

MIL-T-81914(AS)
28 February 1973

MILITARY SPECIFICATION

TUBING, PLASTIC, FLEXIBLE, CONVOLUTED, CONDUIT GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope - This specification establishes requirements for plastic convoluted tubing that provides mechanical protection and support for electric wire bundles. The continuous operating temperatures range from -67°F (-55°C) to 500°F (260°C) (see 6.1).

1.2 Classification - The properties of the convoluted tubings shall be as specified in the applicable specification sheet.

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 the specification to the extent specified herein.

SPECIFICATIONS

Federal

SS-S-550	Sodium Chloride, Technical for Water Softening Units
PPP-B-636	Box, Fiberboard
PPP-B-640	Box, Fiberboard, Corrugated, Triple-Wall

Military

MIL-P-116	Preservation, Methods of
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance

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MIL-T-81914(AS)**SPECIFICATIONS****Military** (Cont'd)

MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-I-7444	Insulation Sleeving, Electrical, Flexible
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8243	Anti-Icing and Deicing-Defrosting Fluid
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base

STANDARDS**Military**

MIL-STD-104	Limits for Electrical Insulation Color
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-147	Palletized and Containerized Unit Loads 40 Inch X 48 Inch Pallets, Skids, Runners, or Pallet Type Base

(Copies of specifications and standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials

ASTM D 638-68	Test for Tensile Properties of Plastics
ASTM D 792-66	Tests for Specific Gravity and Density of Plastics by Displacement

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ASTM D 876-65 Testing Nonrigid Vinyl Chloride Polymer
 Tubing

ASTM D 1924-70 Determining Resistance of Synthetic Polymeric
 Materials to Fungi

(ASTM Standards are published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.

Uniform Freight Classification Rules and Container Specification
for Rail Shipments

(Application for copies should be addressed to the Uniform Freight Classification Committee, 202 Union Station, Chicago, Illinois 60606.)

National Motor Freight Classification Rules and Container Specifications for Truck Shipments

(Application for copies should be addressed to the National Classification Board, Sixteenth Street, Washington, D.C. 20002.)

3. REQUIREMENTS

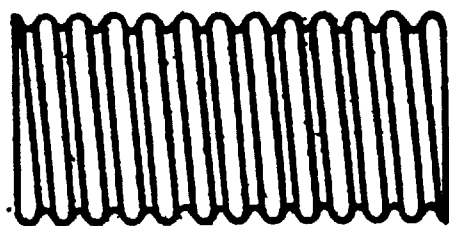
3.1 Specification sheets - The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets.

3.2 First article - When specified by the procuring activity (see 6.2), the products furnished under this specification shall have been tested and have passed the first article inspection of 4.3.

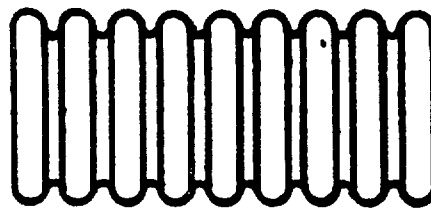
3.3 Material - The material used to fabricate the tubing shall be of the polymer type specified in the applicable specification sheet and shall be formulated to meet the requirements of this specification.

3.4 Convolution type - The tubing supplied under this specification shall have right hand thread helical or annular type convolutions (see Figure 1). The availability of each is noted in the applicable specification sheet.

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Helical (right hand)



Annular

Figure 1. Convolution Type

3.5 Data - Unless otherwise specified by the procuring activity, no data, other than the test reports which accompany the first article test samples (4.3.2), is required by this specification or by the documents referenced in Section 2.

3.6 Construction details - When examined as specified in 4.6.1, all construction details - dimensions, tolerances, weights, and convolutions per inch shall be in accordance with the applicable specification sheet.

3.7 Shelf life - After storage for two years at 65 to 95°F, the convoluted tubing shall meet the as received requirements for low temperature flexibility, tensile strength and elongation. The manufacturer shall certify to this requirement. Certification shall be forwarded by the manufacturer as part of the test report required in 4.3.2.

3.8 Physical property requirements - Physical properties shall be as specified in Table I. The specific values shall be in accordance with the applicable specification sheet.

3.8.1 Abrasion resistance - When an abrasion resistance requirement is desired, the procuring activity shall specify the test method and the desired values (see 6.2). The supplier shall forward certification to this requirement as part of the test report required in 4.3.2.

3.9 Workmanship - When examined visually, the convoluted tubing shall be free from internal voids, blisters, bumps, tears, pinholes, longitudinal seams, cracks, foreign matter or other defects that would be detrimental to appearance and performance.

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TABLE I
Physical Property

Property	Test Method Paragraph
Stress in psf @ 10% strain	4.6.2
Specific gravity	4.6.3
Crush resistance	4.6.4
Low temperature flexibility	4.6.5
Heat shock	4.6.6
Heat resistance	4.6.7
Fluid resistance	4.6.8
Flammability	4.6.9
Fungus resistance	4.6.10
Dielectric breakdown	4.6.11

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 in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by 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 supplies and services conform to prescribed requirements.

4.2 Classification of inspections - The inspections and testing of the convoluted tubing shall be as follows:

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(a) First article inspection (see 4.3)

(b) Quality conformance inspection (see 4.4)

4.3 First article inspection - First article inspection shall be performed on the first lot or order of tubing furnished under this specification and on any subsequent lot or order when specified by the procuring activity (see 6.2). First article inspection shall consist of all the tests and inspections of this specification. Instructions for testing and approving the tubing are located in 6.3.

4.3.1 First article sample - Unless otherwise specified by the procuring activity, 18 feet of convoluted tubing shall be submitted for each size range specified in Table II for which first article approval is desired. Approval of the first article sample will automatically extend approval to all sizes included in the specific range. The first article sample shall have been produced in the same facilities intended for the production run.

TABLE II

Size Ranges For First Article Sample

Range	I.D. Inch
1	0.188 to 0.375
2	over 0.375 to 0.875
3	over 0.875 to 1.250
4	over 1.250

4.3.2 Manufacturer's data - For each procurement, the manufacturer shall submit two (2) copies of his test report to the procuring activity which show the tubing conforms to all the requirements of this specification. The test report shall reference the specific requirements and test methods of this specification. The test report shall include the certifications required by 3.7 and 3.8.1. In addition, when a first article sample is required (see 4.3) the manufacturer shall submit copies of the test report along with the first article sample.

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4.4 Quality conformance -

4.4.1 Lot formation - Unless otherwise specified, a lot shall consist of all the convoluted tubing of the specification sheet and one size manufactured at one time from the same batch of raw material forming part of one contract or order and submitted for inspection at one time.

4.4.2 Sampling -

4.4.2.1 Physical property tests - Five feet of convoluted tubing shall be randomly selected from each lot (4.4.1) and tested in accordance with 4.4.3.1.

4.4.2.2 Visual and dimensional inspection - The samples for this inspection shall be selected in accordance with Inspection Level S-3 of MIL-STD-105. The sample unit shall be two (2) feet. Each sample shall be inspected as specified in 4.4.3.2.

4.4.2.3 Preparation for delivery - A quantity of shipping containers fully prepared for delivery, just prior to closure, shall be randomly selected from each lot in accordance with Inspection Level S-2 of MIL-STD-105. The lot size for purposes of this inspection shall be the number of shipping containers. The inspection shall be conducted in accordance with 4.4.3.3.

4.4.3 Inspection and tests -

4.4.3.1 Physical property tests - Test specimens prepared from the sample selected in 4.4.2.1 shall be tested for conformance to the requirements in Table III. Two specimens shall be tested to each requirement. In addition, the sample may be subjected to any other test or inspection herein when required by the procuring activity. Nonconformance of a test specimen to a single requirement shall be cause for rejecting the lot represented by the sample.

4.4.3.2 Visual and dimensional inspection - Samples selected as specified in 4.4.2.2 shall be visually examined to the requirements in Table IV. The Acceptable Quality Level (AQL) for this inspection shall be 1.5 percent defective.

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TABLE III

Physical Property Inspection

Property	Test Paragraph
Stress, psi @ 10% strain	4.6.2
Low temperature flexibility	4.6.5
Heat shock	4.6.6
Flammability, when applicable	4.6.8

TABLE IV

Visual and Dimensional Inspection

Property	Test Paragraph
Workmanship & appearance	3.6
Construction details	
Inside diameter, min.	4.6.1.1
Weight	4.6.1.2
Minimum bend radius	4.6.1.3
Convolutions per inch	4.6.1.4

4.4.3.3 Preparation for delivery - Shipping containers selected in accordance with 4.4.2.3 shall be visually examined for conformance to Table V and to all applicable requirements of Section 5 of this specification. The Acceptable Quality Level (AQL) for this examination shall be 2.5 percent defective. In addition, shipping containers fully prepared for delivery shall be examined for closure defects.

TABLE V

Inspection of Preparation For Delivery

Examination	Defect
Packaging	Not Level Required By Contract or Order Material or Construction Not as Specified
Packing	Not Level Required By Contract or Order Any Nonconforming Component Closure Not as Specified Material or Construction Not as Specified
Count	Less Than Specified in Contract or Order
Marking	Packaging and Packing - Omitted, Illegible, Incorrect, Incomplete or Not in Accordance With Contract

4.5 Test methods -

4.5.1 Standard conditions - Standard conditions shall be $73 \pm 1^{\circ}\text{C}$ ($73.4 \pm 2^{\circ}\text{F}$) and a relative humidity of 50 ± 5 percent.

4.5.2 Conditioning - Unless otherwise specified herein, the convoluted tubing, all test fixtures and measurement gauges shall be maintained at Standard conditions for 24 hours.

4.5.3 Test specimens - All test specimens shall be cut from the first article or quality conformance sample. Unless otherwise specified, the number of specimens for each test shall be three.

4.5.4 Reporting of test results - Unless otherwise specified in the applicable test method, test results shall be reported as the average of the 3 values. However, each individual value shall be noted in the test report and shall conform to the specified requirement.

4.6 Physical property procedures -4.6.1 Construction details -

4.6.1.1 Dimensions - The inner and outer diameters and wall thickness shall be determined in accordance with ASTM D 876, or equivalent method.

4.6.1.2 Weight - A 12 ± 0.031 inch length of tubing shall be weighed to the nearest 0.1 gram. Weight per 100 feet of tubing shall be determined as follows:

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$$W \times 453.6 \times 100 = \text{wt per 100 feet.}$$

W = weight of specimen in grams.

4.6.1.3 Minimum bend radius - The minimum bend radius shall be determined by pulling a metal slug through a length of tubing, after that tubing has been bent around a mandrel whose radius is equal to the specified minimum bend radius. The metal slug shall be elliptical in shape, its largest diameter 10 percent less than the diameter of the tubing undergoing test. The length of the plug shall be 1.5 times its diameter. The force required to pull the ball through the tubing shall not exceed 3 pounds. See Figure 2.

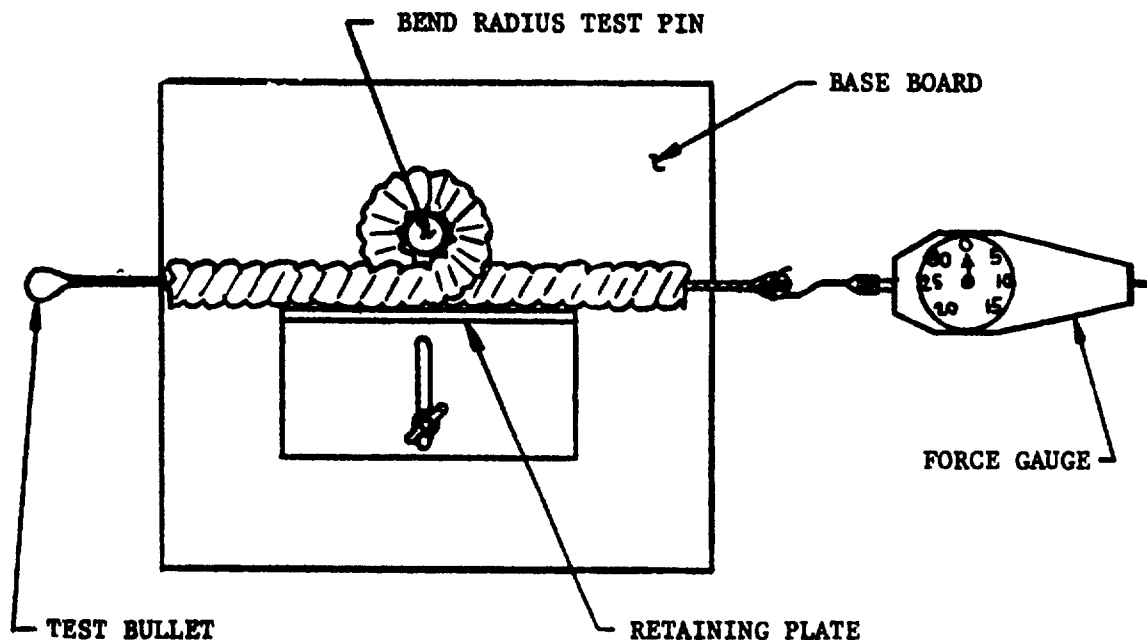


Figure 2. Minimum Bend Apparatus

4.6.1.4 Convolutions per inch - The number of convolutions per inch shall be determined by counting the total convolutions in a 6 ± 0.013 inch section of tubing. Convolutions per inch shall be the total convolutions divided by 6.

4.6.2 Tensile strain properties - Full sections of tubing shall be equipped with suitable fittings which will prevent slippage. The distance between fittings shall be 6 ± 0.013 inch and shall constitute the bench marks for test. The specimen shall be extended to 10 percent strain in an ASTM D 638 tensile apparatus, or equivalent. The tensile stress in psi at 10 percent strain shall be recorded. Individual values shall not deviate more than ± 10 percent from the average value of the 5 specimens examined.

4.6.3 Specific gravity - The specific gravity of the tubing shall be determined using Method A-1 of ASTM D 792.

4.6.4 Crush resistance - Horizontal crush specimens shall be determined using a tensile testing instrument properly modified with a compression cell and two circular, flat metal plates, each at least 2 inches square. The lower plate may be covered with a 600 grit sandpaper or equivalent to help prevent specimen slippage. The rate of compression for all specimens shall be 0.5 inch per minute. A one inch specimen (± 0.063 inch) shall be centered horizontally on the lower plate of the modified testing instrument. The specimen shall then be compressed to 70 percent of its original diameter. The force in pounds shall be recorded at each 5 percent compression. The reported values shall be the force in pounds required to compress the tubing 25 percent.

4.6.5 Low temperature flexibility - A length of tubing shall be secured to the apparatus shown in Figure 3. The apparatus shall be placed in a cold chamber at $-65 \pm 2^\circ\text{F}$ ($-54 \pm 1^\circ\text{C}$) and the tubing flexed over the mandrels at the rate of 15 ± 2 cycles per minute. A cycle shall consist of one flex over each mandrel. The number of cycles for each tubing shall be as specified in the applicable specification sheet. The tubing shall be examined for cracking.

4.6.6 Heat shock (Longitudinal change) - Change in length after heat shock shall be determined by placing 4 ± 0.032 inch bench marks on a 6 inch piece of tubing and then conditioning the tubing in an oven for 4 hours at the temperature specified in the applicable specification sheet. The tubing shall be suspended horizontally by inserting an 8 by 0.125 inch diameter mandrel through the tubing and resting the ends of the mandrel on metal blocks. After exposure, the test assembly shall be removed from the oven and conditioned for one hour prior to re-measuring the bench marks. The tubing shall also be examined for any decomposition, cracking and dripping or flowing. Percent change in length shall be determined as follows:

$$\% \text{ change} = \frac{l_2 - l_1}{l_1} \times 100$$

where l_1 = original bench mark length

where l_2 = re-measured bench mark, after exposure

4.6.7 Heat aging - Three six inch lengths of tubing shall be positioned in an oven as specified in 4.6.6. The tubing shall be conditioned for the time and temperature specified in the applicable specification sheet. After exposure, the tubing shall be cooled to standard conditions and tested as specified in 4.6.2.

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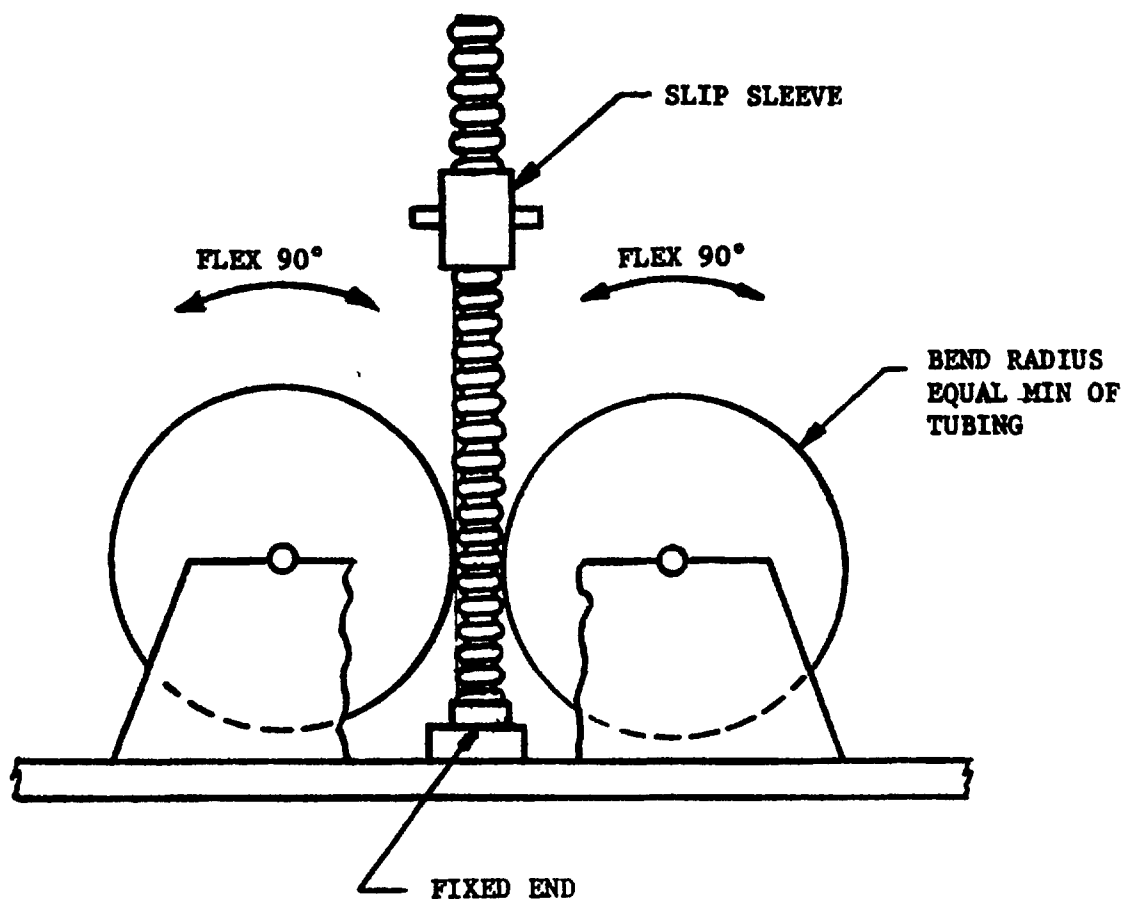


Figure 3. Low Temperature Flex Apparatus

4.6.8 Fluid resistance - Three 6 inch lengths of tubing shall be immersed in each of the fluids listed in Table VI. The volume of the fluid shall be not less than 20 times that of the tubing. After 24 hours immersion at standard conditions, the tubing shall be removed from the fluid, dried by wiping, conditioned for 45 minutes and then tested as specified in 4.6.2 and 4.6.3.

4.6.9 Flammability - Flammability shall be determined in accordance with ASTM D 876.

4.6.10 Fungus Resistance - Fungus resistance shall be determined in accordance with ASTM D 1924.

4.6.11 Dielectric breakdown voltage - A clean bare copper wire (AWG 12) shall be inserted into, and run throughout the length of a 24-inch piece of tubing. The tubing shall be bent into a "U" shape and held in that position by tying the ends. A one percent aqueous sodium chloride (SS-S-550) solution shall be poured into the tubing to within six inches of the top. The tubing shall be placed in a vessel which contains additional sodium chloride solution. The top 7 inches of the tubing, on each side, shall be above the level of the solution. This portion of the tubing shall remain dry during the test. The specimen shall be conditioned one hour before applying the potential (see applicable specification sheet) between the electrodes. The voltage shall be increased from 0 to the required potential within 30 seconds and then increase until breakdown occurs. The voltage at breakdown shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Packaging - Packaging shall be Level A or C as specified (see 6.2).

5.1.1 Level A - The convoluted tubing shall be packaged by method III of MIL-P-116. The tubing may be coiled or wound on spools. When coiled, the tubing shall be encased in a suitable fiberboard container. When wound on spools, the spool shall provide rigid support and shall not distort nor change shape during shipment. The standard length available shall be as specified in the applicable specification sheet.

5.1.2 Level C - The convoluted tubing shall be packaged in accordance with the manufacturer's commercial practice.

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5.2 Packing - Packing shall be Level A, B or C, as specified (see 6.2).

5.2.1 Level A - Shipping containers shall contain identical tubing of the same specification sheet, class and size and shall enclose the contents in a snug, tight-fitting manner. Shipping containers shall conform to Class weather-resistant, compliance symbol V3c or V3s, of PPP-B-636 for gross weights up to 70 pounds, or to Class 2 of PPP-B-640 for gross weights up to 200 pounds. If more than one spool of coiled tubing is packed into a shipping container, the spools shall be separated both vertically and horizontally by sheets constructed of fiberboard conforming to the domestic class of the applicable container specification. Containers shall be closed and strapped in accordance with the applicable container specification.

5.2.2 Level B - Shipping containers shall contain identical tubing of the same specification sheet, class and size and shall enclose the contents in a snug, tight-fitting manner. Shipping containers shall conform to Class domestic of PPP-B-636 for gross weights up to 70 pounds or to Class 1 of PPP-B-640 for gross weights up to 200 pounds. If more than one spool of coiled tubing is packed into a shipping container, the spools shall be separated both vertically and horizontally by sheets constructed of fiberboard conforming to the domestic class of the applicable container specification. Containers shall be closed and strapped in accordance with the applicable container specification.

5.2.3 Level C - Packages which require overpacking for acceptance by common carrier shall be packed in exterior type shipping containers in a manner which will insure safe delivery and acceptance of the point of delivery at lowest cost. Containers shall comply with the rules and regulations applicable to the selected mode of transportation.

5.3 Unitized loads - Unitized loads should be used when practical and shall be commensurate with the level of packing stated in the contract or order (see 6.2). MIL-STD-147 shall be used when loads are palletized.

5.4 Marking - All markings of packages and shipping containers shall be in accordance with MIL-STD-129 and shall also include:

- (a) Date manufactured
- (b) Expiration date
- (c) Lot, batch or control number
- (d) Other markings as required by contract or order

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6. NOTES

6.1 Intended use - The convoluted plastic tubing (conduit) furnished under this specification is intended for use as a component in aircraft electrical harness systems where ease of accessibility for repair of individual conductors and removal of electronic components with all cables intact is required. The convoluted tubing provides a minimum weight material that gives a great degree of flexibility and maintains maximum mechanical and environmental protection of the harness system.

6.2 Ordering data - Procurement documents should specify the following:

- (a) Title, number and date of this specification and the applicable specification sheet
- (b) Part number (See applicable Specification sheet)
- (c) Quantity
- (d) Packaging and packing required (see section 5)
- (e) First article approval, when required (see 4.3)
- (f) Abrasion resistance requirement, and test procedure, when required (see 3.6.1)

6.3 First article instructions - When first article inspection is required, the procuring activity shall designate the laboratory to which the first article samples shall be forwarded. The size of the first article sample shall be as specified in 4.3.1.

6.4 Properties not tested for -

6.4.1 Flammability and fluid resistance - Polytetrafluorethylene and fluorinated ethylene propylene tubings do not support combustion and are therefore not subjected to the flammability tests.

6.4.2 Fungus resistance - Polyvinylidene Fluoride, fluorinated ethylene propylene, and polytetrafluorethylene tubings do not support fungus growth.

Preparing Activity
Navy - AS
(Project No. 9330-N548)

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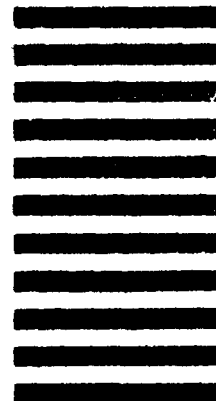
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