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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-T-81914

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Submitted for recognition as an American National Standard

Tubing, Plastic, Flexible, Convoluted, Conduit, General Specification for

NOTICE

This document has been taken directly from U.S. Military Specification MIL-T-81914(AS), Supplement 1, 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-H-81914(AS), Supplement 1. 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 qualifications requirements and associated qualified products lists are mandatory to DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this technical report.

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.

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SPECIFICATION SHEETS

MIL-T-81914/1(AS) TUBING, PLASTIC, FLEXIBLE, CONVOLUTED, POLYTETRAFLUOROETHYLENE, STANDARD CONVOLUTIONS
MIL-T-81914/2(AS) TUBING, PLASTIC, FLEXIBLE, CONVOLUTED, POLYTETRAFLUOROETHYLENE, CLOSE CONVOLUTION
MIL-T-81914/3(AS) TUBING, PLASTIC, FLEXIBLE, CONVOLUTED, FLUORINATED ETHYLENE PROPYLENE, STANDARD CONVOLUTION
MIL-T-81914/4(AS) TUBING, PLASTIC, FLEXIBLE, CONVOLUTED, FLUORINATED ETHYLENE PROPYLENE, CLOSE CONVOLUTION

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 the specification to the extent specified herein.

2.1 ASTM Publications:

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

ASTM D 638 Test for Tensile Properties of Plastics
ASTM D 792 Tests for Specific Gravity and Density of Plastics by Displacement
ASTM D 876 Testing Nonrigid Vinyl Chloride Polymer Tubing
ASTM D 1924 Determining Resistance of Synthetic Polymeric Materials to Fungi

2.2 U.S. Government Publications:

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

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

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

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

2.3 Uniform Freight Classification Publication:

Available from Uniform Freight Classification Committee, 202 Union Station, Chicago, Illinois 60606.

Uniform Freight Classification Rules and Container Specification for Rail Shipments

2.4 National Motor Freight Classification Publication:

Available from National Classification Board, Sixteenth Street, Washington, D.C. 20002.

National Motor Freight Classification Rules and Container Specifications for Truck Shipments

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.

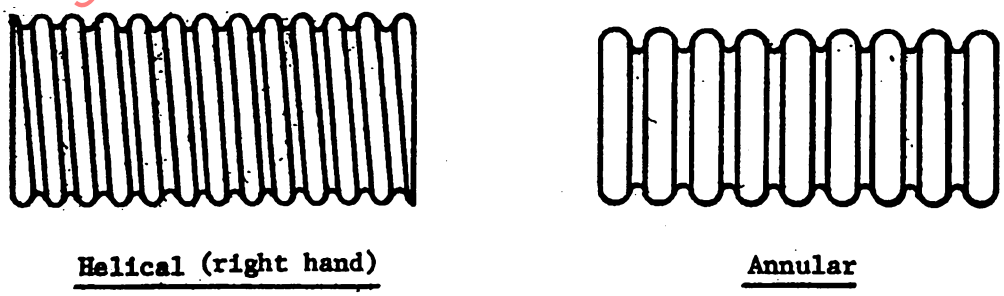

FIGURE 1. Convolution Type

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.

TABLE I. Physical Property

Property	Test Method Paragraph
Stress in psi @ 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:

(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.

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.

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 ± 1°C (73.4 ± 2°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:

W X 453.6 X 100 = 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.

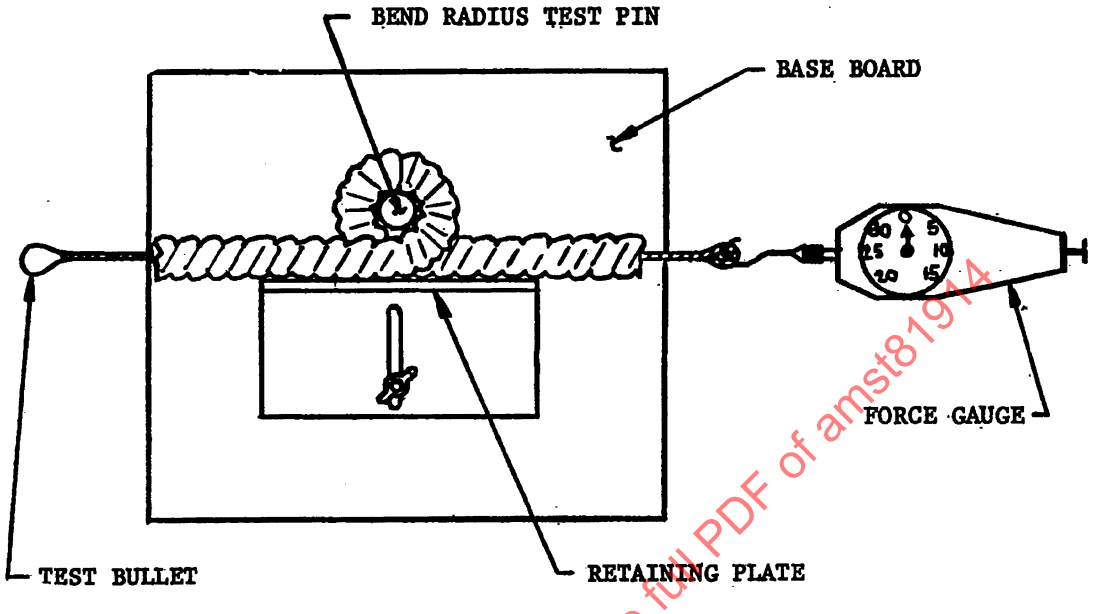

FIGURE 2. Minimum Bend Apparatus

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 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 properties 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 ± 2°F (-54 ±1°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 markes 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 remeasuring 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:

$$\% \text{ change} = \frac{1_2 - 1_1}{1_1} \times 100$$

where 1_1 = original bench mark length

where 1_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.

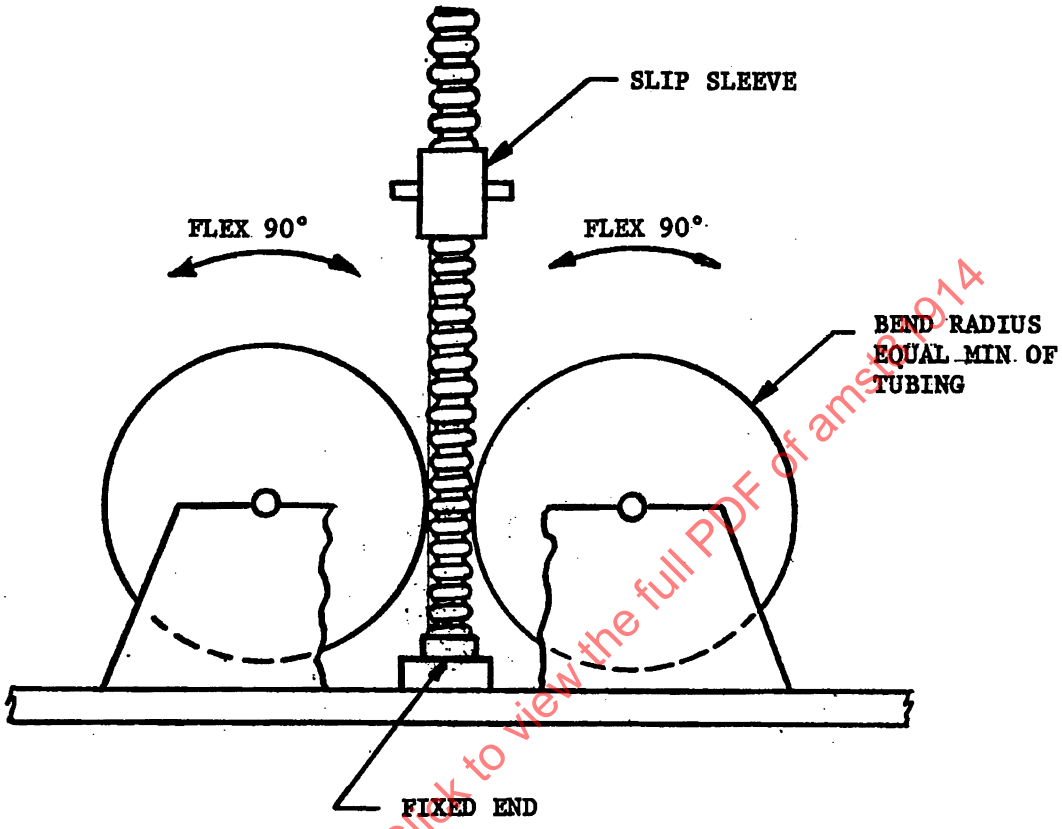

FIGURE 3. Low Temperature Flex Apparatus

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.

TABLE VI Test Fluids

Fluid	Conforming to
Hydraulic fluid, petroleum base	MIL-H-5606
JP-4 fuel	MIL-T-5624
Lubricating oil	MIL-L-7808
Lubricating oil	MIL-L-23699
5% NaCl	SS-S-550
Deicing fluid	MIL-A-8243