

MIL-P-22241B  
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SUPERSEDING  
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MILITARY SPECIFICATION

PLASTIC SHEET (AND FILM) POLYTETRAFLUOROETHYLENE

(TFE-FLUOROCARBON RESIN)

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

1. SCOPE

1.1 Scope. This specification covers sintered, unfilled, unpigmented polytetrafluoroethylene (TFE-fluorocarbon resin) sheet ranging in thickness from 0.001 inch to 4 inches inclusive.

1.2 Classification. The polytetrafluoroethylene (TFE-fluorocarbon) sheet shall be of the following types and grades, as specified (see 6.2).

Type I - Molded (not skived) sheet 0.030 inches thick and above

Grade A - Premium  
Grade B - General purpose  
Grade C - Mechanical

Type II - Skived sheet (usually called skived tape), 0.001 to 0.300 inches thick inclusive.

Grade A - Premium  
Grade B - General purpose

Type III - Cast sheet (usually called film), 0.001 to 0.005 inches thick inclusive

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## 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.

## SPECIFICATIONS

## FEDERAL

- L-P-403 - Plastic Molding Material, Polytetrafluoroethylene (TFE-Fluorocarbon)
- PPP-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 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) 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 - Test for Tensile Properties of Plastic.
- D883-71 - Nomenclature Relating to Plastics.
- D792-66(1970) - Specific Gravity and Density of Plastics by Displacement.
- D1389-62(1970) - Dielectric Proof-Voltage Testing of Thin Solid Electric Insulating Materials.
- D1457-69 - TFE-Fluorocarbon Resin Molding and Extrusion Materials.
- D1708-66(1970) - Tensile Properties of Plastics by use of Microtensile Specimens.

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

National Motor Freight 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, DC 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. Molded sheet, skived sheet, and skived film shall be made from TFE-fluorocarbon resin conforming to L-P-403. Cast film shall be made from TFE-fluorocarbon dispersion.

3.2 Property values (see 6.3). The sheet shall conform to the property values specified in table I, when tested as specified in the applicable procedure of 4.3.

Table 1 - Property values

Property	Type I			Type II		Type III	Paragraph reference to applicable test
	Grade A	Grade B	Grade C	Grade A	Grade B		
Tensile strength, minimum, psi							
0.001 inch thick	-	-	-	3000	-	4300	4.3.2
0.002	-	-	-	3400	2800	4300	
0.003	-	-	-	3600	2800	4300	
0.004	-	-	-	3600	2800	4300	
0.005	-	-	-	3600	2800	4300	
over 0.005	4000	3000	2000	4000	2800	4300	
Elongation, minimum percent							
0.001 inch thick	-	-	-	150	-	400	4.3.2
0.002	-	-	-	270	200	400	
0.003	-	-	-	270	200	400	
0.004	-	-	-	270	200	400	
0.005	-	-	-	270	200	400	
over 0.005	300	200	150	300	200	370	
Melting point range °C (°F)	327° ± 10°C (620° ± 18°F)	327° ± 10°C (620° ± 18°F)	327° ± 10°C (620° ± 18°F)	327° ± 10°C (620° ± 18°F)	327° ± 10°C (620° ± 18°F)	327° ± 10°C (620° ± 18°F)	4.3.3
Specific gravity	2.14 to 2.19	2.14 to 2.19	2.14 to 2.20	2.14 to 2.21	2.14 to 2.21	NR <sup>1</sup>	4.3.4
Dielectric strength, short time test, Volts per mil, minimum <sup>2</sup> /Nominal thickness, inch							
0.001	-	-	-	3000	-	4300	4.3.5
0.002	-	-	-	-	-	4000	
0.003	-	-	-	2500	2000	3600	
0.004	-	-	-	-	1600	3000	
0.005	-	-	-	2000	-	2400	
0.006	-	-	-	-	-	-	
0.007	-	-	-	-	-	-	
0.008	-	-	-	-	-	-	
0.009	-	-	-	-	-	-	
0.010	-	-	-	-	-	-	
0.015	-	-	-	1400	1200	-	
0.020	-	-	-	-	-	-	
0.025	-	-	-	-	-	-	
0.030	820	680	410	620	680	-	
0.040	720	600	360	720	400	-	
0.050	650	540	330	650	540	-	
0.060 and above	600	500	300	600	500	-	
Electrical flows at 800 volts per mil, maximum per 100 foot length	NR	NR	NR	NR	NR	-	4.3.6
Nominal thickness inch <sup>3</sup>							
0.001	NR	NR	NR	NR	NR	8	
0.002	NR	NR	NR	NR	NR	4	
0.003	NR	NR	NR	NR	NR	2	
0.004	NR	NR	NR	NR	NR	0	

1/ NR - Not Required

2/ Dielectric strength shall be determined in air for all material less than 0.030 inches thick. Dielectric strength shall be determined under oil for all material 0.030 inches thick and above.

3/ For thickness where dielectric strength has not been specified, interpolate on the basis of dielectric strength varying inversely as the square root of the thickness.

4/ When intermediate thickness is specified, the property values shall be specified by the procuring activity.

### 3.3 Dimensions and tolerances.

3.3.1 Length and width. The length and width of sheets shall be as specified by the procuring activity. The tolerance on length and width shall be plus 1/4, minus 0 inch.

3.3.2 Thickness. Sheets shall be within the tolerances specified in table II when measured at any point at a temperature range between 23° to 30°C (73.4 to 86°F).

Table II - Thickness tolerance

Nominal thickness, inches	Tolerance,	
	Plus	inches Minus
0.001	0.0001	0.0001
0.002 to 0.005 inclusive	0.0005	0.0005
Over 0.005 to 0.010	0.0015	0.0015
Over 0.010 to 0.016	0.004	0.002
Over 0.016 to 0.031	0.008	0.004
Over 0.031 to 0.062	0.010	0.005
Over 0.062 to 0.093	0.012	0.006
Over 0.093 to 0.125	0.014	0.007
Over 0.125 to 0.157	0.016	0.008
Over 0.157 to 0.188	0.018	0.009
Over 0.188 to 0.250	0.022	0.011
Over 0.250 to 0.375	0.030	0.015
Over 0.375 to 0.500	0.038	0.019
Over 0.500 to 0.625	0.046	0.022
Over 0.625 to 0.750	0.054	0.027
Over 0.750 to 1.000	0.070	0.035
Over 1.000 to 1.250	0.086	0.043
Over 1.250 to 1.500	0.102	0.051
Over 1.500 to 1.750	0.118	0.059
Over 1.750 to 2.000	0.134	0.067
Over 2.000	0.150	0.075

3.4 Color. Sheet shall be natural in color. Types I and II may vary from white to mottled gray or brown. Small gray, brown or black spots shall not be considered as cause for rejection. Type III shall range from cloudy to milky transparent, depending upon thickness.

3.5 Surface finish. Unless otherwise specified by the procuring activity, the material shall be essentially free from surface blisters, wrinkles, cracks and other surface defects.

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3.5.1 Surface treatment. When specified by the procuring activity, one or both sides of the sheets shall be given a special surface treatment to enable the surface to take adhesives or printing ink (see 6.1 and 6.2).

3.6 Workmanship. The sheet shall be uniform and essentially free from cracks, scratches, bubbles, inbedded particles and other defects that affect appearance or which may affect serviceability. (These defects may be defined in accordance with ASTM Method D 883-71, as applicable). Stresses shall be such that the sheet shall not require annealing to conform to the requirements specified herein.

#### 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, finish, and thickness 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. In the event of conflict, this specification shall govern. A supplier's certificate of compliance with 3.1 and the stress requirements of 3.6 shall be furnished.

##### 4.2.2 Inspection of the sheet.

4.2.2.1 Examination of the sheet. 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 plastic sheets 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 sheet for defects in appearance, construction, and workmanship. The sample unit for this examination, specified in table III, shall be one sheet. Not more than five sample units shall be taken from any one package of sheets.

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 finish, transparency or opacity, or not meeting specified requirements for these properties as specified in 3.4 and 3.5.
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 sheet for dimensional defects. The sample unit for this examination specified in table IV, shall be one plastic sheet.

Table IV. Examination for dimensional defects

Examine	Defect
Length and width of sheets	Varies by more than + 1/4, -0 inch from length and width specified.
Thickness	Varies by more than the tolerance specified in table II.

4.2.2.1.3 Examination of the sheet for defects in assembly. The sample unit for this examination, specified in table V, shall be one package of sheets.

Table V. Examination for defects in assembly

Examine	Defect
Assembly of sheets	Not evenly stacked
	Not interleaved to prevent adherence of sheets

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4.2.2.1.4 Examination of the sheet for defects in the count per package of sheets. The sample unit for this examination specified in table VI, shall be one package of sheets.

Table VI. Examination for defects in the count per package

Examine	Defect
Sheets	Average count per package of sheets 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	<p>Not level specified; not in accordance with contract requirements.</p> <p>Sheets not unit wrapped and packaged as specified.</p> <p>Packaging material not as specified; closures not accomplished by specified or required methods or materials.</p>
Packing	<p>Not level specified; not in accordance with contract requirements.</p> <p>Any nonconforming component; component missing, damaged or otherwise defective affecting serviceability.</p> <p>Container not as specified; closures not accomplished by specified or required methods of materials.</p> <p>Inadequate application of components, such as: incomplete closures of case liners or container flaps, loose or inadequate strappings, bulged or distorted containers.</p>
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, not in accordance with contract requirements.

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

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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

4.2.3 Testing. The sheet 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 sample size for testing shall be expressed in units of packages of sheet. The sample unit shall consist approximately of only sufficient material to prepare all required specimens. The inspection level shall be S-1 with an acceptance number of 0. When the test method requires testing more than one specimen, the results for each test shall be the averaged results of the specimens.

#### 4.3 Test methods.

4.3.1 Conditioning. Test specimens shall be conditioned in accordance with procedure A of ASTM D 618-61(1970). Testing shall be at  $23^{\circ} \pm 2^{\circ} \text{ C}$  ( $73.4^{\circ} \pm 3.8^{\circ} \text{ F}$ ) and maintenance of constant humidity is not necessary.

#### 4.3.2 Tensile strength and elongation.

4.3.2.1 Type I material. The ultimate tensile strength and elongation of type I, grades A, B and C material shall be determined by testing five specimens in accordance with ASTM D 638-68, using the microtensile specimen of ASTM D 1708-66(1970). The initial jaw separation shall be  $0.875 \pm 0.005$  inches and the speed of testing shall be 2.0 inches per minute. Sheets greater than 0.062 inches and up to 0.625 inches thick shall be machined to  $0.062 \pm 0.010$  inches thick before cutting specimens. Sheets 0.625 inches thick and over shall have a slice somewhat thicker than 0.062 inches cut in a plane parallel to, and not less than 0.500 inches from the plane of one end of the sheet. The slice shall be machined on both faces to  $0.062 \pm 0.010$  inches thick, and the specimens cut from the machined slice. Tool marks shall be removed by light sanding in a longitudinal direction for all specimens reduced to specified thickness by machining.

4.3.2.2 Type II material. For Grade A, type II material, the ultimate tensile strength and elongation shall be determined by testing five specimens in accordance with ASTM D 1457-69. For Grade B, type II material, the ultimate tensile strength and elongation shall be determined by testing five specimens in accordance with ASTM D 638-68, using the microtensile specimen of ASTM D 1708-66(1970). The initial jaw separation shall be  $0.875 \pm 0.005$  inches and the speed of testing shall be 2.0 inches per minute. Specimens shall be cut with the long axis parallel to the skive marks. Sheets greater than 0.062 inches thick shall be machined to  $0.062 \pm 0.010$  inches before cutting specimens.

4.3.3 Melting point. Melting point shall be determined on one specimen in accordance with ASTM D 1457-69.

4.3.4 Specific gravity. Three specimens shall be tested in accordance with ASTM D 792-66(1970). Method A1 of ASTM D 792-66(1970) shall be used.

4.3.5 Dielectric strength.

4.3.5.1 Dielectric strength in air (see note 2 in table I). Dielectric strength shall be determined by testing five specimens in accordance with ASTM D 149-64(1970), using the short-time test and the 1/4 inch diameter electrodes in air.

4.3.5.2 Dielectric strength under oil (see note 2 in table I). Dielectric strength shall be determined by testing five specimens in accordance with ASTM D 149-64(1970), using the short-time test and the 1/4 inch diameter electrodes. The test shall be conducted under oil.

4.3.6 Electrical flaws (for type III material). Testing shall be in accordance with ASTM D 1389-62(1970), except that 1/2 inch wide sponge electrodes wet with 1 percent saline solution are used in place of metal electrodes. The test shall be conducted on a specimen twenty-five feet in length and if the specimen fails to meet requirements, a retest shall be made on two additional specimens each 100 feet in length.

5. PREPARATION FOR DELIVERY.

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

5.1 Packaging. 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) sheet 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. Sheet 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. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A. Sheet packaged as specified in 5.1.1 shall be separated by thickness and shall be packed in shipping 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 specification.

5.2.2 Level B. Sheet packaged as specified in 5.1.1 shall be separated by thickness and shall be packed in shipping containers conforming to PPP-B-585 (class 1), PPP-B-601 (domestic type) 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. Sheet packaged as specified in 5.1, shall be packed in a manner to insure carrier acceptance and safe delivery at destination at lowest transportation rate for such supplies. Containers shall be in accordance with Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable.

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

## 6. NOTES

6.1 Intended use. Polytetrafluoroethylene (TFE-fluorocarbon) sheets may be considered for use in applications requiring continuous 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.

Grade A materials are used for void free moldings and skived tapes for maximum electrical as well as mechanical properties.

Grade B materials are intended for general purpose electrical, mechanical and chemical applications such as gaskets and seals.

Grade C materials are mechanical grade sheet for noncritical chemical, electrical and mechanical applications.

Type III materials are intended primarily for electrical applications such as capacitors and dialysis membranes.

Surface treated material (see 3.5.1) may be used when cementing to other material is required.

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).
- (c) Sheet length and width (see 3.3.1).
- (d) Sheet thickness (see 3.3.2).
- (e) Surface treatment, if required (see 3.5.1).
- (f) Selection of applicable levels of packaging and packing required including unit packaging and intermediate packaging quantities, if required (see 5.1 and 5.2).

6.3 International standardization agreement. Certain provisions of this specification are the subject of international standardization agreement ABC-NAVY-STD-17C. When amendment, revision, or cancellation of this specification is proposed which will effect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

Custodians:

Army - MR  
Navy - SH  
Air Force - 11

Preparing Activity:  
Army - MR

(Project No. 9330-0378)

Review Interest:

Army: MU, EL, ME, GL, MI  
Navy: SH, EC  
Air Force: 11