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INTERNATIONAL
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AEROSPACE INFORMATION REPORT

SAE AMS 3727A

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Submitted for recognition as an American National Standard

Superseding AMS 3727

RESIN, EPOXY, MATRIX, THERMOSETTING
Moderate Temperature Resistant, Unfilled

1. SCOPE:

1.1 This specification covers a heat-reactive, thermosetting, epoxy resin matrix in the form of a semi-solid. The resin matrix thermally cures to an epoxy polymer.

1.2 Applications:

This resin has been used typically in the manufacture of moderate-temperature, high-strength composite prepreg materials, but usage is not limited to such applications.

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 SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2825 Material Safety Data Sheets
AMS 3099 Curing Agent, Solid Aromatic Amine, 4,4'-Diaminodiphenyl Sulfone (NON-CURRENT)
AMS 3296 Diglycidyl Ester Resin
AMS 3701 Epoxy Resin, Tetraglycidyl Methylenedianiline (TGMDA), 10,000 to 14,000 Centipoise Viscosity (NON-CURRENT)
ARP1610 Physical-Chemical Characterization Techniques, Epoxy Adhesive and Prepreg Resin Systems

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 1652 Epoxy Content of Epoxy Resins

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be a thermosetting formulation conforming to the composition shown in Table 1.

TABLE 1 - Material Formulation

Component	Percent by Weight
AMS 3701 Tetraglycidyl Methylenedianiline (See 3.1.1)	52.0 to 56.0
AMS 3296 Epoxy, Diglycidyl Ester Resin	10.0 to 16.0
AMS 3099 4,4'-Diaminodiphenyl Sulfone (DDS)	28.0 to 34.0
Boron Trifluoride Amine Complex	0.5 to 1.5

3.1.1 Same as AMS 3701 except viscosity shall be 12,000 to 16,000 centipoises (12 to 16 Pa•s).

3.2 Volatile Content:

Shall be not greater than 1.5%, determined in accordance with 4.5.1.

3.3 Properties:

Resin shall conform to requirements shown in Table 2, determined in accordance with specified test methods.

TABLE 2 - Resin Properties

Paragraph	Property	Requirement	Test Method
3.3.1	Epoxy Content (equivalent per 100 grams)	0.36 to 0.62	ASTM D 1652
3.3.2	4,4'-Diaminodiphenyl Sulfone	28.0 to 34.0%	4.5.2
3.3.3	Boron Trifluoride Amine Complex	0.5 to 1.5%	4.5.3
3.3.4	Epoxy Diglycidyl Ester Resin	10.0 to 16.0%	ARP1610
3.3.5	Thermal Analysis by Differential Scanning Colorimetry (DSC)	$-T_{peak}$ 202 to 222 °C (396 to 432 °F)	4.5.4
3.3.6	Resin Rheology Flow Number, minutes/poise	5.0 to 10.0	4.5.5

3.4 Quality:

The resin, as received by purchaser, shall be uniform in quality and condition, and free from foreign materials and from contaminants detrimental to usage of the resin.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

(R)

The vendor of resin shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the resin conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for volatile content (3.2) and epoxy content (3.3.1) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of resin to a purchaser, when a change in ingredients 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 and Testing:
(R)

Shall be as follows:

4.3.1 For Acceptance Tests: Each lot of resin shall be sampled at random to provide sufficient resin 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 resin 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.

4.3.1.2 A batch shall be the quantity of material run in a reactor or mixer at one time.

4.3.1.3 When a statistical sampling plan has been agreed upon by purchaser and
(R) vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6 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 resin shall be approved by purchaser before resin for production use is supplied, unless such approval be waived by purchaser. Results of tests on production resin 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 resin which are essentially the same as those used on the approved sample. 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 ingredients and/or processing and, when requested, sample resin. Production resin made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

Shall be as follows:

4.5.1 Volatile Content: Shall be determined by accurately weighing (W_1) to the nearest 0.0001 gram, four samples weighing not less than 1.0 gram each. Using porcelain crucibles (preferably covered) previously brought to constant weight by igniting at 845 °C ± 25 (1553 °F ± 45), dry samples in a circulating-air oven at 175 °C ± 5 (347 °F ± 9) for 15 minutes. Cool in a desiccator and reweigh (W_2). Calculate the individual results of the four determinations using Equation 1.

$$\text{Volatile Content, \%} = \frac{(W_1 - W_2)}{W_1} \times 100 \qquad \text{(Eq. 1)}$$

4.5.1.1 Report both the individual results and the arithmetic mean.

4.5.2 4,4'-Diaminodiphenyl Sulfone (DDS) Content: Shall be determined by infrared absorption spectroscopy (IR) in accordance with ARP1610. The percent by weight DDS shall be reported.

4.5.3 Boron Trifluoride Amine Complex Content: Shall be determined by atomic absorption (AA) in accordance with ARP1610. The percent by weight accelerator shall be reported.

4.5.4 Thermal Analysis by Differential Scanning Calorimetry (DSC): Shall be used to measure the exotherm peak temperature for the self-curing reaction in accordance with ARP1610. The temperature obtained for a heat rate of 5 °C/minute (9 °F/minute) shall be reported.

4.5.5 Resin Rheology, Flow Number:

4.5.5.1 Remove epoxy resin matrix from the freezer and allow it to warm to room temperature before opening the package. Hydraulically press resin samples between teflon cloths to approximately 0.005 inch (0.13 mm) thickness and place them, uncovered, in a desiccator at room temperature for 24 hours prior to testing.

4.5.5.2 After desiccation, cut 24-mm diameter circular resin wafers for rheology tests.

4.5.5.3 Determine the flow characteristics of the resin by a spectrometer in the parallel plate mode, using the following instrumental parameters and test conditions:

Sample Plates: 25 mm disposable
Gap Setting: 0.5 mm ± 0.01
Starting Temperature: 50 °C (122 °F)
Strain: 50%
Frequency: 10 rads/second
Heating Rate: 50 °C (122 °F) (start) to gel temperature at 1 °C/minute (2 °F/minute)
Program Plot: Viscosity versus time. Plot data to 10^3 poise.

4.5.5.4 Calculate flow number by integrating Equation 2.

$$Flow\ Number = \int_{t_o}^{t_{gel}} \frac{dt}{n} \qquad \text{(Eq. 2)}$$

$$= \frac{minutes}{poise}.$$

where: t = time (minutes)
n = time dependent viscosity (poise)
t_{gel} = t at n = 10^3 poise

4.5.5.5 Report the flow number as $\frac{minutes}{poise}$.

4.6 Reports:

The vendor of resin shall furnish with each shipment a report showing the results of tests for volatile content and epoxy content, including copies of thermograms and chromatograms, and stating that the resin conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3727A, vendor's product designation, date of manufacture, quantity, and results to be reported (See 4.5.1, 4.5.2, 4.5.3, and 4.5.4).

4.6.1 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 resin for production use. Each request for modification of resin formulation shall be accompanied by a revised data sheet for the proposed formulation.

4.7 Resampling and Retesting:
(R)

If any specimen used in the above tests fails to meet the specified requirements, disposition of the resin may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the resin represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 A lot of resin may be packaged in small quantities and delivered under the basic lot approval provided lot identification is maintained.

5.1.2 Resin shall be packaged in airtight containers and maintained at a temperature not higher than -18 °C (0 °F). Type and size of containers shall be as agreed upon by purchaser and vendor.