3M

Scotch-Weld™

Structural Core Splice Adhesive

AF 3024

Technical Data **Issue No. 2**

Introduction

3M™ Scotch-Weld™ Structural Core Splice Adhesive AF 3024 is a 250°F (121°C) to 350°F (176°C) curing, low density, expandable core splice adhesive film. AF 3024 was designed for filling mismatch areas or reinforcing and splicing honeycomb core. It offers the following advantages:

- High expansion (250%)
- Low sag during cure
- Low volatile loss
- High performance from -67°F to 350°F (-55°C to 176°C)
- Compatible with 3M™ Scotch-Weld Adhesive Films and Composites
- Full expansion even at slow heat up rates (.5°F/minute)

Description

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

	100 mil	50 mil	25 mil
Color:	Off White	Off White	Off White
Base:	Epoxy	Epoxy	Epoxy
Form:	Unsupported Film	Unsupported Film	Unsupported Film
Thickness:	100 ± 10 mil	50 ± 5 mil	25 ± 5 mil
Weight (Approx):	.5 lb/ft^2 (2.44 Kg/m^2)	0.25 lb/ft^2 (1.22 Kg/m^2)	0.13 lb/ft^2 (.61 Kg/m^2)
Expansion Ratio:	2.5-2.6	2.5-2.6	2.4-2.5
Volatile Loss (250°F cure):	Less than 1%	Less than 1%	Less than 1%
Uncured Density (approximate):	60 lb/ft^3 (.96 g/cc)	60 lb/ft^3 (.96 g/cc)	60 lb/ft^3 (.96 g/cc)

Available as 10" x 24" flat sheets and in various roll length and widths.

Product Performance

1. Volatile Content:

The volatile content for AF 3024 was determined by measuring the weight loss of 4" x 4" square sample of AF 3024 during cure. The polyethylene separating liner was removed prior to cure.

	250°F (121°C) for 90 minutes 5-10°F rise rate/minute	350°F (176°C) for 60 minutes 5-10°F rise rate/minute
Volatile content for 25 mil:	Less than 1%	Less than 1.5%
Volatile content for 50 mil:	Less than 1%	Less than 1.5%
Volatile content for 100 mil:	Less than 1%	Less than 1.5%

2. Cured Density:

The free film cured density for AF 3024 25, 50 and 100 mil was determined by weighing the cured volatile content specimens and dividing by the volume of the specimens.

Cured Density (Typical)	23-25 lb/ft^3 (.37-.40 g/cc)

3. Expansion During Cure:

The free film expansion ratio for AF 3024 25, 50 and 100 mil was determined by dividing the average cured thickness of the volatile content specimens by the average original (uncured) thickness.

	250°F (121°C) Cure	350°F (176°C) Cure
Expansion Ratio:		
Expansion Ratio (Typical)	2.4-2.5	2.5-2.6

4. Slump or Sag:

Sag during cure was measured by laminating 4 layers of 25 mil, 2 layers of 50 mil, or 1 layer of 100 mil AF 3024, 1" x 2", on a 4" x 7" x .063" clean aluminum panel. It was then placed in a vertical position with the 2" dimension horizontal. A scribe line was made along the bottom 2" long edge of the AF 3024. This assembly was cured as given below and slump or sag is the distance the AF 3024 flowed beyond the scribe line.

Cure Cycle:	250°F (121°C), 90 minutes 4-6°F/minute 0 PSIG	350°F (176°C), 90 minutes 4-6°F/minute 0 PSIG
Sag or Slump: (typical)	1/4" (.6 cm)	3/8" (1 cm)

Product Performance
(continued)

5. Tube Shear Strength:

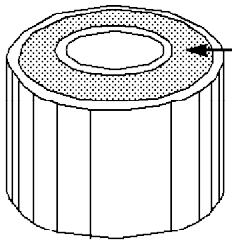
a. Original Properties

The tube shear strength has been determined on AF 3024, 50 mil, using the procedure outlined in 3M Test Method C-280. Tube shear specimens are prepared by placing 45 ± 0.2 grams of AF 3024 between the walls of (2) 9" long tubes and cured in an oven. After cure, the tubes were cut into 0.5" specimens as shown below and tested by pushing out the inside tube at a rate of 0.05"/minute.

Test Specimen

$$\text{Tube Shear} = \frac{P}{0.784 \text{ in.}}$$

P = force (lb)



Core Splice Adhesive

Outer Tube – 1" OD, 0.049" thick
5052-0 bare aluminum

Inner Tube – 1/2" OD, 0.049" thick
5052-0 bare aluminum

Cure Cycle A: 250°F (121°C) for 90 minutes, 4-6°F rise rate/minute
Cure Cycle B: 350°F (176°C) for 60 minutes, 4-6°F rise rate/minute
Test Results (Typical Averages)

Test Temperature °F	(°C)	Cure Cycle A psi	(MPa)	Cure Cycle B psi	(MPa)
-67	(-55)	1450	(10.0)	2200	(15.2)
75	(24)	1430	(9.9)	2070	(14.3)
180	(82)	1550	(10.7)	1550	(10.7)
250	(121)	700	(4.8)	1100	(7.6)
350	(176)	—	—	300	(2.1)

b. Fluid Immersion Tests:

Tube shear specimens prepared from AF 3024, 50 mil, and cured using Cure Cycle B were immersed for the indicated times and then tested at 75°F (24°C):

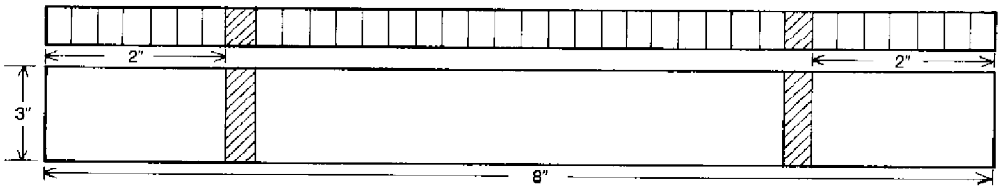
Immersion Fluid	Immersion Time, Hours	Tube Shear Strength psi	(MPa)
Al Jet Fuel	720	1312	(9.0)
JP-4 Jet Fuel	720	1595	(11.0)
Skydrol® 500B/4	720	1287	(8.9)
Ethylene glycol	720	1369	(9.4)
Isopropyl alcohol	720	1565	(10.8)
Methyl ethyl ketone	360	2147	(14.8)
1,1,1 trichloroethylene	360	1458	(10.1)
Salt water	720	1359	(9.4)
Control (no immersion)	0	1522	(10.5)
Water boil (tested at 250°F [121°C])	24	881	(6.1)
Control (tested at 250°F [121°C])	0	1366	(9.4)

Product Performance *(continued)*

6. Flexural Shear Strength:

a. 350°F (176°C) cure, 1/8" cell, 25 mil adhesive

Flexural shear strength of AF 3024, 25 mil, was determined by using a 3" x 8" beam flexure specimen with a splice made with AF 3024, 25 mil, located 2" from both ends of the flexure specimen as shown below:



Adherends: 2024-T3 bare aluminum, .063" thick.

Surface Preparation: FPL etch.

Primer: 3M™ Scotch-Weld™ Adhesive Primer EC-3917.

Primer Application: Spray coat to approximately 0.1 mil dry thickness.

Primer Dry: 60 minutes air dry followed by 60 minutes at 250°F (121°C).

Face Sheet Adhesive: 3M™ Scotch-Weld™ Adhesive Film AF 143-2 (0.1 lb/ft^2).

Honeycomb Core: 8.1 lb/ft^3-1/8" cell-1/2" thick – 5052 alloy – 2 mil foil – nonperforated.

Core Splice: Two splices, 2" in from each end of specimen. Spliced with one layer of AF 3024, 25 mil.

Cure Cycle: 350°F (176°C) for 60 minutes, 4-5°F rise rate/minute, 25 psig.

Test: 3" x 8" specimens tested for flexural shear strength using double point loading at .02"/minute. (Reference ASTM C 393).

Test Procedure:

Core shear strength determined according to ASTM C 393 using the following conditions:

Load Pad: Double point loading.

Load Rate: 0.02"/minute.

Span: 6 inches.

$$\text{Core Shear (psi)} = \frac{P}{b\,(t + t_c)}$$

Where: P = Load at failure; b = beam width; t = specimens thickness; t_c = core thickness

Test Results:

Test Temperature	Flexural Shear psi	(MPa)
75°F (24°C)	811	(5.6)
350°F (176°C) (10 minute soak)	723	(5.0)

b. 250°F (121°C) cure, 1/8" cell, 25 and 50 mil adhesive

Flexural shear strength was determined using the same procedures as in "6a" above except the face sheet adhesive was AF 163-2K .06 lb/ft^2 and the bonds were cured at 250°F (121°C) instead of at 350°F (176°C).

Test Results:

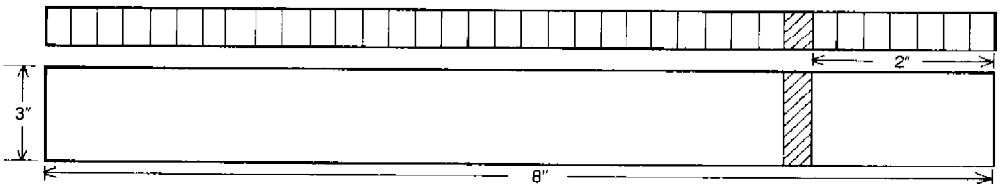
Test Temperature	AF 3024, 25 mil	AF 3024, 50 mil
75°F (24°C)	873 psi (6.0 MPa)	905 psi (6.2 MPa)
250°F (121°C)		358 psi (25 MPa)

Product Performance *(continued)*

6. Flexural Shear Strength ***(continued)*:**

c. 250°F (121°C) cure, 1/8" cell, 50 mil adhesive

Flexural shear strength of AF 3024, 50 mil, was determined by using a 3" x 8" beam flexure specimen with a splice made with AF 3024, 50 mil, located 2" from one end of the flexure specimen as shown below:



Adherends: 2024-T3 alclad aluminum, .063" thick.

Surface Preparation: FPL etch.

Face Sheet Adhesive: 3M™ Scotch-Weld™ Adhesive Film 163-2K 0.6 lb/ft^2.

Honeycomb Core: 8.1 lb/ft^3-1/8" cell-1/2" thick – 5052 alloy – 2 mil foil – nonperforated.

Core Splice: 2" in from one end of specimen. Spliced with one layer of AF 3024, 50 mil.

Cure Cycle: 250°F (121°C) for 60 minutes, 40 psi pressure (rise rate shown below).

Test: 3" x 8" specimens tested for flexural shear strength using double point loading at .02"/minute. (Reference ASTM C 393).

Test Procedure: (same as "6a")

Test Results:

	Flexural Shear	
Test Temperature	**1-2°F rise rate/minute**	**7-8°F rise rate/minute**
75°F (24°C)	848 psi (5.8 MPa)	859 psi (5.9 MPa)
220°F (104°C)	535 psi (3.7 MPa)	542 psi (3.7 MPa)

d. 250°F (121°C) cure, 1/4" cell, 50 mil adhesive

Flexural shear strength of AF 3024, 50 mil was determined by using a 3" x 8" beam flexure specimen with splices made with AF 3024, 50 mil, located 2" from one end of the flexure specimen as shown for "6c" above.

Adherends: 2024-T3 alclad aluminum, .063" thick.

Surface Preparation: FPL etch - unprimed

Face Sheet Adhesive: 3M™ Scotch-Weld™ Adhesive Film AF 163-2K 0.6 lb/ft^2 and .08 lb/ft^2 as indicated below.

Honeycomb Core: 1/4" cell, 5/8" thick – 5052 alloy – 4 mil foil – nonperforated.

Core Splice: 2" in from one end of specimen. Spliced with two layer of AF 3024, 50 mil.

Cure Cycle: 250°F (121°C) for 60 minutes, 25 psi, 3-6°F rise rate/minute.

Test: 3" x 8" specimens tested for flexural shear strength using double point loading at .02"/minute. (Reference ASTM C 393).

Test Procedure: (same as "6a")

Test Results:

	Face Sheet Adhesive	
Test Temperature	**AF 163-2K .06 lb/ft^2**	**AF 163-2 .08 lb/ft^2**
75°F (24°C)	850 psi (5.9 MPa)	910 psi (6.3 MPa)

Product Performance *(continued)*

7. Metal to Honeycomb – Flatwise Tensile Strength

All properties were measured on 2" x 2" honeycomb core bonded to 2" x 2" by 1½" tensile blocks with AF 3024, 50 mil, using the procedure of MIL-A-25463.

Adherends: 2024-T3 bare aluminum blocks FPL etched
Honeycomb Core: 5052 alloy, 3/16" cell, 1/2" thick, 2 mil foil, nonperforated
Cure Cycle: 350°F (176°C) for 60 minutes, 10°F (6°C) rise rate/minute, 35 psi

Test Temperature:		AF 3024 50 mil	
°F	(°C)	psi	(MPa)
75	(24)	939	(6.5)
300	(149)	109	(.8)

8. Tube Shear Strength After Salt Spray and Water Boil Aging

The following are tube shear strengths tested per Test Number 5 within the Product Performance section of this data sheet. Cure cycle was 250°F (121°C), 60 min, 4-5°F/minute rise.

	AF 3024 50 mil Tested @ 75°F (24°C)	
Conditioning	psi	(MPa)
*30 day Salt Spray @95°F (35°C)	1057	(7.3)
*3 day Water Boil	1368	(9.4)

***Note:** Tubes primed with 3M™ Scotch-Weld™ Adhesive Primer EC-3960 prior to immersion and test.

9. Open Time Data After 10 Days Aging at 90°F (32°C)

The following are tube shear strengths tested per Test Number 5 within the Product Performance section of this data sheet. Prior to cure, the AF 3024, 50 mil, was aged for 10 days at 90°F (32°C). Cure cycle was 250°F (121°C), 60 minutes, 4-5°F/minute rise.

	AF 3024 50 mil Tested @ 75°F (24°C)	
Conditioning	psi	(MPa)
*75°F (24°C)	1495	(10.3)
*3 day Salt Spray @95°F (35°C)	1283	(8.8)
*3 day Water Boil	1465	(10.1)

***Note:** Tubes primed with 3M™ Scotch-Weld™ Adhesive Primer EC-3960 prior to immersion and test.

Scotch-Weld™
Structural Core Splice Adhesive
AF 3024

Product Application

The product performance data were developed using the following suggested procedures.

1. **Surface Preparation:**

   A thoroughly cleaned, dry, grease-free surface is recommended for maximum performance. Cleaning methods which will produce a breaktree water film on metal surfaces generally satisfactory.

   A. Aluminum Skins and Tubes (3M Test Method C-2803 or ASTM D 2651)

   1. Alkaline Degrease – Immerse skins in Oakite 164 solution (9-11 oz./gallon water) at 190 ± 10°F (82 to 93°C) for 15 ± 5 minutes. Rinse in generous quantities of clear running distilled, deionized, or tap water.
   2. Optimized FPL Etch Solution (1 liter)

Material	Amount
Distilled Water	700 ml plus balance of liter (see below)
Sodium Dichromate	28 to 67.3 grams
Sulfuric Acid	287.9 to 310.0 grams
Aluminum Chips	1.5 grams/liter of mixed solution

      To prepare 1 liter of this solution, dissolve sodium dichromate in 700 ml of distilled water. Add sulfuric acid and mix well. Add additional distilled water to fill 1 liter. Heat mixed solution to 150 to 160°F (66 to 71°C). Dissolve 1.5 grams of 2024 bare aluminum chips per liter of mixed solution. Gentle agitation will help aluminum dissolve in about 24 hours.

      To FPL etch panels, place them in the above solution at 150 to 160°F (66 to 71°C) for 12 to 15 minutes.

      Note: Review and follow safety and precautionary information provided by chemical supplier prior to preparation of this etch solution.
   3. Rinse – Rinse face sheets in clear running tap water.
   4. Dry – Air dry 15 minutes; force dry 10 minutes minimum at 140°F (60°C) maximum.

   B. Aluminum Honeycomb Core

   1. Soak in clean aliphatic naptha* (to conform to TT-N-95A) for five minutes at room temperature. Dry 10 minutes at 140°F (60°C) maximum.
   2. Optional – Immerse in acid etching solution above in A. for (2) minutes at 150 ± 5°F (66 to 71°C). Rinse, air dry and force dry in similar manner to skin panels.

   *When using solvents, extinguish all ignition sources and follow the manufacturer's precautions and directions for use.

2. **Film:**

   Care should be taken to avoid contaminating adhesive and cleaned or primed aluminum by any substance which will hinder wetting action of the adhesive.

   A. Film Application

   1. Cut portion of film to be used from roll with protective liners in place.
   2. Remove paper liner from one side of the film.
   3. Place film on metal or edge or honeycomb core using the remaining liner as a protective cover.
   4. On metal surfaces, roll film into position with a rubber roller to insure that no air is trapped between film and metal.
   5. Remove second protective liner.
   6. Assemble parts and cure.

Product Application
(continued)

3. Cure Cycle:

A. General

The tack, flow, expansion, and cure initiation temperature for AF 3024 is a time-temperature relationship and depends upon the rate of heat input.

Normally, AF 3024 will begin to cure when a temperature of 225°F (107°C) is reached. The rate of heat input affects the degree of expansion. Rise rates to cure temperature lower than .5°F/min (.3°C/min) generally result in less expansion while rise rates above 10°F/min (6°C/min) result in higher expansion.

For AF 3024 minimum cure temperature for 230°F (110°C) is suggested to effect a useful cure in reasonable length of time (approximately 90 minutes).

Full or partial vacuum applied during cure will cause excessive expansion of AF 3024.

Storage and Handling

Storage at 0°F (-18°C) or below is suggested for AF 3024 to obtain maximum shelf life. Our data indicates, however, that no loss in mechanical properties is obtained after aging at temperatures up to 90°F (32°C) for 10 days.

Care must be taken when handling AF 3024 at low temperatures because it can easily crack. Warm AF 3024 to ambient conditions in the sealed package to prevent moisture condensation on the adhesive surface.

3M Standard shelf life of AF 3024 is 6 months from date of shipment from 3M when stored at 0°F (-18°C) or lower.

Precautionary Information

Refer to Product Label and Material Safety Data Sheet for health and safety information before using this product. For additional health and safety information, call 1-800-364-3577 or (651) 737-6501.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free (800) 235-2376. Our fax number is (417) 869-5219. Address correspondence to: 3M Aerospace Central, 3211 E. Chestnut Expressway, Springfield, MO 65802.

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ISO 9002

This Adhesives Division product was manufactured under a 3M quality system registered to ISO 9002 standards.

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