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INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3656E

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Submitted for recognition as an American National Standard

Superseding AMS 3656D

Polytetrafluoroethylene Extrusions Normal Strength, As Sintered

1. SCOPE:

1.1 Form:

This specification covers a virgin, unfilled polytetrafluoroethylene resin in the form of extruded and sintered rods, tubes, and shapes.

1.2 Application:

These products have been used typically for parts, such as insulators, bearings, seals, and back-up rings requiring chemical inertness up to 260 °C (500 °F), but usage is not limited to such applications.

1.3 Classification:

Extrusions are classified as follows:

Type 1 Parts deemed critical by purchaser and requiring dielectric strength test (3.2.4) and radiographic inspection (3.3.1); testing of all other specified properties is required.

Type 2 Parts deemed critical by purchaser and requiring radiographic inspection (3.3.1). Dielectric strength test (3.2.4) is not required.

Type 3 Parts, such as insulating bearings, bushings, and mounting posts, requiring dielectric strength test (3.2.4). Radiographic inspection (3.3.1) is not required.

Type 4 Parts, such as seals, back-up rings, and bearings, not requiring electrical insulation. Radiographic inspection (3.3.1) and dielectric strength test (3.2.4) are not required.

1.3.1 Unless a specific type is ordered, Type 1 shall be supplied.

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1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications:

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

ASTM D 149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 638	Tensile Properties of Plastics
ASTM D 638M	Tensile Properties of Plastics (Metric)
ASTM D 792	Specific Gravity (Relative Density) and Density of Plastics by Displacement

2.2 U.S. Government Publications:

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

MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Material:

The product shall be extruded from polytetrafluoroethylene powder without admixture of fillers, pigments, or adulterants and shall be sintered.

3.1.1 Color: Shall be predominantly white. Surface discoloration from sintering and/or annealing may vary from white to mottled gray or brown. Small gray, brown, or black spots shall not in themselves be unacceptable provided they do not have a detrimental effect on the finished product.

3.2 Properties:

Extrusions shall conform to requirements shown in Table 1, Table 2, Table 3, and Table 4; tests shall be performed on the extrusions supplied and in accordance with specified test methods, insofar as practicable. Properties are applicable to all types except as specified in 3.2.4.

3.2.1 Tensile Strength at 23 °C ± 1 (73 °F ± 2): Shall be as shown in Table 1, determined in accordance with 4.5.1.

TABLE 1A - Minimum Tensile Strength, Inch/Pound Units

Form	Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength psi
Rods, Shapes	Up to 0.500, excl	1600
Rods, Shapes	0.500 to 1.500, incl	1700
Rods, Shapes	Over 1.500	1800
Tubes	All sizes	1600

TABLE 1B - Minimum Tensile Strength, SI Units

Form	Nominal Diameter or Distance Between Parallel Sides Millimeters	Tensile Strength MPa
Rods, Shapes	Up to 12.70, excl	11.0
Rods, Shapes	12.70 to 38.10, incl	11.7
Rods, Shapes	Over 38.10	12.4
Tubes	All sizes	11.0

3.2.2 Elongation at 23 °C ± 1 (73 °F ± 2): Shall be as shown in Table 2, determined in accordance with 4.5.1.

TABLE 2 - Minimum Elongation

Form	Nominal Diameter or Distance Between Parallel Sides Inches	Nominal Diameter or Distance Between Parallel Sides Millimeters	Elongation %
Rods, Shapes	Up to 0.500, excl	Up to 12.70, excl	100
Rods, Shapes	0.500 to 1.500, incl	12.70 to 38.10, incl	125
Rods, Shapes	Over 1.500	Over 38.10	150
Tubes	All sizes	All sizes	100

3.2.3 Specific Gravity at 23/23 °C (73/73 °F) shall be as shown in Table 3, determined in accordance with ASTM D 792, Method A, with two drops of wetting agent added to the water.

TABLE 3 - Specific Gravity

Form	Nominal Diameter or Distance Between Parallel Sides Inches	Nominal Diameter or Distance Between Parallel Sides Millimeters	Specific Gravity
Rods, Shapes	Up to 0.500, excl	Up to 12.70, excl	2.12 - 2.17
Rods, Shapes	0.500 to 1.500, incl	12.70 to 38.10, incl	2.13 - 2.18
Rods, Shapes	Over 1.500	Over 38.10	2.14 - 2.19
Tubes	All sizes	All sizes	2.12 - 2.17

3.2.4 Dielectric Strength, Short Time Test: Shall be as shown in Table 4, determined in accordance with 4.5.2; applicable only to Type 1 and Type 3 extrusions.

TABLE 4A - Minimum Dielectric Strength, Inch/Pound Units

Form	Nominal Diameter or Distance Between Parallel Sides Inches	Dielectric Strength Volts/mil
Rods, Shapes	Up to 0.500, excl	600
Rods, Shapes	0.500 to 1.500, incl	650
Rods, Shapes	Over 1.500	700
Tubes	All sizes	600

TABLE 4B - Minimum Tensile Strength, SI Units

Form	Nominal Diameter or Distance Between Parallel Sides Millimeters	Dielectric Strength kV/mm
Rods, Shapes	Up to 12.70, excl	23.6
Rods, Shapes	12.70 to 38.10, incl	25.6
Rods, Shapes	Over 38.10	27.6
Tubes	All sizes	23.6

3.3 Quality:

Extrusions, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the extrusions.

3.3.1 Type 1 and Type 2 extrusions shall be radiographically inspected. Radiographic procedures and standards for acceptance shall be as agreed upon by purchaser and vendor.

3.4 Tolerances:

The tolerances shown in Table 5, Table 6, and Table 7 apply at 23 to 30 °C (73 to 86 °F):

3.4.1 Rods and Shapes:

TABLE 5A - Diameter Tolerances, Inch/Pound Units

Nominal Diameter or Distance Between Parallel Sides Inches	Tolerance Inch plus only
Up to 0.250, incl	0.008
Over 0.250 to 0.500, incl	0.016
Over 0.500 to 0.750, incl	0.020
Over 0.750 to 1.000, incl	0.024
Over 1.000 to 1.250, incl	0.030
Over 1.250 to 1.500, incl	0.038
Over 1.500 to 1.750, incl	0.046
Over 1.750 to 2.000, incl	0.052
Over 2.000 to 2.250, incl	0.068
Over 2.250 to 2.500, incl	0.076

TABLE 5B - Diameter Tolerances, SI Units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Tolerance Millimeters plus only
Up to 6.35, incl	0.20
Over 6.35 to 12.70, incl	0.41
Over 12.70 to 19.05, incl	0.51
Over 19.05 to 25.40, incl	0.61
Over 25.40 to 31.75, incl	0.76
Over 31.75 to 38.10, incl	0.96
Over 38.10 to 44.45, incl	1.17
Over 44.45 to 50.80, incl	1.32
Over 50.80 to 57.15, incl	1.73
Over 57.15 to 63.50, incl	1.93

3.4.2 Tubes:

TABLE 6A - Diameter Tolerance, Inch/Pound Units

Nominal OD or ID Inches	ID Tolerance Inch minus only	OD Tolerance Inch plus only
Over 0.187 to 2.000, incl	0.062	0.062

TABLE 6B - Diameter Tolerance, SI Units

Nominal OD or ID Millimeters	ID Tolerance Millimeters minus only	OD Tolerance Millimeters plus only
Over 4.75 to 50.80, incl	1.57	1.57

TABLE 7A - Concentricity Tolerances, Inch/Pound Units

Nominal ID Inches	Variation from Concentricity Inch, maximum (See 3.5.2.1)
Up to 0.500, incl	0.020
Over 0.500 to 1.000, incl	0.031
Over 1.000 to 1.750, incl	0.045
Over 1.750 to 2.500, incl	0.062

TABLE 7B - Concentricity Tolerances, SI Units

Nominal ID Millimeters	Variation from Concentricity Millimeters, maximum (See 3.5.2.1)
Up to 12.70, incl	0.51
Over 12.70 to 25.40, incl	0.79
Over 25.40 to 44.45, incl	1.14
Over 44.45 to 63.50, incl	1.57

3.4.2.1 With a zeroed dial indicator on the OD of a tube segment mounted on a tight-fitting mandrel, rotate the tube about the centerline of the ID. Alternatively, with zeroed dial indicator on the ID of a tube, rotate the tube in a V-block. In either case, note the highest positive and negative dial indicator readings; the sum of these numerical values is the maximum variation from concentricity.

Example:

Highest positive reading:	0.005 inch (0.13 mm)
Highest negative reading:	0.003 inch (0.08 mm)
Maximum variation from concentricity:	0.008 inch (0.20 mm)

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of extrusions shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the extrusions conform to the requirements of this specification.

4.2 Classification of Tests:

Tests for all technical requirements, as applicable to the specified type, are acceptance tests and preproduction tests and shall be performed prior to or on the initial shipment of extrusions to a purchaser, on each lot, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction extrusions shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient extrusions shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all extrusions of the same configuration, made from the same batch of compound, in one production run, and presented for vendor's inspection at one time.

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample extrusions shall be approved by purchaser before extrusions for production use are supplied, unless such approval be waived by purchaser. Results of tests on production extrusions shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production extrusions which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample extrusions. Production extrusions made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Tensile Strength and Elongation: Shall be determined in accordance with ASTM D 638 or ASTM D 638M using a testing speed of 2 inches per minute (0.8 mm/s) and measuring elongation over a 2-inch (50.8-mm) gage length. The test specimen for rod, and for shapes where size permits, shall conform to Figure 1 of this specification except that rods 0.250 inch (6.35 mm) and under in diameter may be tested in full cross-section.

4.5.2 Dielectric Strength: Shall be determined in accordance with ASTM D 149 on specimens 0.040 inch ± 0.001 (1.02 mm ± 0.03) thick. The test shall be conducted under oil using 0.062-inch (1.57-mm) diameter corrosion-resistant steel electrodes with rounded edges. If flash-over is a problem on small diameter rod or on shapes, specimens shall be prepared by drilling holes from opposite ends of a piece of product, leaving a web, 0.040 inch ± 0.001 (1.02 mm ± 0.03) thick, in the middle of the specimen. Electrodes shall be the same as used for the wafer specimen and shall be inserted in the holes in the specimen.

4.6 Reports:

The vendor of extrusions shall furnish with each shipment a report showing the results of tests on each lot, as applicable to the specified type, to determine conformance to tensile strength, elongation, specific gravity, and dielectric strength and stating that the extrusions conform to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3656E, vendor's compound number, form and size or part number, and quantity.

4.7 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the extrusions may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the extrusions represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Packaging shall be accomplished to ensure that the extrusions, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any other normal hazard.

5.1.1.1 A lot of extrusions may be packaged in small quantities and delivered under the basic lot approval provided lot identification is maintained.