

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 3688A
Superseding AMS 3688

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ADHESIVE, FOAMING, HONEYCOMB CORE SPLICE, STRUCTURAL
-67° to +180°F (-55° to +80°C)

1. SCOPE:

1.1 Form: This specification covers a foaming-type, heat-curing, resin-base adhesive in the form of paste or sheet.

1.2 Application: Primarily for use in splicing aluminum alloy or nonmetallic honeycomb core and for providing a shear tie between core edges and inserts or edge members in honeycomb assemblies for use over the range -67° to +180°F (-55° to +80°C). It is useful for filling gaps between core faces which are inserted into channels or similar areas where bonding pressure cannot be obtained.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) 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

AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn
(2024-T3 Flat Sheet, -T351 Plate)

AMS 4348 - Honeycomb Core, Aluminum Alloy, Corrosion Inhibited, for
Sandwich Construction, 5052, 350 (175)

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

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2.2.1 Military Specifications:

MIL-C-7438 - Core Material, Aluminum, for Sandwich Construction
MIL-A-25463 - Adhesive, Film Form, Metallic Structural Sandwich Assemblies

2.2.2 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Material: The adhesive shall be a heat-curing (nominally 250°F (120°C)) resin system containing fillers and foaming agents as necessary to meet the requirements of 3.2 and 3.3. The adhesive shall have low sagging properties to ensure complete filling of core-splice gaps when splices are cured in a vertical position. Adhesive shall be suitable for splicing nonperforated honeycomb core without damage to core node bonds located adjacent to the splice.

3.1.1 Sheet Adhesive: Shall be supplied as an unsupported sheet with a suitable nonadhering separator film on both surfaces.

3.1.2 Paste Adhesive: Shall be supplied as a thixotropic paste, single-component or two-part system, suitable for extrusion from a disposable cartridge or caulking gun.

3.2 Properties of Uncured Adhesive: Adhesive, as received, shall conform to the following requirements; tests shall be performed on the adhesive supplied and in accordance with test procedures specified herein:

3.2.1 Storage Life:

3.2.1.1 Single component adhesive, packaged as specified herein, shall meet
Ø the requirements of 3.3 after storage at a maximum temperature of 0°F (-18°C) for up to 3 months from date of receipt from the manufacturer.

3.2.1.2 Two-part paste system, as specified herein, shall meet the requirements of 3.3 after storage at the temperature and for the time specified by the
Ø manufacturer, but not less than 3 months. Manufacturer's specified storage life shall begin at date of receipt from the manufacturer.

3.2.2 Working Life: Single-component adhesive, and two-part paste systems mixed in accordance with manufacturer's instructions, shall meet the requirements
Ø of 3.3 for any time up to 48 hr after exposure to a relative humidity of 50 - 70% and a temperature of 70° - 80°F (21° - 27°C); paste adhesive shall remain extrudable for this time period.

- 3.3 Properties of Cured Adhesive: Shall be as follows, determined on specimens
 Ø prepared as in 4.5 and cured at $250^{\circ}\text{F} + 10$ ($120^{\circ}\text{C} + 5$) for 60 min. ± 5
 using a heat-up rate of 3 - 5 F (2 - 3 C) deg per minute.

3.3.1 Curing Properties:

- | | | | |
|---------|-----------------------------------|-------------------|-------------------|
| 3.3.1.1 | Sagging, max | 0.05 in. (1.3 mm) | 4.5.1 |
| 3.3.1.2 | Expansion Ratio, min | 1.7 | 4.5.2 or
4.5.3 |
| 3.3.1.3 | Peak Exotherm
Temperature, max | 350°F (177°C) | 4.5.4 |

3.3.2 Cured Properties:

- | | | | |
|---------|-------------------------------|--|-------|
| 3.3.2.1 | Density, max | 40 lb per cu ft (640 kg/m ³) | 4.5.5 |
| 3.3.2.2 | Beam Shear
Ø Strength, min | | 4.5.6 |
| | At -67°F (-55°C) | 720 psi (4.96 MPa) | |
| | At -75°F (24°C) | 720 psi (4.96 MPa) | |
| | At 180°F (82°C) | 500 psi (3.45 MPa) | |

- 3.4 Quality: Adhesive, as received by purchaser, shall be uniform in quality
 Ø and condition, clean, smooth, homogeneous, and free from foreign materials
 and from imperfections detrimental to usage of the adhesive.

- 3.5 Tolerances of Sheet Adhesive: Thickness shall be as specified, ± 0.010 in.
 (+0.25 mm). Width and length shall be 12 x 24 in. (300 x 600 mm) or as
 Ø specified, ± 0.250 in. (+6 mm), -0.125 in. (-3 mm). Width and length of
 specially slit foam shall be as specified, ± 0.030 in. (± 0.75 mm).

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of adhesive shall supply all
 samples for vendor's tests and shall be responsible for performing all
 Ø 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 adhesive conforms
 to the requirements of this specification.

4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Tests to determine conformance to requirements for
 Ø expansion ratio (3.3.1.2) and beam shear strength at 75°F (24°C) (3.3.2.2)
 are classified as acceptance tests and shall be performed to represent
 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 adhesive 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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient adhesive shall be taken at random from each lot to perform all required tests. The number of tests 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 adhesive produced in a single production run from the same batches of raw materials and presented for vendor's inspection at one time. An inspection lot shall not exceed 500 lb (225 kg) and may be packaged and delivered in small quantities under a basic lot approval as long as the lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) for the adhesive 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. Only one panel need be tested for peak exotherm temperature (3.3.1.3).

4.4 Approval:

4.4.1 Sample adhesive shall be approved by purchaser before adhesive for production use is supplied, unless such approval be waived by purchaser. Results of tests on production adhesive 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 adhesive which are essentially the same as those used on the approved sample adhesive. 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 processing and, when requested, sample adhesive. Production adhesive made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Sagging: The sagging characteristics of an adhesive shall be determined by fabricating a beam shear specimen in accordance with 4.5.6.1, with no face bonding adhesive between the upper facing and the core and using a 0.020 in. (0.50 mm) thick upper facing. After curing as in 3.3, remove the upper facing, observe the degree of fill of the splice, and measure the sag of the splice adhesive from the upper face of the core. Evidence of adherence of foam adhesive on the upper face over the entire splice area will also constitute evidence of acceptable sagging characteristics.

4.5.2 Expansion Ratio for Sheet Adhesives:

4.5.2.1 Cut three 2 x 2 in. (50 x 50 mm) pieces of sheet adhesive and measure the thickness of each piece at each corner and at the center to the nearest 0.01 in. (0.3 mm).

4.5.2.2 Place the specimens separately on a caul plate which has been covered with a suitable parting agent to prevent adhesion of the test pieces to the plate.

4.5.2.3 Place the caul plate with the specimens in a circulating-air oven which is at a temperature not higher than 80°F (27°C) and raise the temperature to 250°F + 10 (120° + 5) at a rate of 3 - 5 F (2 - 3 C) deg per minute. Maintain the specimens at 250°F + 10 (120° + 5) for 60 min. + 5 and cool to room temperature.

4.5.2.4 Measure the thickness of each specimen at each quadrant to the nearest 0.01 in. (0.3 mm) and calculate the expansion ratio as follows:

$$\text{Expansion Ratio} = \frac{\text{Average thickness of each specimen after cure}}{\text{Average original thickness of the specimen}}$$

4.5.3 Expansion Ratio for Paste Adhesives:

4.5.3.1 Clamp a sheet of 0.100 in. (2.50 mm) thick aluminum alloy having a 2.0 in. (50 mm) diameter hole in the center to a caul plate. All metal surfaces, including the inside edges of the hole, shall be covered with a suitable parting agent to prevent adhesion of the test specimen to the tool.

4.5.3.2 Extrude sufficient paste adhesive to fill the hole in the sheet. Using a knife blade or suitable scraper, wipe across the hole to fair the adhesive flush with the upper surface of the sheet.

4.5.3.3 Place the caul plate with the specimens in a circulating-air oven which is at a temperature not higher than 80°F (27°C) and raise the temperature to 250°F + 10 (120° + 5) at a rate of 3 - 5 F (2 - 3 C) deg per minute. Maintain the specimens at 250°F + 10 (120° + 5) for 60 min. + 5 and cool to room temperature.

- 4.5.3.4 Measure the thickness of each specimen at each quadrant to the nearest 0.01 in. (0.3 mm) and calculate the expansion ratio as follows:

$$\text{Expansion Ratio} = \frac{\text{Average thickness in in. (mm) of each specimen after cure}}{0.10 \text{ in. (2.5 mm)}}$$

- 4.5.4 Peak Exotherm Temperature: Shall be determined on a test panel consisting of two 0.020 x 12.0 x 12.0 in. (0.50 x 300 x 300 mm) aluminum alloy faces and a 2.00-in. (50-mm) thick, 3/16-in. (4.8-mm) cell size nonmetallic core as shown in Fig. 1. The core shall be spliced in the center of the panel. A suitable thermocouple shall be inserted in the approximate geometric center of the splice. The panel shall be cured as specified in 3.3. The maximum temperature of the thermocouple during cure of the test panel shall be reported.

4.5.5 Density of Cured Adhesive:

- 4.5.5.1 Measure the width and length or the diameter of the cured specimens used in the expansion ratio determinations (4.5.3) to the nearest 0.01 in. (0.3 mm).
- 4.5.5.2 Weigh each specimen to the nearest milligram.
- 4.5.5.3 Using the average thickness of each specimen obtained during the expansion ratio determination, calculate the density of the cured adhesive as follows:

$$\text{Density, lb/cu ft} = \frac{\text{Weight, g}}{\text{Volume, cu in.}} \times 3.81$$

$$\text{Density, kg/m} = \frac{\text{Weight, g}}{\text{Volume, cm}^3} \times 1000$$

4.5.6 Beam Shear Strength:

- 4.5.6.1 Specimen Preparation: Beam shear test panels shall be prepared using 0.125 in. (3.12 mm) thick AMS 4037, or equivalent, aluminum alloy sheet facings and 0.625 in. (15.62 mm) thick 7.9-1/4-40 (5052) T aluminum alloy honeycomb core conforming to AMS 4348 or to MIL-C-7438. Butting of core sections and splice locations shall be as shown in Fig. 2. Test panels shall be bonded using a face-to-core adhesive conforming to MIL-A-25463, Type 1, suitable for curing at 250°F (120°C). Test panels shall be cured in accordance with 3.3 using 50 psi $\pm$ 5 (350 kPa $\pm$ 0.03).

- 4.5.6.2 Beam shear testing shall be conducted as specified in MIL-C-7438 for flexural shear. Tests shall be conducted at the temperature specified in 3.3.2.2 within $\pm 2^{\circ}\text{F}$ ($\pm 1^{\circ}\text{C}$) after not less than 10 min. at the test temperature as verified by a thermocouple attached to the specimen in the splice material.

4.6 Reports:

- 4.6.1 The vendor of adhesive shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the adhesive conforms to the other technical requirements of this specification. The report shall include the purchase order number, AMS 3688A, vendor's material designation, lot number, date of manufacture, form, and quantity. For two-part paste adhesives, it shall also include the manufacturer's recommended time and temperature storage conditions.
- 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 adhesive for production used. Each request for modification of formulation shall be accompanied by a revised data sheet for the proposed formulation.
- 4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 3688A, contractor or other direct supplier of adhesive, supplier's material designation, part number, and quantity. When adhesive for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of adhesive to determine conformance to the requirements of this specification, and shall include in the report a statement that the adhesive conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.
- 4.7 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the adhesive 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 adhesive represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

- 5.1.1 Sheet Adhesive: Shall be supplied flat with each sheet protected on both sides by nonadherent separator film. Sheets shall be packaged individually, or as specified, in sealed bags of suitable nonadherent material to prevent penetration of moisture or loss of volatiles.

5.1.2 Paste Adhesive: Shall be packaged in suitable containers or in disposable polyethylene cartridges, as ordered, for use in extrusion equipment. Each container or cartridge shall be sealed to prevent penetration of moisture or loss of volatiles.

5.1.3 Packing: The protected sheets, containers, or cartridges shall be packed in an exterior container capable of protecting the adhesive adequately during shipment and storage.

5.1.4 Each unit shall be identified with not less than the following information, using characters of such size as to be legible and which will not be obliterated by normal handling:

ADHESIVE, FOAMING, HONEYCOMB CORE SPLICE, -67° to +180°F (-55° to +80°C)
AMS 3688A

FORM (Sheet or Paste)

MANUFACTURER'S MATERIAL DESIGNATION _____

PURCHASE ORDER NUMBER _____

DATE OF MANUFACTURE _____

LOT NUMBER _____

QUANTITY OR THICKNESS _____

Ø PERISHABLE - STORE BELOW 0°F (-18°C) (or, for two-part paste, as specified by the manufacturer including storage life time)

5.1.4.1 Sheet Adhesive: Shall be identified by marking on at least one of the protective separator films on each sheet.

5.1.4.2 Paste Adhesive: Shall be identified by marking on each container or cartridge.

5.1.5 Marking of Exterior Package: Each exterior shipping container shall be legibly marked with not less than the information of 5.1.4 in such a manner that the markings will not smear or be obliterated during normal handling or use.

5.1.6 Containers of adhesive shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the adhesive to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.7 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1, 5.1.2, 5.1.3, and 5.1.6 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.