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12 September 1977
SUPERSEDING
MIL-P-46115A(MR)
7 May 1971

MILITARY SPECIFICATION
PLASTIC MOLDING AND EXTRUSION MATERIAL,
POLYPHENYLENE OXIDE

This specification is approved for use by the Army Materials and Mechanics Research Center, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one type of polyphenylene oxide molding and extrusion material (see 6.1).

1.2 Classification. Polyphenylene oxide material shall be of one type and the following classes and forms, as specified (see 6.2).

Type I

Class 1 - Mechanical applications.

Class 2 - Electrical applications.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. 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

PPP-D-723 - Drum, Fiber.

PPP-D-729 - Drum, Shipping and Storage, Steel, 55 Gallon.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129 - Marking for Shipment and Storage.

FSC 9330

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Army Materials and Mechanics Research Center, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MIL-P-46115B(MR)

(Copies of specifications, standards, drawings, and publications required by contractors 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:

- D 149 - Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies.
- D 150 - A-C Loss Characteristics and Dielectric Constant (Permittivity) of Solid Electrical Insulating Materials.
- D 256 - Impact Resistance of Plastics and Electrical Insulating Materials.
- D 618 - Conditioning Plastics and Electrical Insulating Materials for Testing.
- D 638 - Tensile Properties of Plastics.
- D 648 - Deflection Temperature of Plastics Under Load.
- D 792 - Specific Gravity and Density of Plastics by Displacement.

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

Underwriters' Laboratories (UL), Inc.

- UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, dated December 1973.

(Application for copies should be made to the Underwriters' Laboratories, Inc., 207 E. Ohio Street, Chicago, IL 60611.)

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification

(Application for copies should be addressed to the American Trucking Associations Inc., Traffic Department, 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.)

MIL-P-46115B(MR)

3. REQUIREMENTS

3.1 Material. The material shall consist of polyphenylene oxide resin formulated for use in injection molding and extrusion. Reclaimed material is permitted when it meets all requirements specified herein and its molecular weight is essentially the same as that of the unused polymer for the class of material specified.

3.2 Property values. Specimens prepared from class 1 material, as specified in 4.3.1, shall conform to the property values specified in table I, when tested as specified in the applicable procedure of 4.3. Specimens prepared from class 2 material shall conform to the property values specified in tables I and II.

Table I. Property values^{1/}

Property	Value
Specific gravity, min.	1.05
Specific gravity, max.	1.07
Deflection temperature under load, at 1820 KPa (264 psi), °C (°F), min.	166 (330)
Impact strength, Izod, J/m notched (ft lb/in notched), min.	58.6 (1.1)
Tensile yield stress, MPa (psi), min.	68.9 (10,000)
Elongation at break, percent, min.	40
Flammability	94V-1 ^{2/}

^{1/} Metric unit abbreviations: K = kilo, Pa = pascals, J/m = joules per meter,
M = mega

^{2/} 94V-1 by Underwriters' Laboratories test specified in 4.3.7. Correlation with flammability under actual use conditions is not necessarily implied.

MIL-P-46115B(MR)

Table II. Electrical property values^{1/}

Property	Value
Dielectric constant at 1 megahertz, max.	2.58
Dissipation factor at 1 megahertz, max.	0.0012
Dielectric strength, short time test on 3.17 mm (1/8 inch) thick specimen volts per mil, min.	400

^{1/}Applicable only to class 2 material.

3.3 Form. The material shall be furnished in the form of molding powder, granules or pellets, unless one of the forms is specified (see 6.2). When a particular particle size is specified, the limits and method of testing shall be as specified by the procuring activity (see 6.3).

3.4 Color. Unless otherwise specified, the compound shall be furnished in the titanium dioxide filled form, which is normally beige in color.

3.5 Suitability (compatibility) for use with explosives. (Applicable only when specifically designated in the applicable contract, order, drawing or specification.) When so specified, application shall be made to a Government laboratory or other Government approved laboratory designated by the procuring activity for determination of suitability of the material for use with a particular explosive or explosives (see 6.2 and 6.4).

3.6 Workmanship. The powder, granules or pellets shall be uniform in color within each container and from container to container. The form shall be uniform from container to container. The material shall be free from contamination as determined by visual examination.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor 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.

MIL-P-46115B(MR)

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, 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 the specification and to the extent specified, of all referenced subsidiary specifications and standards. In the event of conflict, this specification shall govern. A supplier's certificate of conformance to 3.1 and the titanium dioxide filler specified in 3.4 shall be furnished.

4.2.2 Inspection of material.

4.2.2.1 Examination of the material. Examination of the material shall be made in accordance with the classification of defects, inspections levels and acceptable quality levels (AQLs) set forth below. The lot size, for purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of 22.7 kg (50 pounds) for examination in 4.2.2.1.1, and in units of shipping containers for examination in 4.2.2.1.2.

4.2.2.1.1 Examination of the material for defects in appearance and workmanship. The sample unit for this examination specified in table III shall be approximately 22.7 kg (50 pounds).

Table III. Examination of the material for defects in appearance and workmanship

Examine	Defect
Appearance and workmanship	Form not as specified. Color not the normal beige, or not as specified. Form not uniform. Color not uniform. Not clean, presence of foreign material.

MIL-P-46115B(MR)

4.2.2.1.2 Examination of packaging. An examination shall be made in accordance with table IV, to determine that packing and marking comply with section 5 requirements. 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 IV. Examination for packaging

Examine	Defect
Packing	Not level specified; not in accordance with contract requirements. Any nonconforming component, component missing, damaged or otherwise defective affecting serviceability. Inadequate application of components such as: Incomplete closures of case liners; container flaps, loose or inadequate strappings, bulged or distorted containers.
Quantity of material	Less than specified or indicated quantity.
Weight	Gross weight exceeds specified requirements.
Markings	Interior or exterior markings omitted, illegible, incorrect, of improper size, location or sequence or method of application. Not in accordance with contract requirements.

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

<u>Examination paragraph</u>	<u>Inspection level</u>	<u>AQL</u>
4.2.2.1.1	II	2.5
4.2.2.1.2	S-2	2.5

MIL-P-46115B (MR)

4.2.3 Classification of tests. All tests under this specification shall be classified as lot acceptance tests. They shall be made on each lot of material offered against this specification and, in conjunction with the above examination, shall be the basis of acceptance or rejection of the lot.

4.2.4 Testing. The material shall be tested for the applicable characteristics listed in table I, in accordance with the test methods specified for each lot submitted for inspection. The lot size, for the purpose of determining the sample size for testing (see MIL-STD-105) shall be expressed in units of 22.7 kg (50 pounds). 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 or determination is specified for testing.

4.3 Test procedures.

4.3.1 Preparation of specimens. The material shall be injection molded into specimens as described in the individual test method using the technique of molding recommended by the supplier. In the absence of such instructions, the following procedure shall be used:

a. Dry the material for 4 hours at 125°C.

b. Use a screw type injection molding machine under the following conditions:

- (1) Melt temperature range: 288° - 329°C (550° - 625°F)
- (2) Mold temperature range: 135° - 149°C (275° - 300°F)
- (3) Cycle, seconds, minimum: 30
- (4) Pressure: Sufficient to give 3 seconds or less ram travel time.

4.3.2 Conditioning. All specimens except those for water absorption, and flammability shall be conditioned in accordance with procedure A of ASTM D 618. Water absorption test specimens shall be conditioned either as described in the method, or dried as obtained by transferring the molded specimen directly from the mold into a sealed metal container or into a desiccator. Unless otherwise specified, all testing shall be done under standard conditions of temperature and humidity as specified in ASTM D 618.

4.3.3 Specific gravity. A minimum of 2 molded specimens of any convenient size shall be tested in accordance with method A-1 or A-2 of ASTM D 792.

4.3.4 Deflection temperature under load. A minimum of two 6.34 mm (1/4 inch) thick specimens shall be tested in accordance with procedure A of ASTM D 648.

MIL-P-46115B(MR)

4.3.5 Impact strength. A minimum of 5 specimens, each 6.34 mm (1/4 inch) thick, shall be tested in accordance with method A of ASTM D 256.

4.3.6 Tensile yield stress and elongation. Five specimens shall be tested for tensile yield strength and elongation at break in accordance with ASTM D 638. The specimens shall be 3.17 mm (1/8 inch) thick and shall conform to the dimensions of type I of figure 1 of that method. Speed B shall be used. The yield strength is the stress at the first point at which the load vs extension curve becomes horizontal.

4.3.7 Flammability. Specimens shall be tested in accordance with Underwriters' Laboratories UL 94, dated December 1973, using a thickness of 1.90 ± 0.25 mm (0.075 ± 0.010 inch). The number of specimens to be tested and dimensions for length and width shall be as specified in Underwriters' Laboratories UL 94.

4.3.8 Dielectric constant and dissipation factor (for class 2 material only). The dielectric constant and dissipation factor shall be determined on 5 specimens, each 102 mm (4 inches) in diameter and 3.17 mm (1/8 inch) thick, in accordance with ASTM D 150, using a frequency of one megahertz.

4.3.9 Dielectric strength (for class 2 material only). The dielectric strengths of 5 specimens, each 102 mm (4 inches) in diameter and 3.17 mm (1/8 inch) thick, shall be determined by the "short-time test" of ASTM D 149.

5. PACKAGING

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

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

5.1.1 Level A. Unless otherwise specified, the material shall be packed in one of the following types of containers:

- a. Fiber drums conforming to PPP-D-723, type II, grade A, or type III, grade A, in quantities of 200 pounds, maximum.
- b. Metal drums conforming to PPP-D-729, type III or type IV in quantities of 400 pounds, maximum.

MIL-P-46115B(MR)

Insofar as practical, drums shall be of uniform shape and size, with minimum cube and tare consistent with the protection required. Drums shall contain identical quantities and shall be closed in accordance with the applicable container specification. Fiber drums shall be furnished with a 0.004 inch thick polyethylene liner properly heat sealed.

5.1.2 Level B. Unless otherwise specified, the material shall be packed in one of the following types of containers:

- a. Fiber drums conforming to PPP-D-723, type I, grade A in quantities of 200 pounds maximum.
- b. Metal drums conforming to PPP-D-729, type III or type IV, in quantities of 400 pounds, maximum.

Insofar as practical, drums shall be of uniform shape and size with minimum cube and tare consistent with the protection required. Drums shall contain identical quantities and shall be closed in accordance with the applicable container specification. Fiber drums shall be furnished with a 0.004 inch thick polyethylene liner properly heat sealed.

5.1.3 Level C. Packing shall be in accordance with commercial practice adequate to ensure acceptance and delivery by the carrier for the mode of transportation employed. Containers shall comply with the requirements of the Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable to the mode of transportation.

5.2 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. Material conforming to this specification is recommended for injection molding or extruding into items which possess good electrical properties in high humidity environments, together with nonflammability, fungus resistance, and good strength at elevated temperatures. This material has a maximum continuous use temperature in oxidizing environments in the neighborhood of 107°C (225°F), at which temperature it retains more than half of its room-temperature strength and almost its full room-temperature stiffness. Exposures at temperatures up to its deflection temperature 185°C (365°F) are feasible for short times in air or for longer times in non-oxidizing environments. The material is resistant to stress cracking in most aqueous environments but is subject to stress cracking under some conditions in some organic environments. Typical applications are sonnebuys, field telephone sets and cable connectors (requiring electrical properties), cryogenic ducting for aircraft (requiring a low brittleness temperature), and surgical instruments (requiring strength and stiffness plus ability to resist repeated steam sterilizations).

MIL-P-46115B(MR)

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Class required (see 1.2).
- c. Form, including size range and method of determining, if required (see 3.3 and 6.3).
- d. Resistance to explosives, if required (see 3.5 and 6.4).
- e. Level of packing required (see 5.1).

6.3 Standard samples. When a particular form, particle size or color is required, a standard sample, accompanied by borderline standards or by a written statement defining the permissible tolerances and methods of determination, should be furnished by the procuring activity or furnished by the supplier and approved by the procuring activity. In the case of color, one standard may be required for use in judging the uniformity of the color or the powder or pellets under 3.4 while another standard may be required for judging the color of a plaque molded from the material.

6.4 Suitability for use with explosives. Information concerning the suitability of many plastics for use with various explosives and chemicals under various conditions is on file at Picatinny Arsenal, Dover, NJ. Procuring activities desiring information on this subject should first contact Picatinny Arsenal to determine whether the information is already available.

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