

POTTING COMPOUND, EPOXY
Two Part, Highly Filled, Heat Cure, High Compressive Strength

1. SCOPE:

1.1 Form: This specification covers a highly filled epoxy potting compound supplied as a two-component system.

1.2 Application: Primarily for cast shapes, for encapsulation of electronic parts, transformers, coils and conductors; where high compressive and flexural strengths are required.

1.3 Classification: The compound is classified as follows:

Type I: The color of cured compound shall be within the range of color numbers 34079 and 34102, incl, of FED-STD-595.

Type II: The color shall be optional, either natural color or color as ordered.

1.3.1 Type I shall be supplied unless Type II is ordered.

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

REAFFIRMED

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

- ASTM D257 - DC Resistance or Conductance of Insulating Materials
- ASTM D618 - Conditioning Plastics and Electrical Insulating Materials for Testing
- ASTM D648 - Deflection Temperature of Plastics under Flexural Load
- ASTM D695 - Compressive Properties of Rigid Plastics
- ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM D792 - Specific Gravity and Density of Plastics by Displacement
- ASTM D2471 - Gel Time and Peak Exothermic Temperature of Reacting Thermosetting 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 Federal Standards:

FED-STD-595 - Colors

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 an epoxy-based compound complete with fillers and curing agents or other ingredients necessary to yield products which meet the requirements of 3.2 and 3.3.

3.2 Storage Life: The compound shall meet the requirements of 3.3 at any time up to nine months from date of manufacture when stored below 32°C (90°F) in the original unopened containers. Compound which has passed the shelf life expiration date may be tested for extension of shelf life. Tests shall consist of base resin viscosity (3.3.1.1), hardener viscosity (3.3.1.2), and the cured material properties 3.3.2.1 through 3.3.2.7. If the compound meets the requirements of these tests, the shelf life may be extended for three months from the date of test. After expiration of the first shelf life extension, the compound may be tested for additional shelf life extension as stated above. If the compound meets the requirements of these tests, the shelf life may be extended one month from date of retest.

3.3 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with test methods specified in 4.5.

3.3.1 Components:

3.3.1.1 Component Viscosities: Shall be as follows, based on the average of three determinations:

3.3.1.1.1 Base Resin: Shall not exceed 2.6×10^6 centipoises, determined at 21° to 24°C (70° to 75°F) in accordance with 4.5.1 not less than 72 hr after the material is first compounded.

3.3.1.1.2 Hardener: Shall not exceed 6.5×10^5 centipoises, determined at 21° to 24°C (70° to 75°F) in accordance with 4.5.2 not less than 72 hr after the material is first compounded.

3.3.2 Mixed Uncured Compound: Shall have the following properties when prepared in accordance with 4.5.3.1:

3.3.2.1 Viscosity: Shall not exceed 8.0×10^5 centipoises, determined at 24° to 27°C (75° to 80°F) in accordance with 4.5.3.2.

3.3.2.2 Gel Time: Shall not exceed 20 min. at 120°C (250°F), determined in accordance with 4.5.3.3.

3.3.2.3 Peak Exotherm: Shall not exceed 6°C (10°F), determined in accordance with 4.5.3.4 at 70°C (160°F).

3.3.3 Cured Compound: The compound shall exhibit the following properties after being prepared and tested in accordance with specified test methods:

3.3.3.1	Specific Gravity, min	2.1	4.5.4.2
3.3.3.2	Compressive Strength, min	32,000 psi (220 MPa)	4.5.4.3
3.3.3.3	Compressive Modulus of Elasticity	$2.3 - 3.8 \times 10^6$ psi (15,860 - 26,200 MPa)	4.5.4.4
3.3.3.4	Flexural Strength, min	17,000 psi (115 MPa)	4.5.4.5
3.3.3.5	Flexural Modulus of Elasticity	$2.8 - 3.6 \times 10^6$ psi (19,305 - 24,820 MPa)	4.5.4.6
3.3.3.6	Area under Flexure Stress/Strain Curve, min	26.5 in.-lb/sq in. (4640 N·m/m ²)	4.5.4.7
3.3.3.7	Heat Distortion Temperature, min	70°C (158°F)	4.5.4.8
3.3.3.8	Insulation Resistance, min	1×10^{11} ohms	4.5.4.9
3.3.3.9	Coefficient of Linear Thermal Expansion, max 25° to 75°C (75° to 165°F)	22×10^{-6} in./in. per $^\circ\text{F}$ (40×10^{-6} mm/mm per $^\circ\text{C}$)	4.5.4.10
	-55° to 25°C (-65° to 75°F)	14×10^{-6} in./in. per $^\circ\text{F}$ (25×10^{-6} mm/mm per $^\circ\text{C}$)	

3.4 Quality: The base resin and hardener, as received by purchaser, shall be uniform in quality and condition, clean, and free from lumps and foreign material.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the compound 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 compound conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for base resin viscosity (3.3.1.1.1), hardener viscosity (3.3.1.1.2), mixed viscosity (3.3.2.1), specific gravity (3.3.3.1), compressive strength (3.3.3.2), compressive modulus of elasticity (3.3.3.3), flexural strength (3.3.3.4), flexural modulus of elasticity (3.3.3.5), area under flexural stress/strain curve (3.3.3.6) and quality (3.4) 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 initial shipment of compound to a purchaser, when a change in material, processing, or both 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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient compound 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 compound produced in a continuous production run from the same batches of raw materials under the same fixed conditions and presented for vendor's inspection at one time. A lot shall not exceed 6000 lb (2700 kg) of compound and may be packaged and delivered in smaller quantities provided lot identification is maintained.

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. The sample size is normally not less than 1 gal (4 L).

4.4 Approval:

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

4.4.2 Vendor shall use ingredients, manufacturing procedures and processes, and methods of inspection on production compound which are essentially the same as those used on the approved sample compound. 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, processing, or both, and, when requested, sample compound. Production compound made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods: Shall be in accordance with the following:

4.5.1 Base Resin Viscosity: Shall be determined using a Brookfield RVF Helipath viscosimeter with a T-F spindle at 4 revolutions per minute. The viscosity reading shall be made at the tenth revolution of the spindle.

4.5.1.1 Three viscosity measurements shall be made on each batch of base resin and the average value of the three readings determined.

4.5.2 Hardener Viscosity: Shall be determined using a Brookfield RVF Helipath viscosimeter with a T-F spindle at 10 revolutions per minute. The viscosity reading shall be made at the tenth revolution of the spindle.

4.5.2.1 Three viscosity measurements shall be made on each batch of hardener and the average value of the three readings determined.

4.5.3 Mixed Compound Properties:

4.5.3.1 Compound Mixing: Immediately prior to mixing, the base resin container shall be agitated on a paint shaker for not less than 45 min. and the hardener container shall be agitated on the shaker for not less than 30 minutes. The mixed molding compound shall be prepared by thoroughly mixing the base resin with the hardener as recommended by the manufacturer. Immediately degas the mixed material at an absolute pressure of 2 to 4 torr (270 to 520 Pa) for 3 min. + 1 at 60° - 70°C (140° - 160°F). The mixed compound shall be used in testing the mixed viscosity, gel time, and peak exotherm properties within 5 min. of mixing.

- 4.5.3.2 Viscosity: Shall be determined on each lot of molding compound, mixed at room temperature and degassed as specified in 4.5.3.1, by using a Brookfield RVF Helipath viscosimeter with a T-F spindle at 10 rpm, at 24° to 27°C (75° to 80°F). The viscosity shall be recorded after 10 revolutions of the spindle.
- 4.5.3.2.1 Three viscosity measurements shall be made on each batch and the average value of the three readings determined.
- 4.5.3.3 Gel Time: Shall be determined in accordance with ASTM D2471 on a batch of compound mixed and degassed as specified on 4.5.3.1.
- 4.5.3.4 Peak Exotherm: Shall be determined in accordance with ASTM D2471 on a batch of compound mixed as specified in 4.5.3.1 using a thermocouple centered in a 6-cu in. (100 mL) volume contained in a 3.3-oz (90 mL) cup placed in a bath at 71°C $\pm$ 1 (160°F $\pm$ 2).
- 4.5.4 Cured Compound Properties:
- 4.5.4.1 Specimen Preparation: Resin and hardener shall be prepared, mixed, and degassed as specified in 4.5.3.1 and poured into suitable molds. Test bars shall be cast using best commercial practice including vibration and evacuation as necessary. The compound shall be cured as recommended by the manufacturer.
- 4.5.4.2 Specific Gravity: Shall be determined in accordance with ASTM D792, Method A-1, on three samples approximately 1.5 in. (37.5 mm) long taken from test bars cast without overflow in vertical 0.5 in. (12.5 mm) square by 6 in. (150 mm) molds and allowed to cool slowly.
- 4.5.4.3 Compressive Strength: Shall be determined in accordance with ASTM D695. The specimens shall be a right prism 0.5 x 1.6 in. (12.5 x 40 mm). Five specimens shall be tested. The end faces of each specimen shall be flat, parallel to each other, and perpendicular to the sides within 0.003 in. (0.08 mm) total variation. The cross-sectional area of each specimen shall be determined by measuring the two 0.5-in. (12.5 mm) dimensions within 0.001 in. (0.02 mm). All dimensional measurements shall be made immediately prior to testing.
- 4.5.4.3.1 A compressive force/compressive deformation chart shall be made for each specimen using a deflectometer and suitable automatic recording device. The sensor of the deflectometer shall be placed adjacent to the specimen so as to exclude machine related deflections from the deflection measurement. In addition, a deflection correction factor shall be obtained for the deflection measurement by determining the inherent deflection in the equipment when the full scale load is applied to a specimen of the same length as the test specimen, but which has negligible deflection under the full scale load. (This correction factor is necessary for determining the compressive modulus in 4.5.4.4.) The compressive strength for each test specimen shall be calculated by dividing the maximum compressive load carried by the specimen by the original cross sectional area of the specimen.

4.5.4.4 Compressive Modulus of Elasticity: Shall be determined by using the chart from the compressive strength test of 4.5.4.3 for each of the five compression specimens. A tangent line shall be drawn on the initial linear portion of the curve. A point along this line and common to the curve shall be selected. The correction factor at this point, obtained in 4.5.4.3.1 shall be subtracted from this deformation to obtain the true total deformation of the specimen. This true deformation shall be used in the following calculation. The unit strain shall be determined by dividing the true specimen deformation by the original specimen length. The compressive modulus shall then be calculated by dividing the load at the selected point on the curve by the unit strain and dividing the result by the original cross-sectional area of the specimen.

4.5.4.5 Flexural Strength: Shall be determined as specified in ASTM D790, Method 1. Specimen shall be 0.5 in. (12.5 mm) square by 5 in. (125 mm) long; a 4-in. (100 mm) span shall be used. The width and depth of the specimen shall be measured to within 0.001 in. (0.02 mm). Five specimens shall be tested. The flexural strength S , shall be calculated as follows:

$$S = 3PL/2bd^2$$

where

P = maximum load, lb (N)
 L = support span, in. (mm)
 b = width of the specimen, in. (mm)
 d = depth of the specimen, in. (mm)

4.5.4.6 Flexural Modulus of Elasticity: Shall be determined in accordance with ASTM D790, Method 1, from the load deflection chart generated in the flexural strength tests. Flexural modulus (E) shall be calculated as follows:

$$E = L^3 m/4bd^3$$

where

m = slope of the tangent to the initial straight line portion of the curve, lb/in. (N/m)

L , b and d are as stated for the flexural strength test.

- 4.5.4.7 Area Under the Flexural Load/Deformation Curve: Shall be determined using a polar planimeter (Gleason Instrument Co. or equivalent) and the curve from the flexural strength test in 4.5.4.5. The area under the curve shall be determined by tracing the entire three sides of the "triangular shaped" figure formed by the curve on the load/deformation chart. A constructed line shall be drawn perpendicular to the deformation axis of the chart to intersect the failure point on the curve to form the triangular figure. The area of the figure in sq in. (mm^2) is multiplied by the scale factors on the chart to obtain the test value.
- 4.5.4.7.1 The value shall then be divided by the cross-sectional area of the test specimen as determined by the width and depth measurements obtained in 4.5.4.5 for the specimen. The result is the value for the area under the flexure stress/strain curve. Determine the average of the five specimens.
- 4.5.4.8 Heat Distortion Temperature: Shall be determined on three specimens conditioned in accordance with ASTM D618, Procedure A. Testing shall be in accordance with ASTM D648. An acceptable alternative is thermal mechanical analysis using test specimens approximately 0.125 in. (3 mm) square. Determine the average of the three specimens.
- 4.5.4.9 Insulation Resistance: The DC insulation resistance of three specimens shall be determined in accordance with ASTM D257. The specimens shall conform to C of Fig. 3 ASTM D257, except that the specimen shall be 0.5 in. (12.5 mm). The specimens shall be conditioned in accordance with ASTM D618, Procedure C, prior to measuring the resistance. The test shall be performed using a commercial megohm meter.
- 4.5.4.10 Coefficient of Linear Thermal Expansion: Shall be determined by thermal mechanical analysis or approved equivalent. Two specimens shall be tested at each temperature range specified in 3.3.3.9 for a total of four specimens. Specimen size shall be either approximately 0.125 in. (3 mm) square by 0.2 to 0.3 in. (5 to 7.5 mm) thick, or 0.5 in. (12.5 mm) in diameter by 0.2 to 0.3 in. (5 to 7.5 mm) thick. The heating rate shall be 10 C (18 F) deg per minute. Prior to testing, the specimens shall be conditioned in accordance with ASTM D618, Procedure A.

4.6 Reports:

- 4.6.1 The vendor of the compound shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the compound conforms to the other technical requirements of this specification. This report shall include the purchase order number, AMS 3733A, vendor's material designation, lot number, date of manufacture, and quantity.