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MIL-P-22296B
2 November 1973
SUPERSEDING
MIL-P-22296A
6 June 1967

MILITARY SPECIFICATION

PLASTIC TUBES AND TUBING, POLYTETRAFLUOROETHYLENE (TFE-FLUOROCARBON RESIN), HEAVY WALLED

This specification is approved for use by all departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers unfilled, unpigmented, heavy walled polytetrafluoroethylene (TFE-fluorocarbon resin) tubes and tubing. It does not cover tubes primarily intended for fluid handling.

1.2 Classification. The polytetrafluoroethylene (TFE-Fluorocarbon resin) tubes and tubing shall be of the following types and grades, as specified (see 6.2).

Type I - Normal dimensional stability
Type II - Superior dimensional stability
Type III - Normal dimensional stability and completely inspected for internal defects.
Type IV - Superior dimensional stability and completely inspected for internal defects.
Grade A - Premium quality
Grade B - Standard quality

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.

/FSC 9330/

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SPECIFICATIONS

FEDERAL

L-P-403 - Plastic Molding Material, Polytetrafluoroethylene (TFE-Fluorocarbon)
PPI-B-585 - Boxes, Wood, Wirebound
PPP-B-601 - Boxes, Wood, Cleated-Plywood
PPP-B-636 - Boxes, Shipping, Fiberboard

MILITARY

MIL-P-116 - Preservation, Methods of
MIL-L-10547 - Liners, Case, Waterproof

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications 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 a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

D149-64 (1970) - Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies.
D618-61 (1971) - Conditioning Plastics and Electrical Insulating Materials for Testing.
D638-68 - Tensile Properties of Plastics.
D792-71 (1970) - Specific Gravity and Density of Plastics by Displacement.
D883-71 - Nomenclature Relating to Plastics.
E94-68 - Radiographic Testing.

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103).

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National Motor Fright Traffic Association, Inc., Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations Inc., Tariff Order Section, 1616 P Street N.W., Washington, D. C. 20036).

Uniform Classification Committee, Agent:

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606).

3. REQUIREMENTS

3.1 Material. The heavy walled tubes and tubing shall be molded or extruded from polytetrafluoroethylene (TFE-fluorocarbon resin) conforming to L-P-403. The type and class of material conforming to L-P-403 shall be specified in the contract or purchase order. Heavy walled tubes and tubing shall be defined as having a minimum wall thickness of 1/4 inch.

3.2 Property values. The tubes and tubing shall conform to the property values shown in table I, when tested as specified in the applicable procedure of 4.3.

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Table I. Property values.

	Type I		Type II		Type III		Type IV	
	Grade A	Grade B	Grade A	Grade B	Grade A	Grade B	Grade A	Grade B
Specific gravity, min.	2.15	2.14	2.15	2.14	2.15	2.14	2.15	2.14
Tensile strength, min., psi	2000	1500	2000	1500	2000	1500	2000	1500
Elongation, min., percent	100	75	100	75	100	75	100	75
Dielectric strength, min., 0.040 inch specimen, volts per mil	600	500	600	500	600	500	600	500
Dimensional stability, max., change in dimension, percent								
Length	-	-	1.5	1.5	-	-	1.5	1.5
Outside diameter	-	-	0.5	0.5	-	-	0.5	0.5

3.3 Freedom from internal defects. Types III and IV material shall be free from internal defects when inspected by radiographic testing in accordance with the applicable procedure in 4.3.

3.4 Color. The tubes and tubing shall be natural in color for unpigmented resin. The color may vary from white to mottled gray or brown. Small gray, brown, or black spots shall not in themselves be cause for rejection.

3.5 Dimensions and tolerances. (See 3.1 for minimum thickness).

3.5.1 Length. The nominal length of the tubes and tubing and the tolerances thereon shall be as specified (see 6.2).

3.5.2 Diameter. The inside and outside diameters shall be as specified. Unless otherwise specified by the procuring activity, tolerances shall be as shown in table II (see 3.6).

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Table II. Diameter tolerances for tubes and tubing

Nominal inside or outside diameter,[1] (inches)			Tolerance,[2] (inches)
1/16	or	0.0625	0.005
1/8		0.1250	0.007
3/16		0.1875	0.009
1/4		0.2500	0.010
3/8		0.3750	0.012
1/2		0.5000	0.014
5/8		0.6250	0.016
3/4		0.7500	0.017
1		1.000	0.020
1-1/4		1.250	0.022
1-1/2		1.500	0.024
1-3/4		1.750	0.026
2		2.000	0.028
2-1/4		2.250	0.030
2-1/2		2.500	0.032
3		3.000	0.035

[1] Intermediate diameters shall conform to the tolerances of the greater diameter.

[2] The tolerance is plus for outside diameters and minus for inside diameters (see 3.5.2).

3.5.3 Eccentricity. The eccentricity, when measured as one-half the difference between the maximum and minimum wall thickness at either end of the tube or tubing shall not exceed 10 percent of the nominal wall thickness. The nominal wall thickness is one-half of the difference between the nominal outside diameter and the nominal inside diameter.

3.6 Centerless grinding. When specified, the outside surface shall be finished by centerless grinding (see 6.2), and outside diameter tolerances shall be as specified by the procuring activity. Unless otherwise specified by the procuring activity, the other dimensional tolerances of centerless ground tubes and tubing shall be as specified in 3.5.1, 3.5.2, and 3.5.3.

3.7 Workmanship. The tubes and tubing shall be free from blisters, voids, cracks, foreign matter, and other defects that may affect appearance or which may affect serviceability. (These defects may be defined in accordance with ASTM D883-71, as applicable).

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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 Sampling for inspection. Sampling for inspection shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated. For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type, grade, and nominal inside or outside diameter submitted for inspection at one time.

4.2.1 Inspection of materials and components. In accordance with 4.1 above, the supplier is responsible for insuring that materials and components used were manufactured, tested and inspected in accordance with the requirements of referenced, subsidiary specifications and standards to the extent specified, or, if none, in accordance with this specification. In the event of conflict, this specification shall govern. A supplier's certificate of compliance with 3.1 shall be furnished.

4.2.2 Inspection of the tubes and tubing.

4.2.2.1 Examination of the tubes and tubing. Examination shall be made in accordance with the classification of defects, inspection levels and acceptable quality levels (AQLs) set forth below. The lot size, for purposes of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of packages of tubes or tubing as applicable, for examination in 4.2.2.1.1, 4.2.2.1.2, 4.2.2.1.3, 4.2.2.1.4 and in units of shipping containers for examination under 4.2.2.1.5.

4.2.2.1.1 Examination of the tubes and tubing for defects in appearance, construction, and workmanship. The sample unit for this examination, specified in table III, shall be one tube or tubing. Not more than five sample units shall be taken from any one package of tubes or tubing.

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Table III. Examination for defects in appearance, construction and workmanship

Examine	Defect
Appearance	Not clean, presence of imbedded particles, dirt, grit or other foreign matter, that may affect appearance or serviceability.
	Material not uniform in color, or not meeting requirements specified in 3.4.
Construction & Workmanship	Any cracks, scratches, bubbles, warpage, pits or other defects that would affect serviceability.
	Any cut, puncture, sharp crease, wrinkle, tear or hole.
	Edges not clean cut; ragged, crushed or uneven edges.

4.2.2.1.2 Examination of the tubes and tubing for dimensional defects. The sample unit for this examination specified in table IV, shall be one tube or tubing.

Table IV. Examination for dimensional defects

Examine	Defect
Length of tubes and tubing, and tolerances thereon	Not as specified.
Inside and outside diameter	Not as specified. Varies by more than the tolerance specified in table II.
Eccentricity	Not as specified in 3.5.3.

4.2.2.1.3 Examination of the tubes and tubing for defects in assembly. The sample unit for this examination, specified in table V, shall be one package of tubes or tubing.

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Table V. Examination for defects in assembly

Examine	Defect
Assembly of tubes and tubing	Not evenly stacked

4.2.2.1.4 Examination of the tubes and tubing for defects in the count per package. The sample unit for this examination specified in table VI, shall be one package of tubes or tubing.

Table VI. Examination for defects in the count per package

Examine	Defect
Tubes and tubing	Average count per package less than specified.

4.2.2.1.5 Examination of preparation for delivery requirements. An examination shall be made in accordance with table VII to determine that packaging, packing and markings comply with the requirements of Section 5. The sample unit for this examination shall be one shipping container, fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects.

Table VII. Examination of preparation for delivery

Examine	Defect
Packaging	Not level specified; not in accordance with contract requirements.
	Tubes and tubing not unit packaged as specified.
	Packaging material not as specified; closures not accomplished by specified or required methods of materials.
Packing	Not level specified: not in accordance with contract requirements.
	Any nonconforming component; component missing, damaged or otherwise defective affecting serviceability.

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Table VII. Examination of preparation for delivery (cont).

Examine	Defect
	Container not as specified; closures not accomplished by specified or required methods of materials.
	Inadequate application of components, such as: incomplete closures of case liners or container flaps, loose or inadequate strappings, bulged or distorted containers.
Count	Less than specified or indicated quantity of packages per shipping container.
Weight	Gross or net weight exceeds specified requirements.
Markings	Interior or exterior markings (as applicable) omitted, illegible, incorrect, incomplete, of improper size, location, sequence, method of application, or not in accordance with contract requirements.

4.2.2.1.6 Inspection levels and acceptable quality levels (AQLs) for examinations. The inspection levels for determining the sample size and the acceptable quality levels (AQLs) expressed in defects per 100 units, shall be as follows:

Examination Paragraph	Inspection Level	AQL
4.2.2.1.1	I	1.5
4.2.2.1.2	S-3	2.5
4.2.2.1.3	S-2	2.5
4.2.2.1.4	S-2	---
4.2.2.1.5	S-2	4.0

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4.2.3 Testing. The tubes and tubing shall be tested for the applicable characteristics listed in table I, in accordance with the test methods specified herein. The lot size, for the purpose of determining the sample size for testing shall be expressed in units of packages of tubes or tubing. The sample unit shall consist of sufficient material to prepare all required specimens. The inspection level shall be S-1, with an acceptance number of 0. The results for each test shall be the averaged results of the specimens, unless only one specimen is required for testing.

4.3 Test methods.

4.3.1 Conditioning. Test specimens shall be conditioned at 23° ± 2°C (73.4° ± 3.6°F) in accordance with procedure A of ASTM D618-61 (1971) and shall be tested under these conditions with the exception that maintenance of constant humidity is not necessary.

4.3.2 Specific gravity. One specimen shall be tested in accordance with method A1 of ASTM D792-66 (1970).

4.3.3 Tensile strength and elongation. Three specimens shall be tested in accordance with ASTM D638-68 using specimens conforming to figure 2 of this test method.

4.3.4 Dielectric strength. Three specimens, prepared in accordance with 4.3.4.1 or 4.3.4.2 as applicable, shall be tested in accordance with ASTM D149-64 (1970) using the short time test under oil. For flat specimens, the electrodes shall be as specified in table I of ASTM D149-64 (1970). For tubular specimens (see 4.3.4.2), a straight metal rod shall be used for the inner electrode. The rod shall be smooth and of a diameter such that it will fit tightly inside the tube without stretching it. A strip of metal foil 1 ± 0.01 inches wide and not more than 0.005 inch thick shall be used as the outer electrode. A tubular specimen shall be placed on the inner electrode, the latter being sufficiently long that a portion of it will be exposed for use in making the electrical connection. The outer electrode, consisting of a strip of metal foil, shall be wrapped tightly around the middle of the specimen. A total of three turns of foil shall be wrapped around the tubing, the first turn being wound tightest. The coil shall extend approximately 1/2 inch beyond the end of the specimen in order to provide for the outer electrical connection.

4.3.4.1 Flat specimens. When diameter and wall thickness are sufficient, specimens shall be cut as wafers 0.040 ± 0.001 inch thick and of sufficient size to prevent flashover during the test.

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4.3.4.2 Tubular specimens. When tube or tubing dimensions are too small to allow preparation of specimens in accordance with 4.3.4.1, specimens shall be prepared by cutting tubes or tubing into suitable short lengths. Length of specimens shall be sufficient to prevent flashover.

4.3.5 Dimensional stability. Two specimens, each approximately 1 inch in length, shall be cut from the tubes or tubing. The length and outside diameter shall be measured to the nearest 0.001 inch, with diameter being measured at the center point which shall be marked. The specimens shall be placed in a heating chamber maintained at 290° ± 3°C (554° ± 5.4°F), using either oil or air as the heating medium. The specimens shall be maintained in the heated chamber for 2 hours at 290° ± 3°C and then cooled at a rate not exceeding 30°C (54°F) per hour until 23° ± 1°C (73.4 ± 1.8°F) is reached. The length and diameter of each specimen shall be remeasured to the nearest 0.001 inch, with diameter being measured at the marked center point. The change in dimensions shall be calculated from the following:

$$D = \frac{Mh - Mi}{Mi} X100$$

where D = dimensional change in percent
Mi = initial dimension of sample
Mh = dimension of sample after heating

4.3.6 Freedom from internal defects. Three individual, types III and IV, tubes or tubing shall be tested in accordance with ASTM E94-68. The tubes or tubing shall be X-rayed in as many views as necessary to give complete coverage. The X-ray films shall be viewed for defects such as macroscopic cracks, voids, and inclusions. Films showing defects shall have the location of defects determined in order to be sure the defects do not correspond to surface damage or contamination (see 3.7).

5. PREPARATION FOR DELIVERY

Application. The requirements of section 5 apply only to purchase by or direct shipment to the Government.

5.1 Preservation and packaging. Preservation and packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A.

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5.1.1.1 Unit packaging. Unless otherwise specified in the contract or purchase order (see 6.2) tubes and tubing shall be packaged in quantities specified by the procuring activity in accordance with method III of MIL-P-116. Shapes of only one set of nominal dimensions shall be placed in one package.

5.1.1.2 Intermediate packaging. When required, specified quantities of unit packages shall be intermediately packaged as specified in the contract or purchase order (see 6.2).

5.1.2 Level C. Tubes and tubing shall be preserved and packaged to afford adequate protection against deterioration and physical damage during shipment from the supply source to the first receiving activity. The supplier may use standard practice when it meets these requirements.

5.2 Packing.

5.2.1 Level A. Tubes and tubing packaged as specified in 5.1.1 shall be packed in containers conforming to PPP-B-585(class 3), PPP-B-601 (overseas type) or PPP-B-636 (class-weather resistant, grade V2s). Unless otherwise specified containers shall be provided with a case liner conforming to MIL-L-10547. Closure and strapping shall be in accordance with the appendix to the applicable container specifications.

5.2.2 Level B. Tubes and tubing packaged as specified in 5.1.1 shall be packed in containers conforming to PPP-B-585(class 1), PPP-B-601, or PPP-B-636 (variety DW, grade 350). Closure shall be in accordance with the appendix to the applicable container specification.

5.2.3 Level C. Tubes and tubing shall be packed in a manner to insure carrier acceptance and safe delivery at destination at the lowest transportation rate for such supplies. Containers shall be in accordance with Uniform Freight Classification Rules or National Motor Freight Rules, as applicable.

5.3 Marking. In addition to any special marking specified in the contract or order, containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Polytetrafluoroethylene (TFE-fluorocarbon) tubes and tubing may be considered for use in applications requiring resistance to high temperatures (up to 260°C or 500°F), extreme chemical inertness, excellent electrical properties, a very low coefficient of friction, and good maintenance of properties under high vacuum conditions for long periods of time. The tubes and tubing are intended for use in the form of bearings, packing, gaskets, pump liners, and in electrical units.

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6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Type and grade of material (see 1.2 and table I).
(c) Nominal length and tolerances (see 3.5.1).
(d) Inside and outside diameter (see 3.5.2).
(e) Centerless grinding with outside diameter tolerance, if required (see 3.6).
(f) Level of preservation, packaging, and packing required including unit packaging quantities, if required (see 5.1 and 5.2).

6.3 Dimensional stability. Polytetrafluoroethylene tubes and tubing will, as normally processed, contain internal stresses which may result in dimensional changes when the tube is heated or machined. Annealing may relieve some of these stresses and make the tubing less subject to subsequent dimensional changes. However, this stress relief treatment is only partially effective depending upon the thickness and mass of the section. This is due to the relatively low thermal conductivity of the material which will result in the formation of new thermal stresses upon cooling from the annealing to room temperature. The degree of stress relief in the final product will vary with the thickness of the tube, and may be markedly different from center to surface or from center to the ends of a long tube. Also, any subsequent machining of parts from this tubing will introduce additional stresses. No amount of annealing of tube will ensure complete stability in the final product. The best dimensional stability in a particular finished part can only be accomplished by carrying out a stress relief anneal on the finished part after all machining operations have been completed. For close tolerances on a finished part, the best procedure is to machine almost to required dimensions, stress relief anneal, and then take a thin finish cut to exact dimension.

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6.4 Cross index. Table VIII shows the classification of material covered by MIL-P-22296B and the corresponding classification of material specified in MIL-P-22296B, dated 7 January 1960.

Table VIII. Classification in this document and corresponding classification in MIL-P-22296

Classification in MIL-P-22296	Classification in MIL-P-22296B (and MIL-P-22296A)
Type I	
Class G	Type I, grade A
Class D	Type II, grade A
Class R	Type III, grade A
Class P	None
Class DR	Type IV, grade A
Type II	
Class G	Type I, grade B
Class D	Type II, grade B
Class R	Type III, grade B
Class P	None
Class DR	Type IV, grade B

Custodians:
Army - MR
Air Force - 11

Review Interest:
Army - MI, EL, GL
Navy - SH
Air Force - 11, 84

User Interest:
Army - ME
Air Force - 17

Preparing activity:
Army - MR

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER

2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

b. ADDRESS *(Street, City, State, ZIP Code)*

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional

8. DATE OF SUBMISSION *(YYMMDD)*

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