

GLASS ROVING, EPOXY RESIN PREIMPREGNATED
Type E Glass

THIS REVISION CONTAINS ONLY EDITORIAL CHANGES.

1. SCOPE:

- 1.1 Form: This specification covers glass roving impregnated with epoxy resin, the resin being partially processed to a "B" stage condition.
- 1.2 Application: Primarily for use in high strength filament-wound structures for aircraft, missiles, and related structures.
- 1.3 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 latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2825 - Material Safety Data Sheets

SAE Technical Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any particular infringement arising therefrom, is the sole responsibility of the user."

AMS documents are protected under United States and international copyright laws. Reproduction of these documents by any means is strictly prohibited without the written consent of the publisher.

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D2290 - Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method

ASTM D2343 - Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics

ASTM D2344 - Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method

ASTM D2584 - Ignition Loss of Cured Reinforced Resins

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-C-9084 - Cloth, Glass, Finished, for Resin Laminates

MIL-R-9300 - Resin, Epoxy, Low Pressure Laminating

MIL-R-60346 - Roving, Glass, Fibrous (For Prepreg Tape and Roving, Filament Winding, and Pultrusion Applications)

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be glass roving conforming to MIL-R-60346, Type II, Class ECG 135-140, impregnated with epoxy resin formulated to meet MIL-R-9300, Type I, Class 1, the resin being processed to "B" stage condition.

3.1.1 Splices: No splices or knots shall be introduced during the impregnation process except as shall have been previously agreed upon by purchaser and vendor.

3.1.2 Shelf Life: When packaged in vaporproof, heat sealed bags, the preimpregnated roving shall have a shelf life of not less than three weeks when stored at not higher than 4°C (39°F), and not less than three months when stored at not higher than -18°C (0°F).

3.1.3 Cure: Product shall be fully cured by filament winding under 12 - 15 psi (83 - 103 kPa) tension and curing for 1 hour at 95°C ± 15 (203°F ± 27) plus 2 hours at 175°C ± 15 (347°F ± 27), or as recommended by the manufacturer.

3.2 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with specified test methods, insofar as practicable:

3.2.1 As Received (Uncured):

3.2.1.1 Volatile Matter, by weight	0.5 - 2.5%	4.5.1
3.2.1.2 Ignition Loss, by weight	17 - 23%	ASTM D2584

3.2.1.3	Gel Time	1.0 – 3.5 minutes	4.5.2
3.2.1.4	Resin Flow, by weight	8 – 17%	4.5.3
3.2.1.5	Tensile Strength, Impregnated Strand, min	300,000 psi (2068 MPa)	ASTM D2343
3.2.2	<u>As Cured:</u> Specimens, cured as in 3.1.3, shall have the following properties, determined at 23°C ± 1 (73°F ± 2):		
3.2.2.1	Hoop Tensile Strength (NOL Ring), minimum	190,000 psi (1310 MPa)	ASTM D2290
3.2.2.2	Interlaminar Shear Strength, minimum	6000 psi (41 MPa)	ASTM D2344

3.3 Quality: The product, as received by purchaser, shall be uniform in quality and condition and free from foreign materials and from imperfections detrimental to usage of the product.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for volatile matter (3.2.1.1), resin flow (3.2.1.4), and cured hoop tensile strength (3.2.2.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the first shipment of the product to a purchaser, when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

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

4.3 Sampling: Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient product 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 product from the same batches or lots of roving and resin produced in one continuous run and presented for vendor's inspection at one time. An inspection lot shall not exceed 500 pounds (227 kg) and may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.
- 4.3.1.1.1 A batch of resin shall be that quantity formulated and mixed at the same time.
- 4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have 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 4.6.1 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 impregnated roving shall be approved by purchaser before roving for production use is supplied, unless such approval be waived by purchaser. Results of tests on production roving 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 roving which are essentially the same as those used on the approved sample roving. 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 material and/or processing and, when requested, sample roving. Production roving made by the revised procedure shall not be shipped prior to receipt of reapproval.
- 4.5 Test Methods:
- 4.5.1 Volatile Matter: Cut three specimens each 72 inches ± 0.1 (1829 mm ± 2.5) long. Fold each specimen three times to a length of approximately 9 inches (229 mm) and tie loosely into an overhand bow knot. Weigh each specimen to the nearest 0.001 gram. Hang each specimen separately on a rack and place in an oven at $135^{\circ}\text{C} \pm 3$ ($275^{\circ}\text{F} \pm 5$) for 15 minutes ± 1 . Cool to room temperature in a desiccator and weigh each specimen. Calculate volatile as follows:

$$\text{Volatile matter, \%} = \frac{W_0 - W_1}{W_0} \times 100$$

where, W_0 = original weight
 W_1 = final weight

Average the results from the three specimens.

- 4.5.2 Gel Time: Precondition a Fisher-Johns Melting Point Apparatus to $165^{\circ}\text{C} \pm 1$ ($329^{\circ}\text{F} \pm 2$). Place a microscope slide on the heated block, allowing 20 - 30 seconds for it to reach temperature equilibrium. Cut a piece of roving $1/4$ inch $\pm 1/16$ (6.35 mm ± 1.6) long. Place sample on heated microscope slide and commence timing. Within 5 seconds, place a second microscope slide over the sample. As the resin softens and during the first 30 seconds, isolate a drop of resin by gently pressing on the upper slide. Observe lateral movement of the resin drop while periodically pressing on the upper slide. As the resin thickens, the lateral movement will be retarded. A sharp color change and the formation of small droplets when the cover slide is pressed indicate the gel point. Stop the timer and record the elapsed time in minutes as gel time. Report the average of three results.
- 4.5.3 Resin Flow: Cut six lengths of roving, each 3 inches (76 mm) long. Weigh each specimen, consisting of two 3-inch (76-mm) lengths, to the nearest 0.001 gram. With the lengths spaced $1/2$ inch (12.7 mm) apart, sandwich the specimen between four layers (two on each side of specimen) of MIL-C-9084, Type I, Volan A finish glass cloth. Preheat a 1500 gram metal weight to $150^{\circ}\text{C} \pm 5$ ($302^{\circ}\text{F} \pm 9$). Press the sandwiched material on a preheated hot plate and maintain at $150^{\circ}\text{C} \pm 5$ ($302^{\circ}\text{F} \pm 9$) for 2 minutes, using a surface pyrometer to ensure maintenance of the required temperature. While still hot, remove the glass cloth and reweigh each roving specimen to the nearest 0.001 gram. Calculate resin flow as follows:

$$\text{Resin flow, wt \%} = \frac{W_0 - W_1}{W_0} \times 100$$

where, W_0 = Weight of roving before cure

W_1 = Weight of roving with excess resin removed (after cure)

Report the average value of the tests on the three specimens.

4.6 Reports:

- 4.6.1 The vendor of the product shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, AMS 3828B, lot number, vendor's material designation, size, and quantity.
- 4.6.1.1 A material safety data sheet conforming to AMS 2825, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of the impregnated roving for production use. Each request for modification of the product formulation shall be accompanied by a revised data sheet for the proposed formulation.