MILITARY SPECIFICATION

PLASTIC MOLDING AND EXTRUSION MATERIAL,

ETHYL CELLULOSE, FOR ROCKET GRAIN INHIBITING MATERIALS

This specification is approved for use by the Missile Command, Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers ethyl cellulose suitable for injection molding, and extrusion for rocket grain inhibiting materials.

1.2 Classification. The ethyl cellulose compounds shall be of the following types and classes (see Table I), as specified. (See 6.2).

Table I. Classification of ethyl cellulose compounds

Type	Class	Tensile strength, MPa (psi) min	
I - Extrusion	1	37.2	(5400)
	2	33	(4800)
	3	31	(4500)
II - Injection molding	1	26	(3800)

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.

MILITARY

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

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding General, Army Armament Research and Development Command, ATTN: DRDAR-LCA-OK, Dover, NJ 07801 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

(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:

D 569 Measuring the Flow Properties of Thermoplastic Molding Materials.

D 570 Water Absorption of Plastics.

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 785 Rockwell Hardness of Plastics and Electrical Insulating Materials.

D 792 Specific Gravity and Density of Plastics by Displacement.

D 914 Standard Method of Testing Ethyl Cellulose.

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

National Motor Freight Traffic Association, Incorporated, 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, 22 South Riverside Plaza, Chicago, Illinois 60606.)

U.S. Department of Transportation (DOT)

Specification 21C - Fiber Drums

(This and other specifications on hazardous materials issued by DOT are published in the Code of Federal Regulations (CFR), available from the Superintendent of Documents. U.S. Government Printing Office, Washington, D.C. 20402. Spec 21C is published in Title 49, p. 945, #178.224.)

3. REQUIREMENTS

3.1 Material. The material shall consist of plasticized ethyl cellulose thermoplastic compounds as follows:

Proportions. - The ingredients of the material shall be compounded in the following proportions:

	Type 1	Type 2
Ethyl Cellulose Flake	100 Parts	100 Parts
Stabilizer	0 to 2.2 Parts	-----
Plasticizer	17.7 to 25.0 Parts	31 to 35 Parts

When a stabilizer is used, a corresponding reduction in the limits of plasticizer is required. The variation in formulation allows the proportions of flake and plasticizer to be varied to give the proper extrudability and desired physical properties to the compounded material.

3.1.1 Ethyl Cellulose Flake

Ethoxyl content 45% to 47% (ASTM D 914)
Viscosity of flake 65 to 85 x 10^{3} Pa·s (65 to 85 cps)

(When measured at 25° ± 1°C with a 5% solution of the flake in a 60/40 solution of toluene/95% ethanol in accordance with ASTM D 914).

NOTE: One acceptable source of this material is:

Dow Chemical USA (Ethocel, Standard Grade, 70 cps completely deashed).

3.1.2 Plasticizer, substituted phenyl ether - with bis (p-1,1',3,3' tetramethyl butyl phenyl) ether as the principal constituent. (Dow P-1099 plasticizer is the only commercial form of this material).

Specification:

(1)	Color	Light Amber
(2)	Minimum % Transmission through 1 cm. of liquid (450 millimicron wave length)	45
(3)	Viscosity at 25°C, m^2/s (Centistokes)	4 - 8 x 10^{-3} (4000 - 8000)
(4)	% Volatile (148.5°C and 5 x 10^{2} Pa (4mm Hg) pressure for one hour) maximum	9

(5) Acid number 0.5

(6) Specific Gravity, 25/4°C 0.92-0.95

3.1.3 Dye or Colorants. - No dye or other colorant is permissible unless otherwise specified by the procuring agency.

3.1.4 Stabilizer. Epoxy Resin - ERL-2774 (manufactured by Union Carbide Company) may be used as a stabilizer. Alternate materials may be used as stabilizers with permission of the procuring activity.

3.2 Property values. The material shall conform to the property values specified in Table II, when tested as specified in the applicable procedure of 4.3.

Table II. Property values.

Property	Type I			Type II
	Class 1	Class 2	Class 3	Class I
Specific gravity 23°/23°C (73°F) (unpigmented), max.	1.12	1.12	1.12	1.10
Tensile strength, min,	(5400)	(4800)	(4500)	(3800)
MPa (psi)	37	33	31	26
Deflection temperature at 264 psi fiber stress, min:				
°C	71	66	60	49
°F	160	150	140	120
Flow temperature °C	145-155	145-155	145-155	135-145
Water absorption, max, percent weight gain	2	2	2	2
Hardness (Rockwell), min, R Scale	100	100	100	95
Weight loss on heating, max, percent	1.5	1.5	1.5	1.8

3.3 Flow temperature. The flow temperature shall be tested when required by the procuring activity. Flow temperature of a given type and class of material shall be within ± 5°C (9°F) of that specified by the procuring activity.

3.4 Form. The form shall be as specified by the procuring activity. The plastic granule size shall be uniform. The uniformity shall be maintained by screening the plastic granules through a screen with .187 inch square openings. The plastic granules shall pass through a 0.1875-inch size screen.

3.5 Color and transparency. The color and degree of transparency of the material shall be as specified by the procuring activity. Color and transparency shall be uniform. When color is not specified, the material shall have its basic color slightly amber.

3.6 Suitability for use with nitroglycerin or other explosives. When reasonable resistance to nitroglycerin or other explosives is required, the suitability for use with a particular explosive or propellant shall be as specified by the procuring activity. The method for determining nitroglycerin resistance, or resistance to other explosives, shall be as specified by the procuring activity.

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 that supplies and services conform to prescribed requirements.

4.2 Sampling for inspection and acceptance. 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 and class submitted for delivery 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 will govern. A supplier's certificate of compliance with 3.1, 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 list of defects inspection levels and acceptable quality levels (AQL's) 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 45.4 kg (100 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 .454 kg (one pound).

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

Examine	Defect
Appearance and workmanship	Form improper
	Form not uniform
	Color improper
	Transparency improper
	Not clean, presence of foreign material

4.2.2.1.2 Examination of the preparation for delivery requirements. An examination shall be made in accordance with Table IV, to determine that packaging, packing and marking 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 IV. Examination of preparation for delivery

Examine	Defect
Packing	Not level specified; not in accordance with contract requirements

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

4.2.2.1.3 Inspection levels and acceptable quality levels (AQL's) 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:

Examination Paragraph	Inspection Level	AQL
4.2.2.1.1	II	2.5
4.2.2.1.2	S-2	2.5

4.2.3 Testing. The molding material 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 45.4 kg (100 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.

4.2.3.1 Classification of tests. All tests shall be classified as follows:

(a) Lot acceptance tests (see 4.2.3.2).
(b) Periodic lot check tests (see 4.2.3.3).

4.2.3.2 Lot Acceptance tests. Lot acceptance tests shall be made on each lot of material and shall be the basis for acceptance or rejection of the lot except when periodic lot check tests are required. The lot acceptance tests shall be as specified in Table V.

Table V. Lot Acceptance Tests.

Applicable to: Type	Class	Specific gravity	Tensile strength	Deflection temperature	Flow temperature
I	1 to 3	R^1	R	R	R
II	1	R^1	R	R	R

R^1 Indicates test is required.

4.2.3.3 Periodic lot check tests. Periodic lot check tests shall be made on the first lot of material furnished under this specification, and on any subsequent lot specified by the procuring activity. Periodic lot check tests shall consist of all the tests specified in Table II. When periodic lot check tests are made, they shall be included in the basis for acceptance or rejection of the lot.

4.3 Test Methods.

4.3.1 Specimen preparation and conditioning. Specimens shall be prepared by injection molding under conditions specified by the manufacturer. Unless otherwise specified, the dimensions of test specimens shall conform to that specified in the applicable test procedure. Unless otherwise specified, test specimens shall be conditioned in accordance with procedure A of ASTM D 618 and tested at $23^{\circ} \pm 2^{\circ}$ ($73.4^{\circ} \pm 3.6^{\circ}F$) and 45 ± 5 percent relative humidity.

4.3.2 Specific gravity. Two specimens shall be tested in accordance with method A-1 of ASTM D 792, except for specimen size, which will be specified by procuring agency.

4.3.3 Tensile strength. Three specimens shall be tested in accordance with ASTM D 638, using Type I specimen and testing speed B.

4.3.4 Deflection temperature. Three specimens shall be conditioned in accordance with procedure B of ASTM D 618, and tested in accordance with ASTM D 648. Specimen thickness shall be 3.18 mm to 3.35 mm (0.125 to 0.128 inches).

4.3 Water absorption. Three specimens shall be conditioned in accordance with paragraph 5.1.1 of ASTM D 570. Testing shall be in accordance with ASTM D 570, using the 24 hour immersion period, except for specimen size, which will be specified by procuring agency.

4.3.6 Rockwell hardness. Two specimens shall be tested in accordance with procedure A of ASTM D 785 except for specimen size which will be specified by procuring agency.

4.3.7 Weight loss on heating. Three specimens shall be conditioned for a minimum of 48 hours over anhydrous calcium chloride at 23° ± 2°C (73.4° ± 3.6°F). After conditioning, the specimens shall be weighed and placed in a circulating air oven for 72 ± 1 hours at 82° ± 1°C (180 ± 1.8°F). The specimens shall be supported flatwise on a screen in the oven. Upon removal from the oven, specimens shall be cooled in a desiccator over anhydrous calcium chloride to 23° ± 2°C (73.4° ± 3.6°F). The specimens shall be reweighed and the percentage weight loss on heating shall be calculated on the basis of the conditioned weight. Specimen size shall be as specified by procuring agency.

4.3.8 Flow temperature. Two specimens shall be tested in accordance with procedure A of ASTM D 569. The test specimens may be obtained from an injection mold and piling the pieces to the required height. Test specimens shall be conditioned for a minimum of 1 hour at 100° ± 2°C (212° ± 3.6°F) or in accordance with ASTM D 569.

5. PACKAGING

5.1 Packing.

5.1.1 Granules, for Radford Army Ammunition Plant (RAAP) use, shall be packed in a clean 0.1 mm (0.004 inch) thick, polyethylene liner sealed with a reinforced tape and packed in a fiberboard container.

5.1.2 Granules for overseas shipment shall be packed in a clean 0.1 mm (0.004 inch) thick, polyethylene liner sealed with a reinforced tape and packed in a sealed, metal container. (18 gauge, National Industries container number 338Q, or equal).

5.1.3 Granules for domestic shipment shall be packed in a clean 0.1 mm (0.004 inch) thick polyethylene liner sealed with a reinforced tape and packed in a sealed fiber drum, meeting the requirements of DOT Document 21C.

5.2 Marking.

5.2.1 Each container for intraplant use at RAAP shall be marked in nominal 1.27 cm (1/2 inch) letters to indicate Ethyl Cellulose type, Class, lot number, net weight and month and year packed.

5.2.2 Each container for off-plant shipment shall be marked in nominal 1/2 inch letters, with name of manufacturer, Ethyl Cellulose type, Class, lot number, net and gross weight, cubic feet of container, and month and year packed. In addition, shipment shall be marked in accordance with MIL-STD-129 Marking for Shipment and Storage.

6. NOTES

6.1 Intended use. The molding material is used in producing film and molded parts for use with Rocket Propellant Grain (Ballistite Type).

6.2 Ordering data

6.2.1 Procurement requirements. Procurement documents should specify the following:

(a) Title, number and date of the specification
(b) Type and class of material request (see 1.2)
(c) Color and transparency (see 3.5)
(d) Suitability for use with nitroglycerin or other explosive or propellants, if required (see 3.6)
(e) Level of packing (see 5.1)
(f) Quantity desired

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