

# AEROSPACE MATERIAL SPECIFICATION



AMS-DTL-23053

Issued

JUL 1999

Insulation Sleeving, Electrical, Heat Shrinkable,  
General Specification For

FSC 5970

## NOTICE

This document has been taken directly from U.S. Military Specification MIL-DTL-23053E, Supplement 1A and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-DTL-23053E, Supplement 1A. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

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

Copyright 1999 Society of Automotive Engineers, Inc.  
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:  
TO PLACE A DOCUMENT ORDER:  
SAE WEB ADDRESS:

(724) 772-7121  
(724) 776-4970  
<http://www.sae.org>

FAX: (724) 776-0243  
FAX: (724) 776-0790

## 1. SCOPE:

## 1.1 Scope:

This specification establishes the requirements for various types and colors of electrical insulating sleeving that will shrink to a predetermined size upon the application of heat. This specification includes provisions for demonstrating compliance with requirements through in process inspection and statistical process control (see 4.4.3.1). Continuous operating temperature ratings range from -80° to +250°C (-112° to +482°F) (see 6.1).

## 1.2 Classification:

The heat shrinkable sleeving class shall be of the applicable military specification sheet, as specified (see 6.2).

## 1.2.1 Color: The color shall be identified in accordance with the following:

<u>Designator</u>	<u>Color</u>	<u>Designator</u>	<u>Color</u>
0	Black	7	Violet (Purple)
1	Brown	8	Gray (Slate)
2	Red	9	White
3	Orange	C	Clear
4	Yellow	P	Pink
5	Green	T	Tan
6	Blue		

## 2. APPLICABLE DOCUMENTS:

The following publications, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

## 2.1 U.S. Government Publications:

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

A-A-694	Sodium Chloride, Technical
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP5/JP8 ST
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-148
MIL-A-8243	Anti-Icing and Deicing-Defrosting Fluid
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base NATO Code Number 0-156
MIL-F-46162	Fuel, Diesel, Referee Grade

## 2.1 (Continued):

FED-STD-228	Cable and Wire, Insulated, Methods of Testing
MIL-STD-104	Limit for Electrical Insulation Color
MIL-DTL-23053/1C	Insulation Sleeving, Electrical, Heat Shrinkable, Chlorinated Polyolefin, Crosslinked, Flexible
MIL-I-23053/2C	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinyl Chloride, Flexible, Crosslinked and Non-Crosslinked (Inactive for New Design)
MIL-I-23053/3A	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinyl Chloride, Semi-Rigid, Crosslinked and Non-Crosslinked (Inactive for New Design)
MIL-DTL-23053/4D	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Dual-Wall, Rigid Outer Wall Crosslinked
MIL-DTL-23053/5C	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Flexible, Crosslinked
MIL-DTL-23053/6D	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Semi-Rigid, Crosslinked
MIL-DTL-23053/7C	Insulation Sleeving, Electrical, Heat Shrinkable, Polyethylene Terephthalate, Non-Crosslinked
MIL-DTL-23053/8C	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinylidene Fluoride, Semi-Rigid, Crosslinked
MIL-I-23053/9	Insulation Sleeving, Electrical, Heat Shrinkable, Fluorosilicone Rubber, Flexible (Cancelled)
MIL-DTL-23053/10D	Insulation Sleeving, Electrical, Heat Shrinkable, Silicone Rubber, Flexible
MIL-DTL-23053/11C	Insulation Sleeving, Electrical, Heat Shrinkable, Fluorinated Ethylene Propylene, Non-Crosslinked
MIL-DTL-23053/12C	Insulation Sleeving, Electrical, Heat Shrinkable, Polytetrafluoroethylene
MIL-DTL-23053/13B	Insulation Sleeving, Electrical, Heat Shrinkable, Fluoroelastomer, Flexible
MIL-DTL-23053/14B	Insulation Sleeving, Electrical, Heat Shrinkable, Ethylene-Tetrafluoroethylene Fluoropolymer, Semi-Rigid
MIL-DTL-23053/15B	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Heavy Wall, Coated, Flexible, Outer Wall Crosslinked
MIL-DTL-23053/16B	Insulation Sleeving, Electrical Heat Shrinkable, Crosslinked, Elastomeric Polyolefin, Flexible
MIL-DTL-23053/17B	Insulation Sleeving, Electrical, Heat Shrinkable, Flame Retarded, Modified Polyolefin, Flexible Crosslinked
MIL-DTL-23053/18B	Insulation Sleeving, Electrical, Heat Shrinkable, Modified Fluoropolymer, Crosslinked

## 2.2 ASTM Publications:

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

ASTM D 149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 150	A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials
ASTM D 374	Insulation, Thickness of Solid Electrical, Standard Test Methods for
ASTM D 412	Rubber Properties in Tension, Standard Test Methods for
ASTM D 570	Plastic, Water Absorption of
ASTM D 638	Tensile Properties of Plastics
ASTM D 746	Plastics and Elastomers, Brittleness Temperature of by Impact
ASTM D 792	Plastics by Displacement, Specific Gravity (Relative Density) and Density of
ASTM D 876	Tubing, Nonrigid Vinyl Chloride Polymer, Used for Electrical Insulation
ASTM D 882	Tensile Properties of Thin Plastic Sheeting
ASTM D 2671	Tubing, Heat Shrinkable for Electrical Use, Standard Test Method for
ASTM G 21	Polymeric Materials, Synthetic, Recommended Practice for Determining Resistance of, to Fungi

## 2.3 Order of precedence:

In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in the document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS:

### 3.1 Specification sheets:

The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet.

In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

### 3.2 First article:

When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

### 3.3 Dimensions and tolerances:

#### 3.3.1 Inside diameter (ID):

3.3.1.1 As supplied: When determined in accordance with 4.6.3.1.1, the "as supplied" ID shall conform to the requirements of the applicable specification sheet.

3.3.1.2 After unrestricted shrinkage: When determined in accordance with 4.6.3.1.2, the sleeving ID after unrestricted shrinkage shall conform to the requirements of the applicable specification sheet.

3.3.2 Wall thickness: The wall thickness after unrestricted shrinkage shall be determined in accordance with 4.6.3.2 and shall conform to the requirement in the specification sheet.

3.3.3 Longitudinal change: When tested as specified in 4.6.4, the longitudinal change shall not exceed the value specified in the specification sheet.

3.3.4 Concentricity: When tested as specified in 4.6.3.3 the "as supplied" concentricity shall not be less than that specified in the specification sheet.

3.3.5 Unit of issue: Unit of issue for all sleeveings shall be feet (meters). The sleeving may be supplied as a straight piece, coiled, on reels or spools.

3.3.5.1 Straight pieces: Unless otherwise specified in the applicable specification sheet, the standard straight piece unit of issue shall be 4 feet plus/minus 1 inch (121.9 cm plus/minus 2.5cm).

3.3.5.2 Reels, spools and coils: Unless otherwise specified in the contract or order (see 6.2), sleeving length on reels shall be as specified in table I. Sleeving lengths on spools and coils shall be as specified by the acquisition activity.

### 3.4 Properties:

#### 3.4.1 As supplied:

3.4.1.1 Heat shock: When tested as specified in 4.6.8, the sleeving shall show no sign of cracking, flowing, or dripping. After bending through 360 degrees, the sleeving shall show no sign of cracking except that side cracking of the flattened sleeving shall not be cause for rejection.

3.4.1.2 Restricted shrinkage: After testing as specified in 4.6.6, the shrunk sleeving shall fit snugly over the mandrel without cracking and shall withstand the voltage application specified in 4.6.6.3.

3.4.1.3 Modulus: See specification sheet for secant modulus or tensile stress requirement as applicable. Testing shall be as specified in 4.6.12.

3.4.1.4 Cold impact: When tested as specified in 4.6.7.2, the sleeving shall meet the requirement of the applicable specification sheet.

3.4.2 After unrestricted shrinkage: When tested as specified herein and the applicable specification sheet, the sleeving shall conform to the requirements of table II or the applicable specification sheet.

3.4.2.1 Color: The after unrestricted shrinkage color of the sleeving shall be in accordance with the requirements of MIL-STD-104. MIL-STD-104 does not include limits for pink and tan colors. Munsell color notations for these colors shall be as follows:

<u>Color</u>	<u>Light limit</u>	<u>Nominal</u>	<u>Dark limit</u>
Pink	3.75R 6.5/9.0	2.5R 6.0/7.0	1.25R 5.5/6.0
Tan	5YR 5.5/6.0	5YR 5.0/5.0	5YR 4.5/4.0

3.5 Storage Life:

3.5.1 Storage life: The product storage life shall not be less than the time specified in the applicable specification sheet, under the conditions therein. The storage life of the sleeving may be extended in accordance with 3.5.2. The storage life expiration date shall be identified on the product label. When the expiration date of the sleeving has been exceeded it shall be retested prior to being used (see 3.5.2). The sleeving, after storage, and at all retest dates shall conform to the "as supplied" and after unrestricted shrinkage inside diameter (ID) requirements and the wall thickness and longitudinal change requirements after unrestricted shrinkage (see 4.6.5).

3.5.2 Extension of Storage Life: Unless otherwise specified in the specification sheet, the storage life may be extended for a period of time equal to fifty percent (50%) of the original storage life of the sleeving for as many times as the dimensions are still within specification limits, however, no sleeving 12 years or older shall be extended. The extension of storage life shall be determined in accordance with in 4.6.17.

3.6 Clarity stability:

The clear sleeving shall not darken appreciably and the protected marking shall be readable through the sleeving, after the exposures specified in 4.6.17.

3.7 Workmanship:

When examined visually, the sleeving, both before and after shrinkage, shall be free from internal voids, blisters, lumps, dents, tears, pinholes, seams, cracks, foreign matter, or other defect that would be detrimental to fabrication, appearance, or performance. After shrinkage, the sleeving surface shall be smooth and uniform. When the sleeving is of a spirally wound construction or contains a single bonded seam, the overlaps and seams normally associated with these manufacturing techniques shall be acceptable.

#### 4. VERIFICATION:

##### 4.1 Classification of inspections:

The inspection requirements specified herein are classified as follows:

- a. First Article inspection (see 4.3).
- b. Conformance inspection (see 4.4).

##### 4.2 Inspection conditions:

Unless otherwise specified in the test method, all inspections shall be performed in accordance with the test conditions specified in the applicable test method or test paragraph in this specification or specification sheet.

##### 4.3 First article inspection:

First article inspection shall consist of all the tests and inspections specified in the applicable specification sheet. The number of determinations per first article sample shall be as specified in table III. The first article inspection shall be performed on the first lot or order of sleeving furnished under this specification and on any subsequent lot or order when specified by the acquisition activity (see 6.2).

4.3.1 Periodic reinspection: After delivery of a satisfactory first article sample (see 4.3), the manufacturer shall be required to perform the first article inspection once every three years provided the manufacturer is in continuous production on Government contracts. If the manufacturer is not in continuous production of these sleeveings, first article inspection may be requested at any time by the acquisition activity (see 6.2).

4.3.2 First article sample: Unless otherwise specified in the applicable specification sheet or by the acquisition activity, 50 feet of heat shrinkable sleeving of the class and size for which approval is desired shall constitute the first article sample. The sample shall be representative of the workmanship and material to be used during production. Approval of the sample will automatically extend first article approval to all sizes included in the size range. Table IV identifies the size ranges. The First Article sample shall be produced using the same plant facilities intended for the production run. Approval of the first article inspection sample or waiving of the first article inspection does not preclude the requirements for performing the conformance inspection. When required, the first article inspection samples shall be furnished to the Government as directed by the contracting officer (see 6.2).

4.3.2.1 First Article sample identification: The first article sample, when required for direct Government acquisition, shall be plainly identified by securely attached durable tags or labels marked with the following information:

Sample for First Article inspection  
INSULATION SLEEVING, ELECTRICAL, HEAT SHRINKABLE

Name of Manufacturer  
Product Code Number  
Date of Manufacture

Submitted by (name) (date) for First Article inspection in accordance with the requirements of (give specification sheet number, class, and part number as applicable)

4.3.3 First article test report: For each direct Government acquisition, the manufacturer shall submit one copy of his latest first article test report that shows the sleeving conforms to the requirements of the specification. The data shall include certification that the sleeving meets or exceeds the storage life established in the applicable specification sheet. All other acquisitions shall be as agreed upon between the manufacturer and the acquisition activity. When acceptable to the acquisition activity, manufacturer's data may be submitted electronically.

4.4 Conformance inspection:

4.4.1 Lot formation:

4.4.1.1 Production batch compound: A production batch compound shall consist of all the compound prepared in one mixing operation at one time, using the same formulation. The production batch compound shall be tested as specified in 4.4.2.2.

4.4.1.2 Production sleeving lot: Unless otherwise specified, a lot shall consist of sleeving of one specification sheet, class, color and size that has been made at the same plant under essentially the same conditions, processed in a continuous operation from acceptable production compound batches, that is available for inspection at one time.

4.4.2 Sampling:

4.4.2.1 Production batch compound: A sufficient quantity of material (batch compound and/or sleeving) to perform the tests specified in 4.4.3.1 shall be selected from the compound batch or the first sleeving production lot of the batch compound. Physical property tests performed at this time qualify subsequent sleeving lots produced from the same batch compound. Physical properties shall be tested at any stage in processing provided they are not affected by subsequent processing.

4.4.2.2 Production sleeving lot: Samples for visual and dimensional inspection of the production sleeving lot shall be selected in accordance with Table V. Unless otherwise specified in Table VI, the sample unit shall be 4 feet (1.25 m) of sleeving. Each sample shall be inspected as specified in 4.4.3.2.

4.4.3 Inspection and tests:

4.4.3.1 Production batch compound: Test specimens prepared from the sample selected in 4.4.2.1 shall be tested to the requirements of table VII. The number of specimens tested and reporting of results shall be in accordance with table III. Nonconformance of the sample to a single requirement shall be cause for rejection of the batch compound and all sleeving production lots represented by the sample.

4.4.3.2 Production sleeving lot: Samples selected in 4.4.2.2 shall be examined for conformance to the requirements in table VI. There shall be no defects. The number of determinations on each sample shall be as specified in table III. Statistical process control data may be used to demonstrate conformance in place of these inspections (see 6.5).

4.5 Reporting of first article test results:

The number of specimens per test and the method of reporting the results shall be as contained in table III.

4.6 Test methods:

4.6.1 Conditioning prior to test: Unless otherwise specified herein, the heat shrinkable sleeving and measurement gages shall be at room temperature with ambient relative humidity prior to testing before or after heat shrinking. Unless otherwise specified in the specification sheet, an oven with a circulating air velocity of 100 to 200 feet (30.5 to 61.0 m) per minute shall be used whenever heating is required.

4.6.2 ASTM tests: ASTM tests shall be performed in accordance with ASTM Standard Methods of Test (see 2.3) with any exceptions that may be specified herein or in the specification sheets.

4.6.3 Dimensional inspections: Dimensional inspections shall be conducted as specified below. Micrometer measurements shall be made in accordance with ASTM D 374. Contemporary methods of inspection and/or automated control processes, such as continuous monitoring by laser micrometers and ultrasonic gauging may be used provided such methods ensure quality levels and inspection accuracy equal to or better than the methods described below.

#### 4.6.3.1 Inside diameter (ID):

4.6.3.1.1 ID (as supplied): To measure the ID of the sleeving, select a smooth gage rod that has a diameter equal (plus 0, minus 0.002 inch (plus 0, minus 0.051 mm), or 2 percent, whichever is less) to the minimum acceptable ID of the "as supplied" sleeving. The ID shall be considered acceptable when the gage rod passes freely into the sleeving sample without expanding the wall of the sleeving. If the gage rod tends to stick, the gage rod may be dipped in talc or water to facilitate insertion of the rod.

4.6.3.1.2 ID after unrestricted shrinkage: For sleeving shrunk as specified in 4.6.5.1, select a smooth gage rod that has a diameter equal (minus 0, plus 0.002 inch (minus 0, plus 0.051 mm), or 2 percent, whichever is less) to the maximum acceptable sleeving ID after unrestricted shrinkage. The maximum ID dimension of the sleeving shall be considered acceptable when the wall of the sleeving is expanded by the insertion of the gage rod, when there is no visible air space between the end of the sleeving and the rod, or when the gage rod cannot be inserted in the sleeving. For sleeving shrunk as specified in 4.6.5.2, the maximum ID dimension of the sleeving shall be considered acceptable only if the sleeving is snug on the mandrel and there is no air space between the mandrel and the sleeving.

4.6.3.2 Wall thickness: After the unrestricted shrinkage specified in 4.6.5, the wall thickness shall be determined by one of the following methods:

4.6.3.2.1 Micrometer method: The sleeving shall be slit lengthwise into two hemicylindrical pieces. A smooth gage rod shall be selected, measured and placed in contact with the inside surface of the sleeving. The total thickness of the gage rod plus sleeving wall shall then be measured. The maximum and minimum wall thickness shall be calculated by subtracting the gage rod measurement from the measurement of the gage rod plus sleeving wall.

4.6.3.2.2 Optical method: The wall thickness shall be measured with a calibrated microscope.

4.6.3.2.3 Alternate method: Wall thickness shall be determined in accordance with of ASTM D 2671.

4.6.3.3 Concentricity: Concentricity shall be determined in accordance with ASTM D 2671.

4.6.4 Longitudinal change: The longitudinal change of the sleeving shall be determined in accordance with ASTM D 2671, by measuring in the "as supplied" condition and after the unrestricted shrinkage specified in 4.6.5.

4.6.5 Unrestricted shrinkage: Unrestricted shrinkage shall be accomplished using one of the following methods:

4.6.5.1 Unsupported method: Lay a 6 inch (15.2 cm) length of the sleeving on a tray in an oven at the temperature and for the time specified in the specification sheet. If the sleeving becomes tacky in the oven, a small amount of powdered talc may be placed on the tray to prevent sticking. Evaluate in accordance with 4.6.3.1.2.

- 4.6.5.2 Mandrel method: Select a smooth, clean, metallic mandrel that has a diameter equal to the maximum acceptable sleeving ID (after unrestricted shrinkage) minus 0, plus 0.002 inch (minus 0, plus 0.051 mm) or 2 percent, whichever is less. Slip a 6 inch (15.2 cm) length of sleeving on the mandrel and heat in an oven at the temperature and for the time specified in the applicable specification sheet. Evaluate in accordance with 4.6.3.1.2.
- 4.6.6 Restricted shrinkage: After shrinking as specified below, the sleeving shall conform to the requirements of 3.4.1.2 and pass the voltage withstand test of 4.6.6.3.
- 4.6.6.1 Specimen preparation: A smooth, clean metallic mandrel of the configuration shown on figure 1 shall be prepared for each sleeving size. Sleeving length shall be such that each end of the mandrel is slightly exposed for electrical connections after shrinkage. The sleeving and the mandrel shall be conditioned in accordance with 4.6.1, then shrunk using one of the following methods.
- 4.6.6.2 Shrink procedures:
- 4.6.6.2.1 Procedure A: The mandrel shall be at room temperature when inserted into the sleeving. The method of heat application is optional. The specimen shall be heated for 30 minutes at the temperature specified in the applicable specification sheet. When an oven is used as the heat source, it shall be capable of maintaining a  $\pm 5^{\circ}\text{C}$  ( $\pm 9^{\circ}\text{F}$ ) tolerance from the specified temperature.
- 4.6.6.2.2 Procedure B: The mandrel shall be preheated a minimum of 30 minutes at the temperature specified in the applicable specification sheet before insertion into the sleeving. Shrinkage shall be as specified in Procedure A.
- 4.6.6.3 Voltage withstand: Tightly wrap the first layer of the outer electrode, a strip of metal foil, around the sleeving specimen. The outer electrode shall conform closely to the shape of the sleeving particularly at the areas A and R shown on figure 1. Allow sufficient sleeving area at each end to remain unwrapped so that flashover between the mandrel and the foil will not occur. Wrap two more layers of foil over the first wrap allowing a free end of 0.5 inch (12.7 mm) for connection of the electrode. Two thousand volts shall be applied for one minute in accordance with the test procedure of ASTM D 149.
- 4.6.7 Low temperature properties: Low temperature properties of heat shrinkable sleeving shall be determined as specified in the applicable specification sheet using one of the methods specified below.

- 4.6.7.1 Low temperature flexibility: For sleeving sizes less than 0.400 inch (10.2 mm) (maximum ID nominal after unrestricted shrinkage), the sleeving shall be shrunk and conditioned as specified in 4.6.5 onto a stranded AWG wire (nearest AWG which is larger than the sleeving max ID nominal after unrestricted shrinkage). For sleeving sizes 0.400 inch (10.2 mm) and larger, a 6 by 0.25 inch (15.2 by .64 cm) longitudinal strip shall be cut from sleeving that has been shrunk and conditioned as specified in 4.6.5. The specimen (strip or sleeving) and a steel mandrel of the size specified in Table VIII shall be conditioned in a cold chamber for 4 hours at the temperature specified in the applicable specification sheet. After completion of the conditioning period and while still in the cold chamber at the specified temperature, the specimen shall be bent around the mandrel through not less than 360 degrees. Unless otherwise specified in the specification sheet, the time to complete the bend shall be  $10 \pm 2$  seconds. Visually examine the sleeving for cracks.
- 4.6.7.2 Cold impact: Impact determinations shall be conducted in accordance with ASTM D 746 Procedure A, using a longitudinal strip cut from sleeving and prepared as specified in 4.6.7.1. Temperature shall be as specified in the applicable specification sheet.
- 4.6.8 Heat shock (as supplied): A 6 inch (15.2 cm) length of the sleeving or a 6 by 0.5 inch (15.2 by 1.3 cm strip cut longitudinally from sleeving that has a nominal ID greater than 0.5 inch (12.7 mm) as supplied) shall be placed in an oven for 4 hours at the temperature specified in the specification sheet. The specimen may be suspended vertically in the oven by means of a piece of wire attached to a hole in the specimen. While in the oven and after removal from the oven, the specimen shall be examined for evidence of cracking, flowing, or dripping. The specimen shall then be conditioned as specified in 4.6.1 and bent through 360 degrees in two to four seconds over the steel mandrel specified in table VIII. The specimen shall then be visually examined for conformance to 3.4.1.1.
- 4.6.9 Heat resistance: Heat resistance shall be determined in accordance with ASTM D 2671 and the following: After removal from the oven, the sleeving shall be conditioned as specified in 4.6.1 prior to initiating the tests specified in the specification sheet.
- 4.6.10 Corrosion: Prior to corrosion testing, the sleeving sample shall be heat shrunk and conditioned as specified in 4.6.5. The corrosion test procedure(s) specified in the applicable specification sheet shall be followed.
- 4.6.10.1 Corrosion in contact with copper: A six inch (15.2 cm) length of shrunk sleeving shall be slid over a straight, clean, bare copper conductor. For sleeving of 0.25 inch (6.4 mm) inside diameter and smaller (maximum ID after unrestricted shrinkage), a single conductor shall be used; for larger sleeving, a twisted bundle of several conductors shall be used, each AWG 18 or smaller. The specimens on the conductor shall be heated in an air-circulating oven for the time and at the temperature specified in the applicable specification sheet. The specimens shall then be removed from the oven, cooled, and conditioned in accordance with 4.6.1. The sleeving shall be slit open and the copper examined for pitting and blackening. The sleeving shall be considered noncorrosive only if the copper is not pitted or blackened. Darkening of the copper due to normal air oxidation shall not be cause for rejection.

- 4.6.10.2 Copper mirror corrosion: For sizes 0.400 inch (10.2 mm) and larger (maximum ID nominal after unrestricted shrinkage), a 0.25 by 1 inch (6.4 by 25.4 mm) strip shall be cut longitudinally from the shrunk sleeving. For sizes smaller than 0.400 inch (10.2 mm) (maximum ID nominal after unrestricted shrinkage), a number of pieces of shrunk sleeving having an area of approximately 0.25 square inch (6.4 square mm) shall be used. The strip or pieces of sleeving shall be placed in the bottom of a clean, dry 0.5 by 12 inch (1.3 by 30.5 cm) test tube. A copper glass mirror about 0.25 by 1 inch (6.4 by 25.4 mm) and a calibrated thermometer shall be suspended 6 to 7 inches (15.2 by 17.8 cm) above the bottom of the test tube by means of a fine, clean copper wire attached to a cork that has been wrapped in clean aluminum foil. A second clean test tube containing only the mirror and thermometer shall be used as a control. The lower 2 inches (5.1 cm) of the test tube shall be immersed in an oil bath at the temperature and for the time specified in the applicable specification sheet. The temperature of that portion of the test tube containing the copper mirror shall be below 60°C (140°F). After removal from the oil bath and cooling to room temperature, visually examine the mirror for corrosion by placing it on a white background in good light. Evidence of corrosion shall be the removal of the copper film from any part of the mirror as evidenced by the white background showing through. Disregard removal of copper from the bottom 0.063 inch (1.6 mm) of the mirror. Discoloration of the copper film or reduction of its thickness should not be considered corrosion. The mirrors shall be vacuum deposited copper with a thickness equal to 10 ± 5 percent transmission of normal light of 5000 Angstroms. They shall be stored in a vacuum and shall be used only if no oxide film is present and the copper is not visually damaged or contaminated.
- 4.6.11 Fluid resistance: The sleeving shall be heat shrunk and conditioned as specified in 4.6.5.1. A suitable number of 6 inch (15.2 cm) lengths of sleeving shall be totally immersed in each of the six fluids specified in table IX. The volume of the fluid shall be not less than 20 times that of the sleeving. After 24 hours immersion at 24° ± 3°C (75° ± 5°F), the sleeving shall be lightly wiped and then conditioned for 45 plus/minus 15 minutes at room temperature. The sleeving from each of the test fluids shall then be tested for conformance to the tensile strength, ultimate elongation, and dielectric strength (as applicable) of the specification sheet.
- 4.6.12 Modulus:
- 4.6.12.1 Secant modulus (as supplied): Full sections of sleeving shall be tested when the maximum ID as supplied is 0.25 inch (6.4 mm) or less. For larger sizes, a 0.25 inch (6.4 mm) strip shall be cut longitudinally from the sleeving. No metal plugs are necessary when testing full sections of the sleeving. The testing procedure and percent strain shall be as specified in the specification sheet.
- 4.6.12.2 Tensile stress: Full sections of sleeving shall be tested when the maximum ID of the as supplied sleeving to be tested is 0.25 inch (6.4 mm) or less. For larger as supplied sizes, a 0.25 inch (6.4 mm) strip shall be cut longitudinally from the sleeving. No metal plugs are necessary when testing full sections of sleeving. The testing procedure and percent strain shall be as specified in the applicable specification sheet. One inch (2.5 cm) bench marks and 2 inch (5.1 cm) initial jaw separation shall be used. A break at a bench mark or outside the gage length shall be cause for retest.

- 4.6.13 Tensile strength and ultimate elongation: The sleeving shall be heat shrunk and conditioned as specified in 4.6.5. Full sections of sleeving shall be tested when the maximum ID, after unrestricted shrinkage, is 0.25 inch (6.4 mm) or less. For larger sizes, cut a 0.25 inch (6.4 mm) strip longitudinally from the sleeving. No metal plugs are necessary when testing full sections of sleeving. The test procedure for tensile strength and ultimate elongation shall be as specified in the specification sheet. One inch (2.5 cm) bench marks and 2 inch (5.1 cm) initial jaw separation shall be used. Testing speed shall be as specified in the specification sheet. A break at a bench mark or outside the gage length shall be cause for retest.
- 4.6.14 Flammability: Flammability shall be determined in accordance with the appropriate flammability procedure in ASTM D 2671. The procedure shall be as specified in the applicable specification sheet.
- 4.6.15 Color stability: A 4 inch (10.2 cm) specimen of sleeving, shrunk as specified in 4.6.5, shall be placed in an air-circulating oven for the time and at the temperature specified in the applicable specification sheet. After removal from the oven, the specimens shall be cooled, conditioned in accordance with 4.6.1, and examined for conformance to the color requirement of the specification sheet.
- 4.6.16 Clarity stability: A four inch specimen of clear sleeving shall be shrunk, as specified in Procedure A of 4.6.6, onto a marked insulated wire. After shrinkdown, the marking shall be legible through the sleeving. The sleeving shall then be exposed for the time and temperature specified in the applicable specification sheet. Conformance to 3.6 and the applicable specification sheet shall be noted.
- 4.6.17 Extension of Storage Life: The following examination shall be performed to determine storage life extension:
- The as-supplied inside diameter shall be measured in accordance with 4.6.3.1.1.
  - The specimens shall be fully shrunk using the time and temperature specified for unrestricted shrinkage in the specification sheet for the sleeving under examination.
  - The specimen shall be cooled to room temperature and measure the inside diameter in the same manner as before, and the recovered wall thickness in accordance with 4.6.3.2.
  - The measured dimensions shall be compared to the requirements given in Table I of the specification sheet.
  - Storage life shall be extended as specified in 3.5.2.

## 5. PACKAGING:

### 5.1 Packaging:

For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES:

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

### 6.1 Intended use:

Heat shrinkable sleeving is intended for use as a snug-fitting electrical insulator over wire bundles, splices, cables, cable harnesses, bus bars, connectors and terminals, metal or fibrous tubing, hydraulic line couplers, high voltage tubes, flexible wave guides and rectifier leads, as extra insulation over hot spot areas, and as a cable blast shield in rocket launching. Specific property values in Section 3 and in the specification sheets should be evaluated for the particular use intended. When a complete moistureproof seal is required, the manufacturer may recommend the use of a suitable sealant at the ends of the sleeving. Heat shrinkable sleeving can be marked before shrinking and be used to identify materials that cannot be marked directly such as unjacketed wire, shielded wire, thermocouple wires, multiconductor cable, asbestos, and fiberglass. Markings shall be in accordance with procedures in MIL-M-81531. It should be noted that the wall thickness dimension in the specification sheet or manufacturer's data sheet refers to the sleeving after unrestricted shrinkage; if shrinkage is restricted by the object to be enclosed, wall thickness will be less. The particular uses for heat shrinkable sleeving are dependent upon the specific properties described by the individual specification sheets. General end use applications follow:

/1: Intended for use on heavy duty cables or harness systems such as ground support.

/2 and /3: Inactive for new design. Shall not be used in any application when outgassing is a problem.

/4: For one step potting, encapsulation, or moisture sealing and corrosion protection of electrical components or terminations.

/5: Used for light duty harness jackets, wire color coding, marking, or identification.

## 6.1 (Continued):

/6: Used for wire identification, marking, or strain relief.

/7: Used for light duty wire identification and component covering.

/8: Used for wire or termination strain relief at elevated temperatures.

/9: Cancelled.

/10: Used for high or low temperature applications or where ablation resistance in high blast fame is required.

/11: Used where strain relief is necessary at high temperatures.

/12: Used at high temperatures where resistance to flame is important to protect high temperature cable, components, and terminations.

/13: Used in elevated temperature applications or where exposure to elevated temperature solvents is expected.

/14: Used as component and electronic lead strain relief where low expansion ratios are satisfactory. Operates over fairly wide temperature range.

/15: Used for repair of heavy duty cables, splice covers.

/16: Used on heavy duty cables and harness systems, which see high levels of physical abuse, and requires resistance to fuels and oils coupled with high and low temperature extremes.

/17: Used for see through wire identification where flame resistant properties are required.

/18: Used as wire markers, insulation, and wire and component relief. Clear material may be considered for use as replacements for non flame retarded clear sleeveings.

## 6.2 Acquisition requirements:

Acquisition documents must specify the following:

- a. Title, number, and date of this specification, applicable specification sheet, and sleeving class.
- b. Part number (including color designation) (see 1.2 and Specification sheet).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- d. Quantity (total footage) & (unit of issue see 3.3.4.2).
- e. Sleeving length on reels, spools, etc., or straight length if other than specified in 3.3.4.2

## 6.2 (Continued):

- f. Dielectric constant (only if required for a special application) and frequency at which dielectric constant is measured (see 3.4.2).
- g. Specific gravity if required (see 3.4.2).
- h. Whether first article inspection is required (see 4.3 and 4.3.1).
- i. Name and address of the first article inspection facility, if other than the manufacturer (see 4.3.2).
- j. Packaging (see 5.1).

## 6.4 First article:

When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a first article sample, a first production item, or a standard production item from the contractor's current inventory and the number of items to be tested as specified in 4.3. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

## 6.5 In process inspection and statistical process control:

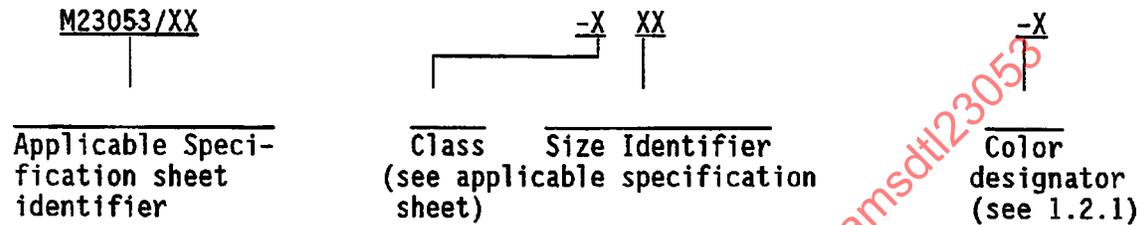
The use of in process inspections and statistical process controls to enhance the conformance inspection process is encouraged. Production control processes in accordance with or equivalent to ISO 9001, section 4.9 have been found to be acceptable. ISO 9001 "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing is an International Standards Organization document and is available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

## 6.5 International standardization agreement:

Certain provisions of this specification are the subject of international standardization agreement ABC-NAVY-STD-17, Electrical Insulating Materials. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

## 6.7 Part number:

The part number shall consist of the basic number of the applicable specification sheet and dash numbers as follows:



EXAMPLE: Examples are given in each specification sheet. The part number is derived in the individual specification sheet with the exception of the color designator from 1.2.1.

## 6.8 Subject term (key word) listing:

Color coded  
 Insulator  
 Protective covering  
 Statistical process controls  
 Strain relief  
 Temperature sensitive  
 Wire insulation covering

## 6.9 This paragraph was deleted as it did not pertain to the converted SAE document.

PREPARED UNDER THE JURISDICTION OF AMS COMMITTEE "CE"

TABLE I. Reel lengths <sup>1/</sup>.

ID, As Supplied inch, (mm)	Minimum Length feet (M)	Number of Lengths maximum	Shortest Length minimum, ft. (m)
.015 to 0.063 (.38 to 1.60)	500 (152.3)	3	125 (38.1)
.064 to .499 (1.60 to 12.7)	200 (61.0)	3	50 (15.2)
.500 to 1.00 (12.7 to 25.4)	100 (30.5)	3	25 (7.6)
Over 1.00 (over 25.4)	50 (15.2)	2	13 (4)

<sup>1/</sup> As reel length increases above minimum footage, the number of individual lengths permitted shall be increased proportionately. When this calculation results in a fraction of 1/2 or less, round down to the lower number.

TABLE II. Properties after unrestricted shrinkage.

Characteristics	Requirement	Test Method
Color	MIL-STD-104 3/	Visual inspection
Color stability	Conform to "as received" limits	4.6.15
Clarity stability	3.6 and specification sheet	4.6.16
Specific gravity	Specification sheet	ASTM-D792
Dielectric constant	Specification sheet	ASTM-D150
Fungus resistance	Specification sheet	ASTM-G21
Tensile strength	Specification sheet	4.6.13
Ultimate elongation	Specification sheet	4.6.13
Dielectric strength	Specification sheet	ASTM-D2671

TABLE II. Properties after unrestricted shrinkage. - Continued

Characteristics	Requirement	Test method
Volume resistivity	Specification sheet	ASTM-D876
Low temperature flexibility	Specification sheet	4.6.7.1
Corrosion	Specification sheet	<u>1</u> /
Heat resistance	Specification sheet	4.6.9 & ASTM-D2671
Water absorption	Specification sheet	ASTM-D570, 24 hrs at 23°C <u>2</u> /
Flammability	Specification sheet	4.6.14
Fluid resistance	Specification sheet	4.6.11
Sealing efficiency	MIL-DTL-23053/4	MIL-DTL-23053/4

1/ See specification sheet for test method.

2/ When testing small (ID) sleeving, special care shall be taken to remove all surface water from the inner wall before reweighing.

3/ For pink and tan color limits see 3.4.1.5.