable or bundle specified by the part number. If the tracer line is visible, the next larger sleeve diameter should be used. For protection sleeve with a shield, the shield shall be attached to inside edge of the sleeve and shall not be exposed to the leading edge of the sleeve.

This sleeve requires a nominal 90 degree overlap of material to ensure protection and prevent creating a foreign object damage in aerospace vehicle applications. Wraparound sleeve sizing is based on the nominal size of the wire bundle, determined by wrapping the material around the bundle and ensuring a nominal 90 degree overlap.

3.4.1.2 The braid of the fibers (when applicable) and metallic strands shall be specified in the detail specification (see 3.4.4).

3.4.1.3 When used, coating materials shall be specified in the detail specification (see 3.3).

3.4.2 Dimensions (see 5.1.2)

Dimensions and overlap angle shall be in accordance with the detail specification.

3.4.3 Weight (see 5.1.3)

The weight of the sleeve per unit length shall be specified in the detail specification.

3.4.4 Sleeve and Shield Coverage (see 5.1.4)

Unless otherwise specified in the detail specification, the sleeve braid of the fiber (when applicable) and the metallic shield strand coverage shall be 85% minimum, or as defined in the detail specification sheet.

Sleeve braid shall be applied with the maximum tension possible so as to prevent loosening or creeping but not to cause broken ends. Braid shall have no gaps. Loose strand ends shall be trimmed to within 0.031 inch (0.79 mm) of the weave and shall lay parallel with the braid. There shall be no splices of the completed braid. The number of braids and the elements of their construction shall be as specified in the detail specification (see 3.1). The percent coverage specified shall be determined in accordance with the formulas shown below.

$$\text{Weave or shield coverage} = (2F - F^2) \times 100\%$$

$$F = \frac{NPd}{\sin a} \quad a = \tan^{-1} \left(\frac{2(W + 2\pi d)P}{C} \right)$$

where:

W = maximum width of braid laid flat

d = diameter of an individual strand of the braid

N = number of ends (fiber or wire strands) per carrier

C = number of carriers (separated group of ends) around the diameter of the braid

P = minimum number of picks per inch (separation points between carriers) along the length of the braid

a = smaller angle between longitudinal axis of the cable and the braid strands or wires

F = fill or space factor

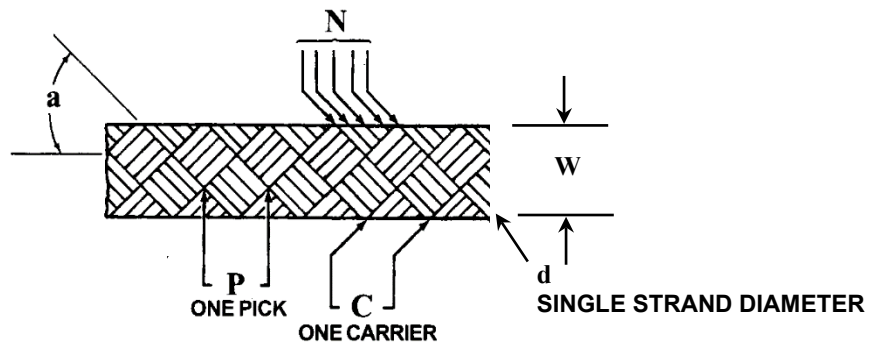


Figure 1 - Sleeve fabric or wire braid

3.4.4.1 Sleeve coverage - braided tubular (see 5.1.4.1)

3.4.4.2 Sleeve overlap - woven wrap-around sleeves (see 5.1.4.2)

3.4.5 Product Identification and Marking (see 5.1.5)

3.4.5.1 Product Identification

The product identification shall be defined by the sleeve color and identification stripe. Unless otherwise specified in the detail specification, the sleeve color number shall be in accordance with Table 1. Part number structure is as follows:

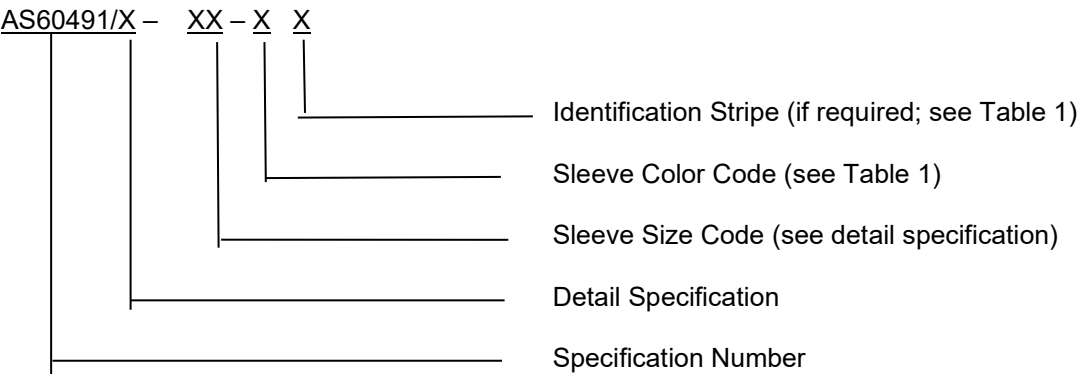


Table 1 - Color code numbers

Color Number	Color	Color Number	Color
0	BLACK	6	BLUE
1	BROWN	7	VIOLET
2	RED	8	GRAY
3	ORANGE	9	WHITE (or NATURAL)
4	YELLOW		
5	GREEN		

3.4.5.2 Wrap-Around Sleeve Tracer Line

A tracer line shall run continuously along the axis of the sleeve. The tracer line color should be a contrasting color to the main sleeve color; i.e., black sleeve use a white tracer line. For specific cable or bundle type applications (i.e., high temperature, fiber optic, etc.) a stripe with identification colors may be used. The identification stripe color and width shall be defined in the detail specification.

The location of the tracer line shall defined by the angle of overlap in the detailed specification.

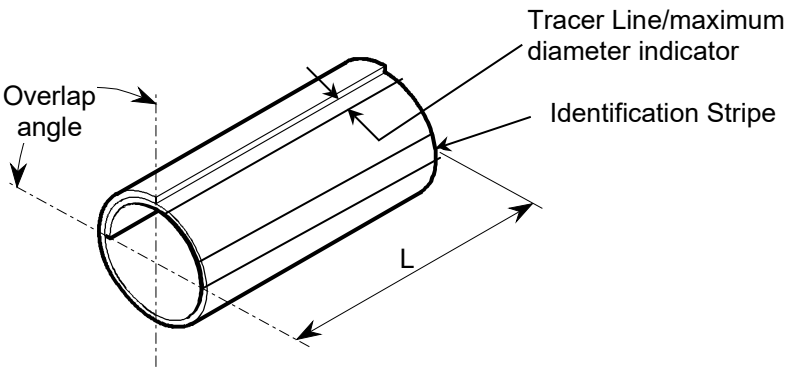


Figure 2 - Tracer line and identification stripe location

3.4.5.3 Marking

Unless otherwise specified in the detail specification sheet, the sleeve shall be identified by a printed marking applied to the outer surface of the sleeve. The identification mark shall not be applied by hot stamp marking or other methods which significantly penetrate the sleeve material. The printed identification shall consist of the following; the sleeve part number as specified in the detail specification sheet, except that inclusion of the color code portion of the part number is not required in the printed marking along with the manufacturer's Commercial and Government Entity (CAGE) designation in accordance with Publication H4/H8. The printed marking shall be at intervals of 6 to 18 inches, as measured from the end of one complete marking to the beginning of the succeeding complete marking. The printing shall be of a color to provide contrast to the sleeve color. Identification printing shall be applied with the vertical axes of the printed characters lengthwise of the sleeve. All printed characters shall be complete and legible.

3.4.6 Product Identification and Marking Durability (see 5.1.6)

The product Identification, tracer line and stripe shall not be obliterated after subsection to the durability and legibility of wire identification test unless otherwise specified in the detail specification sheet.

3.4.7 Assembly Instruction (see 5.1.7)

When specified by contract or purchase order, assembly instructions are required with each package spool (see Section 6).

3.4.8 Workmanship (see 5.1.8)

Sleeve shall be uniform throughout the construction, free from splits, foreign material, or defects that affect the serviceability of the sleeve in the installed condition. There shall be no significant fraying of the fiber or shield strands, holes or irregularity in the fiber or metallic strand braid. The sleeve fibers or shield strands on cut end shall not continuously pull out from the sleeve.

3.5 Component Performance

3.5.1 Sleeve Expansion and Removability/Open and Close (see 5.2)

When tested in accordance with the sleeve and expansion and removability/open and close tests of 5.2, the expandable sleeve and wrap-around sleeve shall show no indication of strand breakage, damage or strand separation. Also, when tested in accordance with the sleeve and expansion and removability/open and close tests of 5.2, the sleeve shield strands shall not be broken, separated, or disconnected (when required) from the sleeve.

3.5.2 Dry Dielectric Voltage (see 5.3)

When tested in accordance with the test methods of 5.3 using dielectric test voltage specified in the detail specification, there shall be no breakdown, flashover, or spark-over.

3.5.3 Shielding Effectiveness (see 5.4)

When EMI shielding is required, the shielding effectiveness shall be defined in the detail specification sheet.

3.5.4 Bend Flexibility (see 5.5)

The sleeve shall show minimal wrinkles or lifting of the leading edge (wrap-around sleeve). When applicable, shield resistance shall be in accordance with the detail specification. The sleeve shield strands shall not be broken. The shield attached to the sleeve shall not be disconnected or separating from the sleeve.

3.5.5 Low Temp Flexibility (see 5.6)

The sleeve shall show no indication of cracking or splitting. When applicable, shield resistance shall be in accordance with the detail specification. The sleeve shield strands shall not be broken. The shield attached to the sleeve shall not be disconnected or separating from the sleeve.