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MILITARY SPECIFICATION

ROVING, GLASS, FIBROUS
(FOR PREPREG TAPE AND ROVING, FILAMENT
WINDING, AND PULTRUSION APPLICATIONS)

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

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the requirements of certain constructions of continuous filament, single or multiple end, fibrous glass rovings. The rovings shall be suitable for use in prepreg tape and filament winding applications for reinforced plastic structures.

1.2 Classification. The rovings shall be of the following types, filament sizes, classes, and yields as specified (see 6.2, 6.3, and 6.8).

Type I - "E" glass

G, H, J, K, L, M, N, P, S, and T filaments

Class 1 - Sizing system compatible with epoxy resin.

Class 2 - Sizing system compatible with polyester resin.

Class 3 - Sizing system compatibility as specified.

Type II - (6.8)

Type III - High tensile strength "S" glass.

Beneficial comments (recommendation, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMR-LS, 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.

FSC 8310

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G filament

Class 1 - Sizing system compatible with epoxy resin.

Type IV - General purpose high tensile strength "S" glass.

G filament

Class 1 - Sizing system compatible with epoxy resin.

Class 2 - Sizing system compatible with polyester.

Roving yield (applicable to all types, filament code designations and classes) as specified (see 3.1.4).

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.

Federal specifications

PPP-B-585 - Boxes, Wood, Wirebound.

PPP-B-601 - Boxes, Wood, Cleated-Plywood.

PPP-B-636 - Box, Fiberboard

(Activities outside the Federal Government may obtain copies of Federal specifications, standards, and commercial item descriptions as outlined under General Information in the Index of Federal Specifications, Standards and Commercial Item Descriptions. The Index, which includes cumulative bimonthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

(Single copies of this specification, other Federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Service Centers in Boston; New York; Washington, DC; Philadelphia; Atlanta; Chicago; Kansas City, MO; Fort Worth; Houston; Denver; San Francisco; Los Angeles; and Seattle, WA.)

(Federal Government activities may obtain copies of Federal specifications, standards, and commercial item descriptions, and the Index of Federal Specifications, Standards and Commercial Item Descriptions from established distribution points in their agencies.)

Military specifications:

- MIL-P-116 - Preservation-Packaging, Methods of
- MIL-R-9300 - Resin, Epoxy, Low Pressure Laminating
- MIL-L-10547 - Liners, Case, and Sheet, Overwrap, Water-Vaporproof or Waterproof Flexible

Military standards:

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

(Copies of Military Specifications and Standards 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 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:

- D 618 - Conditioning Plastics and Electrical Insulating Materials for Testing
- D 2291 - Fabrication of Ring Test Specimens for Reinforced Plastics.
- D 2343 - Tensile Properties of Glass Fiber Strands, Yarns and Rovings Used in Reinforced Plastics.
- D 2344 - Apparent Horizontal Shear Strength of Reinforced Plastics by Short-Beam Method.
- D 2587 - Acetone Extraction and Igniton of Strands, Yarns and Roving for Reinforced Plastics.

(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, Inc., Agent :

National Motor Freight Classification

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

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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 Roving.

3.1.1 Construction. The roving shall consist of a number of continuous glass filaments coated with suitable sizing system (see 3.1.5) and laid essentially parallel with little or no twist. The filaments may or may not be grouped into strands, intermediate in size, between a single filament and the roving itself (see 6.3). The roving shall be supplied in the form of roving balls (see 3.3). The construction shall be in accordance with 3.3, and the acceptable quality levels (AQL), specified in table I (see 4.2.1.1).

Table I. Examination of roving ball for visual defects.

| Examine | AQL percent defective | Defect ^{1/} | Method inspection |
|---|-----------------------------|---|----------------------------------|
| Workmanship: | | | |
| Outer layer ^{2/} Of roving ball (see 1.2, 3.4, 3.4.1 & 6.2) | 1.0 | Dirt, grease oil or foreign matter in quantity sufficient to be detrimental to end use. | Visual |
| | 1.0 | Any knot or fuzz accumulation. | Visual |
| | 1.0 | Any splice or group of two or more splices not in accordance with 3.4.1. | Visual |
| | <u>3/</u> | Difference in color, transpar- ency or other appearance of the filaments. | Visual |
| Package (ball) build: | | | |
| Roving ball (see 3.3, 6.2, and 6.4) | 2.5 | Not cylindrical within 5/16 inch | Carpenter's square & scale |
| | 2.5 | Not centered on tube, where applicable, within 1/8 inch. | Carpenter's square & scale |
| | 2.5 | Diameter or length improper. | Scale |
| | 2.5 | Direction and angle of winding improper. | Scale and visual |
| | 2.5 | Number of turns per trans- verse improper. | Visual |
| | | | Visual |
| Tube (see 3.3 And 6.2) | 2.5 | Inside diameter or length improper. | Visual |
| | 2.5 | Not suitable, color code improper. | Visual |

^{1/}The lot shall be evaluated separately in respect to each category or defect.

^{2/}Unless the external appearance of a ball or supplier's previous history shows interior of the ball may contain defects, a ball shall not be unwound merely for examination for visual defects.

^{3/}The lot shall be rejected if there is a visual difference in color, transparency, or other appearance of the filaments indicating a possible mixing of different types of glass fibers.

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3.1.2 Glass. The chemical composition of "E" glass, as percent by weight, shall be within the limits as follows:

| | |
|--|-------|
| B ₂ O ₃ | 5-10 |
| CaO | 16-25 |
| Al ₂ O ₃ | 12-16 |
| SiO ₂ | 52-56 |
| MgO | 0-5 |
| Na ₂ O and K ₂ O | 0-2 |
| TiO ₂ | 0-1.5 |
| Fe ₂ O ₃ | 0-0.8 |
| F ₂ | 0-1.0 |

The chemical composition of high tensile strength "S" glass and general purpose high tensile strength "S" glass shall be certified (see 4.2.1.1) as being within the limits accepted for these two "S" glasses (see 1.2, table II, and 6.3). Any new or modified "S" glass shall not be acceptable unless approved by the procuring activity.

3.1.3 Filament diameter and code letter of current commercial filaments. The nominal filament diameter range and code letters shall be as follows (see 6.7 for complete list of code letters).

| <u>Filament</u> | <u>Diameter range, inches</u> |
|-----------------|-------------------------------|
| G | 0.00035 - 0.00040 |
| H | .00040 - .00045 |
| J | .00045 - .00050 |
| K | .00050 - .00055 |
| L | .00055 - .00060 |
| M | .00060 - .00065 |
| N | .00065 - .00070 |
| P | .00070 - .00075 |
| S | .00085 - .00090 |
| T | .00090 - .00095 |

3.1.4 Roving yield (see 4.3.4, 6.3, and 6.6). Each roving ball fabricated by either conventional or non conventional roving winding processes shall contain a sufficient number of filaments of the specified diameter code (see 3.1.3) to produce the nominal roving yield specified to within a tolerance of ± 8.5 percent (yield to be specified by procuring activity see 6.2). Certain type I materials produced by other than conventional winding processes shall have a yield tolerance of ± 13 percent when agreed to by suppliers and the procuring activity.

Table II. Property requirements

| Property | Type I | Type III | Type IV |
|---|--|---------------------|------------------------------|
| ¹ /Package (ball density (pounds/cubic inch) minimum maximum | .035 .075 | .035 .065 | .035 .065 |
| ¹ /Shore "O" package ball hardness minimum maximum | Classes 1, 2, and 3 50 90 | Class 1 50 90 | Classes 1, and 2 50 90 |
| Catenary, ² /inches/50feet, maximum | 1.0 | 0.5 | 1.0 |
| Roving yield | see 3.1.4 | see 3.1.4 | see 3.1.4 |
| Acetone extractable content, percent of ignition loss, minimum | NA ³ / | 70 | NA ³ / |
| Resistance to fusion | <u>4</u> / | <u>4</u> / | <u>4</u> / |
| Tensile strength, psi, minimum Other than G G | 200,000 280,000 | NA 500,000 | NA 400,000 |
| Horizontal shear strength (after 6-hour boil) psi, minimum Other than G G | 4,500 ⁵ / or 6,500 ⁵ / 4,500 ⁵ / or 6,500 ⁵ / | | NA <u>6</u> / |
| Specific gravity range (virgin fiber only) | 2.52-2.61 (floats in solution specified in 4.3.8) | NA | NA |

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¹/The supplier has the option to perform either the Package (Ball) Density or the Shore "O" Package Hardness test. Only one or the two tests is required.

²/Unless otherwise specified, the catenary requirement applies only to rovings having a yield of 700 or more yards per pound.

³/NA - Not applicable

⁴/The specimens of 4.3.5 shall not fuse during the specified ignition.

⁵/These values are applicable only when a specific resin system is not specified by the procuring activity (see 6.2). The 4,500 psi minimum applies to polyester type resin matrix and 6,500 psi minimum applies to epoxy type resin matrix. When seemed necessary, the procuring activity shall specify a specific resin system and a corresponding minimum value for horizontal shear strength. For class 3 material, a value agreeable to both supplier and procuring activity shall be agreed upon.

⁶/Applicable only when specified by the procuring activity (see 6.2). Actual values are dependent upon a given resin. Therefore, values shall be agreed upon between the supplier and the procuring activity for the matrix resin which is to be used. Normal values are 8,500 psi for epoxy and 7,000 psi for polyester resin matrices.

3.1.5 Sizing system (see 6.3). Class 1 roving shall have a sizing system selected and applied so as to provide compatibility between the glass and epoxy resin. Class 2 roving shall have a sizing system which is compatible between the glass and polyester resin, and class 3 shall have a sizing system compatible with the resin specified (see 1.2 and 4.2.1.1).

3.2 Property requirements. The roving shall conform to the property values specified in table II, when tested as specified in the applicable procedure of 4.3 (see 4.2.3).

3.3 Package (ball) build (see table I). The roving shall be wound with uniform tension on a tubeless package or a heavy duty winding tube of the dimensions and color code specified (see 6.2) to make essentially cylindrical "roving ball." The dimensions, direction and angle of winding, the number of turns per transverse, and the spacing of the roving, shall be as specified by the procuring activity (see 6.2). When not specified, the manufacturer's standard dimensions, winding pattern, and color code shall be considered acceptable. The roving shall unwind from the ball on commercial filament winding equipment without excessive process interruptions or excessive tension variation.

3.4 Workmanship. The material shall be free from visible dirt, grease, oil, or foreign matter. Any group of knots, strands or fuzz accumulation occurring at any point in the package which is sufficient to cause an appreciable change in the smoothness of the roving shall be cause for rejection unless the defect can be removed without rendering the remainder of the package rejectable (see table I). There shall be no visible differences in color, transparency, or other appearance of the filaments which may indicate mixing of different types of glass fibers for conventional roving products.

3.4.1 Splices. When insertion of a broken strand by skip knotting or mechanical insertion method is not acceptable, it shall be spliced with cellulose acetate cement, or any mutually acceptable substitute, with a one inch minimum overlap. When two or more ends are spliced simultaneously, splices shall be spaced so as to prevent any overlapping of the spliced areas, with the exception of gang splices. The maximum number of splices shall not exceed an average of one splice per pound of roving.

3.5 Storage (applicable only to certain type II rovings). When type III rovings, which have sizing systems which will deteriorate at room temperatures, are supplied, the supplier shall furnish instructions for storage (see 6.5).

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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 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, and in the absence of more formal inspection lot definitions, the inspection lot for examination and tests shall consist of all material of the same type, filament code, and class submitted for delivery and 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, examined, and tested in accordance with the requirements of this specification and, to the extent specified, of all referenced subsidiary specifications and standards. In the event of conflict, this specification will govern.

4.2.1.1 Supplier's certification. The supplier shall certify that (a) all roving balls were produced under the same manufacturing process; (b) the glass is "E", or "S", or general purpose high tensile strength "S" as specified (see 1.2 and 3.1.2); (c) the nominal filament diameter corresponds with code letter designation applicable to the strand specified (see 2.1 and 3.1.3); (d) the sizing on the glass is compatible with the type of resin specified; (e) that all splices if used, were made in accordance with 3.4.1.

4.2.2 Inspection of material.

4.2.2.1 Examination of the roving balls. Examination of the roving balls shall be made in accordance with the classification of defects, inspection levels and 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 one roving ball 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 package build, appearance, workmanship, splices, and storage instructions. The sample unit for this examination specified in table I shall be 1 roving ball. One set of storage instructions shall be supplied for each container of roving balls.

4.2.2.1.2 Examination of the preparation for delivery. An examination shall be made in accordance with table III to determine that packaging, packing and marking comply with section 5 requirements. The sample unit for this examination shall be one shipping container fully packed, selected put prior to the closing operations. Shipping containers fully prepared for delivery shall be examined for closure defects.

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 AQL, expressed as defects per 100 units shall be as follows:

| Examination of paragraph | Inspection level | AQL |
|--------------------------|------------------|-------------|
| 4.2.2.1.1 | II | see table I |
| 4.2.2.1.2 | S-2 | 2.5 |

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

4.2.3 Testing. The material shall be tested for characteristics listed in table II, 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 one roving ball. The sample unit shall consist of sufficient material to prepare all required specimens. Testing for hardness, package (ball) density, catenary and roving yield shall require inspection level II with a 1.0 percent AQL as per MIL-STD-105. All other test shall require inspection level S-2 with a 2.5 percent AQL. One averaged value per ball sampled for each specified property shall determine acceptance as outlined in MIL-STD-105.

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Table III. Examination of the preparation for delivery

| Examine | Defect |
|----------------------|--|
| Ball | <p>Type III roving ball not wrapped in polyethylene film.</p> <p>Types I and IV roving ball not wrapped in polyethylene or other material proving adequate protection.</p> <p>End pad or core plug missing or improper, when applicable.</p> |
| Packaging | <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>Inadequate application of components such as: incomplete closure of poly-ethylene liners.</p> |
| Quantity of material | Less than specified or indicate quantity. |
| Weight | Gross weight exceeds specified requirements |
| Markings | <p>Exterior markings omitted, illegible, incorrect, of improper size, location, sequence or method of application, or not in accordance with contract requirements.</p> <p>When special storage conditions are required, containers not properly marked (see 5.3 and 6.5).</p> |

4.3 Testing methods.

4.3.1 Specimen conditioning and testing. Unless otherwise specified, specimens for tensile and shear testing shall be conditioned in accordance with procedure A of ASTM D 618. Specimens for other testing shall be conditioned for a minimum of 2 hours in accordance with ASTM D 618. Testing shall be at 73.4 ± 3.6 F (23 ± 2 C) and 50 ± 5 percent relative humidity.

4.3.2 Hardness. A shore "O" durometer or equivalent shall be used to test as follows: Set the roving ball on its end on a horizontal flat surface. Support the ball with one hand, hold the durometer in the other, and bring the instrument plunger and foot into contact with outermost layer of roving. Apply such pressure as is required to bring about a constancy in the reading attained on the dial indicator. Make three readings randomly spaced around the circumference and along the length of the ball.

4.3.3 Catenary (Unless otherwise specified, this test is not applicable to roving having a field less than 700 yards per pound). One specimen per roving ball shall be tested and each obtained by pulling roving from the ball until the slack is taken off, then tying a knot in the roving approximately 12 inches from the package. The roving shall be pulled over a spindle and clamped to a strand which is located approximately 50 feet from the spindle. After returning to the roving ball and holding a 50 foot portion of the strand tight, a hard knot shall be tied. A clamp and sufficient weights to give a total of 2 ± 0.1 pounds shall be placed on the hanging end of the roving. The roving shall be grasped lightly at the center of the span (25 feet) and pulled down 1 foot. The roving shall be released. The pull down and release shall be repeated three additional times. The distance between the furthestmost separated strands perpendicular to the lengthwise direction shall be measured.

4.3.4 Roving yield. One specimen shall be tested per roving ball sample. The roving yield shall be computed by dividing the weight into measured length resulting in units such as yards/pound (see 6.3).

4.3.5 Acetone extractable content and resistance to fusion. One specimen per roving ball shall be tested for each requirement in table II as applicable. Testing shall be in accordance with ASTM D 2587 with the following changes:

- (a) The specimen shall consist of an accurately measured length of roving weighing approximately 10 grams.
- (b) Type I roving shall be ignited at a temperature of 1150 ± 45 F (620 ± 25 C). Types III and IV rovings shall be ignited at a temperature of 1500 ± 45 F (815 ± 25 C). The ignited specimen shall be examined for fusion.

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4.3.6 Tensile strength. Five specimens per roving ball shall be tested in accordance with ASTM D 2343. Class 1 of types I, III, and IV roving shall be tested on specimens made with resin conforming to type I, class 1 of MIL-R-9300. When testing class 2 roving, the polyester resin to be used shall be as specified by the procuring activity. When testing class 3 roving, the phenolic, silicone or other resin to be used shall be as specified by the procuring activity. In the event of dispute with either class 1, class 2, or class 3 roving, the resin to be used shall be selected by mutual agreement between the supplier and procuring activity.

4.3.8 Specific gravity range (applicable to type I only). Six specimens of roving, each approximately 1/3 inch (1 centimeter) long, shall be heat cleaned by exposure to a minimum temperature of 1202 F (650 C) for at least 10 minutes. (Note that the temperature of the heat cleaning process will compact the filaments thereby increasing the actual specific gravity of the virgin fibers. Hence, this method is only for identification of type I roving and not a precise measurement of specific gravity of the virgin fiber.) Three heat cleaned specimens shall be dropped directly into a small container such as a 1-1/2 inch diameter test tube with a solution of 2.62 specific gravity which was prepared by mixing 100cc of bromoform (specific gravity 2.84) with 19cc of trichloroethylene (specific gravity 1.46) in a well ventilated hood. Prior to use, the solution should be well sealed to prevent density changes due to evaporation. The roving specimens dropped into the solution shall be allowed to wet out completely. Roving with a specific gravity of 2.61 or less shall be checked for the lower end of the specific gravity range using a mixture of 91cc of bromofoam and 28cc of trichloroethylene yielding a specific gravity of 2.519. The roving specimens shall sink.

4.3.9 Package density. One density determination is made for each ball (package) in the sample from the lot being tested. Density is determined by measuring inside diameter to the nearest 1/16 inch with a steel rule, outside diameter to the nearest 1/16 inch with a circumference tape (or steel rule), length to the nearest 1/16 inch with a steel rule and ball (package) weight to the nearest 0.1 pound and calculating the following:

$$D = \frac{1.27 \times \text{weight}}{\text{length} (d_o^2 - d_i^2)}$$

where D = package (ball density, lbs/cubic inch

d_o = outside diameter, inches

d_i = inside diameter, inches

Report to the nearest 0.001 pounds/cubic inch.

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.

5.1.1.1 Unit packaging. Unless otherwise specified in the contract or purchase order (see 6.2) roving balls shall be packaged in quantities specified by the procuring activity in accordance with the method III of MIL-P-116. Each ball of type III roving shall be wrapped in polyethylene or other material providing adequate protection. Except for type I roving balls, a rigid pad, larger than the roving ball and containing a metal core plug, shall be placed against each end of the wrapped roving ball with plugs press fitted tightly into the ball core. The roving ball shall be supported by its core in the end pads.

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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. Roving balls 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 commercially acceptable practice when it meets these requirements.

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

5.2.1 Level A. Roving balls packaged as specified in 5.1.1 shall be packed in containers conforming to PPP-B-585 (class 3) or PPP-B-601 (overseas type). 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. Roving balls 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 (class weather resistant, grade V2s). Closure shall be in accordance with the appendix to the applicable container specification.

5.2.3 Level C. Roving balls 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 required by the contract or purchase order, containers shall be marked in accordance with MIL-STD-129. When special storage conditions are required, containers shall be marked to specify completely the conditions for storage (see 6.5) as well as the type of glass.

6. NOTES

6.1 Intended use. Fibrous glass roving covered by this specification is intended for making glass reinforced structures by use of prepreg tape or roving, filament winding, and pultrusion methods.

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Type, filament diameter code letter, class and roving yield (yards per pound) required (see 1.2, 3.1.3, 3.1.4, 6.3 and 6.7).
- c. Change in yield tolerance to ± 13 percent when agreed to by supplier and procuring activity for certain type I materials produced by other than conventional winding processes (see 3.1.4).

- d. When deemed necessary for type I roving, specific matrix resin system for horizontal shear strength test and corresponding minimum value (see table II, footnote 4).
- e. Resin to be used for tensile strength determination of class 2 and class 3 roving (see 4.3.6).
- f. Horizontal shear strength test (see table II, footnote 5 and 4.3.7), if required for types III and IV roving, including specific matrix resin to be used and corresponding minimum value.
- g. Outside diameter and length of roving ball (package) (see 3.3 and 6.4).
- h. Inside diameter, and length of winding tube (see 3.3).
- i. Color coding and dimensions of winding tube, if required (see 3.3).
- j. Package (ball) build (winds, direction, turns and spacing), if required (see 3.3).
- k. Selection of applicable level of preservation, packaging, and packing required (see 5.1.1.1 and 5.1.1.2).
- l. Quantities of roving balls (packages) required in the unit and intermediate packages (see 5.1.1.1 and 5.1.1.2).
- m. Special marking, if required (see 3.3).

6.3 Definitions. For the purpose of this specification, the following definitions have been used.

Filament - a single glass fiber, as drawn.

Strand - a plurality of filaments gathered together with little or no twist and bonded with sizing.

Roving - a plurality of strands of filaments gathered together with little or no twist.

Roving yield - the roving yield in yards per pound is obtained as follows:

$$\text{Roving yield} \\ \text{Yards per pound} = \frac{453.6 \times \text{length of specimen (yards)}}{\text{weight of specimen (grams)}}$$

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Upon request, the supplier should provide a value for a yield in grams per kilometer (roving weight in TEX).

Roving designation - a roving ordinarily is designated by a roving yield (yards per pound) and a filament diameter code; i.e., "700G" plus the type and class.

Sizing system - a surface treatment or coating applied to the glass during the fiber forming operation to improve its ability to bond to a laminating resin. Different sizing systems may be necessary for use with different resins.

"E" glass - A low alkali, lime-alumina borosilicate glass noted for its good electrical properties (see 3.1.2 for chemical composition).

"S" glass and general purpose high tensile strength "S" glass - A magnesia-alumina-silicate glass of higher tensile strength and melting point than "E".

6.4 Roving ball (Package) dimensions. Ball (package) dimensions should be based on agreement between supplier and purchaser. The following nominal dimensions are being used for the ball (package).

| Nominal dimensions inches | | | Approximate weight, ¹ / pounds |
|---------------------------|--------|--------------|--|
| O.D. | length | I.D. of core | |
| 7 | 10 | 3 | 15 |
| 10 | 10 | 3 | 35-40 |
| 10 | 10 | 6 | 35 |
| 12 | 10 | 6 | 45 |
| 14 | 10 | 3 | 77 |
| 21 | 24 | 6 | 350-360 |

¹/The weight will vary with the type of roving.

Commercial packaging and packing of the ball (package) should be based on agreement between supplier and purchaser.

6.5 Storage. Certain type III rovings should be stored at subfreezing temperature to prevent deterioration of the sizing. Other type III rovings have stable sizing which do not require refrigeration.

6.6 Construction. In the past, it was common practice to attenuate glass through bushings having 204 or 408 holes to produce strands containing those numbers of filaments and then to supply 1, 12, 15, 20, 30 and 60-end rovings made from those strands as described in 6.3. Although many suppliers still are using this practice, others are attenuating fiber glass through bushings containing up to several thousand holes so that they can make heavy roving containing only a single strand. Since the strands are not twisted, rovings made with the larger single strands are equivalent, for most purposes, to those made with the smaller multiple strands. Since existing drawings may specify roving in accordance with the old multiple strand designation, a purchasing activity receiving a requisition for roving having a specific strand yield and end count should check with the requisitioner to determine whether specification, may be considered for substitution.

6.7 Complete list of filament diameters and code letters. The filament diameter range and code letter G through T are as follows:

| <u>Filament</u> | <u>Diameter range, inches</u> |
|-----------------|-------------------------------|
| G | 0.00035 - 0.00040 |
| H | .00040 - .00045 |
| J | .00040 - .00045 |
| K | .00040 - .00045 |
| L | .00040 - .00045 |
| M | .00040 - .00045 |
| N | .00040 - .00045 |
| P | .00040 - .00045 |
| Q | .00040 - .00045 |
| R | .00040 - .00045 |
| S | .00040 - .00045 |
| T | .00040 - .00045 |

6.8 Type II glass. Type II glass was deleted because it is no longer produced commercially.

Custodians:

Army - MR

Preparing activity:

Army - MR

Review activities:

Army - MI, ER, AR
Navy - SH, AS, OS
DLA - CT
DoD - NS

Project No. 8310-0127

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-R-60346C

2. DOCUMENT DATE (YYYYMMDD)
19810618

3. DOCUMENT TITLE ROVING, GLASS, FIBROUS (FOR PREPREG TAPE AND ROVING, FILAMENT WINDING, AND PULTRUSION APPLICATIONS)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYYYMMDD)

8. PREPARING ACTIVITY

a. NAME ARMY RESEARCH LABORATORY

b. TELEPHONE (Include Area Code)
(1) Commercial (2) AUTOVON
(410) 306-0725

c. ADDRESS (Include Zip Code)
WEAPONS AND MATERIALS RESEARCH DIRECTORATE
ATTN: AMSRL-WM-M
ABERDEEN PROVING GROUND, MD 21005-5069

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:
Defense Standardization Program Office (DLSC-LM)
8725 John J. Kingman road, Suite 2533, Ft. Belvoir, VA 22060-2533
Telephone (703) 767-6888 AUTOVON 427-6888