

ML-M-81531(AS)  
2 May 1967

## MILITARY SPECIFICATION

### MARKING OF ELECTRICAL INSULATING MATERIALS

This specification has been approved  
by the Naval Air Systems Command,  
Department of the Navy.

#### 1. SCOPE

1.1 This specification establishes performance requirements for markings that have been applied to electrical insulating materials (see 6.1).

#### 2. APPLICABLE DOCUMENTS

2.1 The following documents, 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.

##### Federal Specifications

ZZ-E-661 Eraser, Rubber and Rubber Substitute

##### Military Standards

MIL-STD-104 Limits for Electrical Insulation Color

MIL-STD-105 Sampling Procedures and Tables for Inspection  
by Attributes

MIL-STD-120 Gage Inspection

MIL-STD-202 Test Methods for Electronic and Electrical  
Component Parts

(When requesting specifications, standards and publications refer to both the title and number. Copies of this specification and applicable documents may be obtained upon application to the Commanding Officer, Naval Supply Depot (1051), 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. All other documents should be obtained from the procuring activity, or as directed by the Contracting Officer.)

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## 3. REQUIREMENTS

3.1 Preproduction approval - When specified by the procuring activity (see 6.2), the marking shall pass the preproduction inspection (see 4.4.2).

3.2 Identification code and spacing between markings - The identification code to be marked on the insulating material and the amount of spacing between markings shall be as specified by the procuring activity (see 6.1 and 6.2).

3.2.1 Color - The marking color shall be as specified by the procuring activity (see 6.1.1 and 6.2). Colors shall conform to Class I of MIL-STD-104.

3.2.2 Printing type - The printing type shall be as specified by the procuring activity in accordance with the requirements of Table I (see 6.2).

TABLE I  
PRINTING TYPE 1/

Insulation diameter <u>2</u> /	Printing type		
	Height of type face <u>3</u> / ( $\pm .001$ )	Radius of curvature of type face ( $\pm .001$ )	Reading direction
For insulating materials that are not flattened during the printing operation, the following curved and flat face type shall be used:			
.035 to .039	.065	.019	Vertical
.039 to .052	.065	.024	Vertical
.050 to .060	.065	.028	Vertical
.052 to .068	.050	.028	Horizontal
.069 to .096	1/16	.038	Horizontal
.097 to .166	5/64	.055	Horizontal
.167 to .350	7/64	.125	Horizontal
.351 to .624	7/64	Flat face	Horizontal
.625 to 1.000	1/8	Flat face	Horizontal
over 1.000	3/16	Flat face	Horizontal
For an insulating tubing that is flattened during the printing operation, the following flat face type shall be used:			
.035 to .060	.065	Flat face	Vertical
.052 to .068	.050	Flat face	Horizontal
.069 to .096	1/16	Flat face	Horizontal
.097 to .166	5/64	Flat face	Horizontal
.167 to .624	7/64	Flat face	Horizontal
.625 to 1.000	1/8	Flat face	Horizontal
over 1.000	3/16	Flat face	Horizontal

1/ Dimensions in inches.

2/ For heat shrinkable tubing, the height of the type face shall be governed by the "as supplied" insulation diameter.

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3/ Other type face heights may be used when approved by the procuring activity (see 6.2).

3.3 Insulation properties - After completion of all the nondestructive tests specified in the basic specification, standard or drawing covering the insulated wire or insulating material, the marking shall conform to the adherence requirement of 3.4.2 (see 4.5.2.1).

3.4 Properties of the marking -

3.4.1 Indentation - When tested as specified in 4.6.1, the average depth of surface indentation immediately after the indenting operation (except that markings on heat shrinkable tubing shall be measured after the shrinkage specified in 4.6) shall not exceed 0.001 inch for an insulation thickness of 0.010 inch or less, or 0.002 inch for an insulation thickness greater than 0.010 inch. No single measurement of the indentation shall exceed 0.0015 inch for an insulation thickness of 0.010 inch or less, or 0.0025 inch for an insulation thickness greater than 0.010 inch.

3.4.2 Adherence - After rubbing with an eraser as specified in 4.6.2, the marking shall conform to the Workmanship requirement of 3.6.

3.4.3 Solvent resistance - After testing as specified in Test Method 215 of MIL-STD-202, the marking shall conform to the Workmanship requirement of 3.6.

3.5 Environmental - When specified by the procuring activity (see 6.2), the marked insulation shall be subjected to such tests as are necessary to demonstrate the acceptability of the marked insulation under specific environmental or operating conditions.

3.6 Workmanship - When examined visually at a reading distance of 14 inches, each character of the marking shall be uniform, clear, and easily identified as an accurate duplication of the printing type.

3.6.1 Insulation damage - When examined visually, the insulating material shall not show excessive indentation, or other indication that the insulation has been damaged.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

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4.2 Classification of inspection - The inspection of the marking shall be classified as follows:

- (a) Preproduction inspection (4.4)
- (b) Quality conformance inspection (4.5)

4.3 Lot - A lot shall consist of insulating material of a single size and construction that has been marked on one marking machine under essentially the same conditions during one 8 hour working shift and presented for inspection at one time. The lot size shall be the total number of markings that have been made on the lot of insulating material.

4.4 Preproduction inspection -

4.4.1 Sampling - When the procuring activity requires that the marked insulating material be approved prior to production, the specified size and kind of sample shall be sent to the address designated by the procuring activity. The preproduction sample shall be accompanied by a report from the manufacturer or a commercial laboratory. The report shall show the product inspection results for all the requirements of Section 3 of this specification, including any special requirements covered by 3.5. The manufacturer shall certify in writing that the marked insulating material conforms to Insulation properties, 3.3. Complete details of the marking process shall also be submitted with the sample.

4.4.2 Inspection - Prior to delivery of any marked insulation, the manufacturer's report shall be reviewed and the preproduction sample (4.4.1) shall be examined and tested to determine conformance to all the requirements of this specification. Provided the marking process is also acceptable, preproduction approval shall be given a marked insulation that conforms to all requirements.

4.5 Quality conformance inspection -

4.5.1 Sampling -

4.5.1.1 Sampling for tests - If it is not practical to cut samples of markings from the lot of insulating material, the manufacturer shall furnish samples that have been marked with the same identification by the same marking machine and under the same conditions that are used to mark the lot being submitted to inspection. Insulating material having twelve markings shall be furnished for tests from each lot.

4.5.1.2 Sampling of the end item - Samples of the marked insulating material shall be selected at random in accordance with MIL-STD-105 and Table II.

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TABLE II  
SAMPLES OF THE END ITEM

Inspection	Requirement	Inspection Level <u>1</u> /	A. Q. L.	Sampling unit
Identification code	3.2	S-2	Zero defects	A single marking application.
Color, height of marked characters, and reading direction.	3.2.1, 3.2.2	S-2	Zero defects	A single marking application.
Spacing between markings	3.2	S-2	2.5	One spacing.
Workmanship	3.6	II	2.5	A single marking application.
Insulation damage	3.6.1	II	Zero defects	A single marking application.

1/ The lot size shall be the total number of markings that have been made on the lot of insulating material (see 4.3).

4.5.2 Inspection -

4.5.2.1 Inspection of samples for tests - Each marking on the samples furnished in accordance with 4.5.1.1 shall be examined and tested to determine conformance to the applicable requirements specified in Table III. The manufacturer shall certify in writing that the marked insulating material conforms to Insulation properties (3.3). Nonconformance of one marking on a sample to a single requirement shall be cause for rejection of the lot represented by the sample.

TABLE III  
INSPECTION OF SAMPLES FOR TESTS

Inspection	Requirement	Number of markings tested	Test method
Indentation	3.4.1	4	4.6.1
Adherence	3.4.2	4	4.6.2
Solvent resistance	3.4.3	4	Test Method 215 of MIL-STD-202.

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4.5.2.2 Inspection of the end item - Each sample selected in accordance with 4.5.1.2 and Table II, shall be examined and tested to determine conformance to the applicable inspection requirements listed in Table II. A marking that does not conform to all applicable inspection requirements shall be considered defective. If the number of defectives in a sample group exceeds the acceptable quality level (A.Q.L.) specified in Table II, the lot represented by the sample group shall be rejected.

4.6 Test methods - Markings on heat shrinkable tubing shall be tested only after completion of the unrestricted shrinkage procedure specified in the specification covering the tubing.

4.6.1 Indentation - The indentation into the surface of the insulating material shall be measured with a contour projector as specified in paragraph 8.5.5.1 of MIL-STD-120 or with a calibrated microscope. Measurements shall be made to an accuracy of one ten-thousandth of an inch. Three characters of the marking shall be selected at random and measured for depth of indentation immediately after the indenting operation (except that the markings on heat shrinkable tubing shall be measured after the shrinkage specified in 4.6) and prior to heat fusion, overcoating or other secondary bonding processes. Each measurement shall be made at the deepest point of indentation in reference to a smooth surface area immediately adjacent to the indentation. Whenever a single measurement is found to have an indentation greater than the maximum specified in 3.4.1, the marking being tested shall be considered a failure. If each measurement is less than the maximum, the three measurements shall be averaged to determine conformance of the marking to the average indentation specified in 3.4.1.

4.6.2 Adherence - The marked insulating material shall be placed on a flat, solid bench and rubbed with a flat surface of a pencil eraser conforming to the regular grade of ZZ-E-661. If necessary, insulating tubing may be supported by the insertion of a close fitting mandrel. One rub shall be made by firmly pressing the eraser on the sample and rubbing at least a 3/8 inch length of eraser along the entire length of the marking. The eraser shall be wide enough to completely cover the characters being rubbed. The maximum pressure that can be applied manually shall be used when rubbing the marking. The marking shall be subjected to the number of rubs specified in Table IV at the rate of 2 to 3 seconds for each rub. The marking shall then be visually examined at a reading distance of 14 inches for conformance to the Workmanship requirement of 3.6.

TABLE IV

Outer surface of the electrical insulation	Number of rubs across the marking
Polyimide	10
All other surfaces	20

## 5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

## 6. NOTES

6.1 Intended use - Various printing processes can be used to permanently mark the surface of most types of insulating sleeves (flexible, rigid, braided, heat-shrinkable) and all forms of wire insulations (extrusions, tapes, films, coatings). The markings usually consist of circuit identification codes such as those specified in MIL-W-5088 and MIL-W-8160. Identification of each connecting wire as to its function or diagram location facilitates the manufacture of electrical equipment and subsequent repair and maintenance. Materials that cannot be marked directly, such as unjacketed shielded wire, thermocouple wires, multi-conductor cable, asbestos and fiberglass, are identified by use of a marked insulating sleeve as described in 6.5.

CAUTION: Metallic markers or bands should not be used for the identification of electrical circuits.

6.1.1 Marking color - Whenever possible, a black marking should be used on light colored insulating materials that will provide a good contrast to black; and a white marking on very dark colored insulating materials.

6.2 Ordering data - Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Identification code and spacing between markings (see 3.2).
- (c) Size of printing type and reading direction (see 3.2.2).
- (d) Marking color, (see 3.2.1 and 6.1.1).
- (e) Preproduction approval, if required (see 3.1).
- (f) Special requirements, if necessary for a specific application (see 3.5).

6.3 Hot stamp printing precautions - Since the hot stamp printing process will cause a 0.001 to 0.002 inch indentation into the electrical insulation (poor quality marking may cause even deeper indentations) and some heat induced deterioration of the insulation in the immediate area around the markings, there will be a slight decrease in the physical and dielectric properties of the insulation. With an electrical insulation of 0.010 inch or thicker, the change in properties will be so small as to be unmeasurable on commercial test equipment. On the other hand, a thin insulating material may show a significant decrease in electrical properties and in physical properties such as resistance to radiation, chemicals, solvents, heat, abrasion, or vapor transmission. In critical applications, the thickness of insulating material could be increased to nullify the

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effect of the indentation; or another method of identification could be used, such as the use of a marked insulating sleeve over the wire or cable (see 6.5).

6.4 Troubleshooting chart - The following chart may be used to identify and correct improper hot stamp printing procedures.

HOT-STAMPING TROUBLESHOOTING CHART

Defect	Cause	Corrective action
No marking	(1) Improper marking foil (2) Insufficient pressure (3) Lack of heat	(1) Use correct marking foil (2) Increase pressure (3) Increase heat
Weak marking	(1) Insufficient pressure (2) Lack of heat (3) Unclean surface (4) Worn type characters	(1) Increase pressure (2) Increase heat (3) Clean the insulating material (4) Replace worn type characters
Blurred marking	(1) Too much pressure (2) Movement of wire or insulating sleeve (3) Too much heat (4) Old or defective marking foil (5) Worn type characters (6) Unclean holding fixture	(1) Decrease pressure (2) Decrease the size of the holding fixture (3) Decrease heat (4) Replace marking foil (5) Replace worn type characters (6) Clean the holding fixture
Faintness at top of marking	(1) Inadequate feeding of marking foil	(1) Increase the length of - marking foil feed
Uneven spacing	(1) Inadequate feeding pressure on wire or insulating sleeve (2) Excessive friction in the holding fixture (3) Uneven pressure in collecting the marked wire or insulating sleeve	(1) Adjust feed mechanism (2) Increase the size of the holding fixture. (3) Synchronize the collecting mechanism to the feed rate of the marking machine



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## HOT-STAMPING TROUBLESHOOTING CHART (Continued)

Defect	Cause	Corrective action
Degradation of TFE 1/ insulating material	(1) Heat fusion temper- ature too high (2) Heat fusion time too long	(1) Use correct fusion temperature (2) Use correct heat fusion time

1/ Polytetrafluoroethylene

6.5 Marking of insulating sleeves - When a wire or cable cannot be marked directly, mark a suitable insulating sleeve with the specified identification code and install on the wire or cable within three inches of each terminating end (see 6.6).

CAUTION: Do not use insulating sleeves to change the identification of a wire or cable that has already been marked, except in the case of spare wires in potted connectors.

6.5.1 Multiconductor cable identification - Identify multiconductor cables with marked insulating sleeves, installed as described in 6.5. Mark the insulating sleeve with the identification code of each wire in the cable. Immediately following the code, use letters indicating the color of each conducting wire, using the following abbreviations:

BLK - Black	ORN - Orange
BLU - Blue	PR - Purple
BRN - Brown	RED - Red
GY - Gray	WHT - White
GRN - Green	YEL - Yellow

At each terminating end, strip back the outer cable covering and mark the color code letters on each conducting wire.

6.5.2 Coaxial cable identification - Identify coaxial cable by direct marking on the cable or by the use of marked sleeves. If insulating sleeves are required, install them as described in 6.5. In addition, mark coaxial cable on the end terminating in a piece of equipment to match the marking on the equipment terminal.

CAUTION: When marking coaxial cable, take care not to flatten the cable as this may change the electrical characteristics of the cable.

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6.5.3 Thermocouple wire identification - Thermocouple wire is usually identified by the use of marked insulating sleeves as described in 6.5. The wire size in the identification code is replaced by the full name of the thermocouple conductor.

6.6 Installation of insulating sleeves - When it is necessary to secure the insulating sleeving by tying at each end, follow the directions in paragraphs 2-35 and 2-36 of NAVWEPS 01-1A-505, (USAF) T.O. 1-1A-14.

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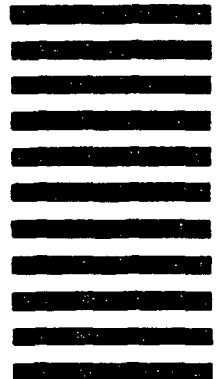
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