Scotch-Weld™
Structural Adhesive Film
AF 3109-2

Technical Data **May, 2002**

Introduction

3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2 is a thermosetting, modified epoxy adhesive film. AF 3109-2 was designed for bonding honeycomb and metal-to-metal components where high strength at 300°F (149°C) is required.

Advantages

- Cure temperatures as low as 225°F (107°C) and up to 350°F (177°C).
- High and moderate tack versions available.
- Excellent performance in metal-to-metal and honeycomb sandwich applications over a temperature range of -67° to 300°F (-55 to 149°C).
- Improved resistance to high moisture pre-cure conditions.
- Can be cured at low pressure (low volatile by-products).
- Unsupported version can be reticulated on honeycomb.

Product Description

Product Name	Scotch-Weld AF 3109-2K	Scotch-Weld AF 3109-2K	Scotch-Weld AF 3109-2K	Scotch-Weld AF 3109-2U	Scotch-Weld AF 3109-2U
Color:	Blue	Blue	Blue	Blue	Blue
Carrier:	Knit Scrim	Knit Scrim	Knit Scrim	Unsupported	Unsupported
Tack:	High	High	High	Moderate	Moderate
Weight: (± .005 lb/ft^2)	.085 lb/ft^2	.060 lb/ft^2	.045 lb/ft^2	.035 lb/ft^2	.015 lb/ft^2

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Typical Product Performance

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

All data in this section was developed using 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960 primed aluminum panels and an adhesive cure cycle of 60 minutes at 250°F (121°C) and 40 psi. A 4-5°F (2-3°C)/minute rise rate to cure temperature was used. Parts were cooled below 200°F (93°C) before removing from autoclave.

1. Metal to Metal – Overlap Shear

All properties were measured on 1" wide, 1/2" overlap specimens cut from 0.063" thick 4" x 7" bonded panels of 2024-T3 alclad aluminum. Tests were conducted per MMM-A-132.

Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 psi	(MPa)	Scotch-Weld AF 3109-2K 0.060 Wt. Scotch-Weld EC-3960 psi	(MPa)	Scotch-Weld AF 3109-2K 0.045 Wt. Scotch-Weld EC-3960 psi	(MPa)	Scotch-Weld AF 3109-2U 0.035 Wt. Scotch-Weld EC-3960 psi	(MPa)	Scotch-Weld AF 3109-2U 0.015 Wt. Scotch-Weld EC-3960 psi	(MPa)
-67 (-55)	5200	(35.9)	5500	(37.9)	5700	(39.3)	5970	(41.2)	5270	(36.3)
75 (23)	6075	(41.9)	5800	(40.0)	5800	(40.0)	5600	(38.6)	5340	(36.8)
250 (121)	3500	(24.1)	3400	(23.4)	2750	(19.0)	3100	(21.4)	3200	(22.1)
300 (150)	1740	(12.0)	1600	(11.0)	1400	(9.7)	1833	(12.6)	2000	(13.8)

2. Metal to Metal – Blister Detection

Properties measured on 1" x 7" blister detection specimens with a 0.218" notch cut to form the 1/2" overlap. Aluminum was 0.063" 2024-T3 bare.

Test Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 psi	(MPa)
75 (23)	4307	(29.7)
270 (132)	3167	(21.8)
300 (149)	1860	(12.8)

3. Metal to Metal – Floating Roller Peel

Peel strength was measured on 1/2" wide specimens cut from 3" x 8" x .063" 2024-T3 bare aluminum panels bonded to 3" x 10" x .025" 2024-T3 bare peeling panel.

Test Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 piw	(N/25mm)	Scotch-Weld AF 3109-2K 0.060 Wt. Scotch-Weld EC-3960 piw	(N/25mm)	Scotch-Weld AF 3109-2K 0.045 Wt. Scotch-Weld EC-3960 piw	(N/25mm)	Scotch-Weld AF 3109-2U 0.035 Wt. Scotch-Weld EC-3960 piw	(N/25mm)	Scotch-Weld AF 3109-2U 0.015 Wt. Scotch-Weld EC-3960 piw	(N/25mm)
-67 (-55)	48	(214)	—	—	—	—	45	(200)	—	—
75 (23)	45	(200)	49	(218)	48	(214)	29	(129)	28	(125)
300 (149)	25	(111)	—	—	—	—	23	(102)	—	—

Typical Product Performance *(continued)*

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

4. Metal to Metal Honeycomb – Climbing Drum Peel

Peel strength was measured on 3" x 8" honeycomb sandwich panels containing a 3" x 10" peel face sheet. Tests were conducted per MIL-A-25463.

Skin: .020" thick 2024-T3 bare aluminum

Core: 0.50" thick, 1/4" cell, 4 mil, 5052 aluminum

Test Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 in•lb/in	(mN/m)	Scotch-Weld AF 3109-2K 0.060 Wt. Scotch-Weld EC-3960 in•lb/in	(mN/m)	Scotch-Weld AF 3109-2U 0.035 Wt. Scotch-Weld EC-3960 in•lb/in	(mN/m)	Scotch-Weld AF 3109-2U 0.015 Wt. Scotch-Weld EC-3960 in•lb/in	(mN/m)
75 (23)	27.0	(120.1)	15.9	(70.7)	10.3	(45.8)	4.6	(20.5)
300 (149)	10.0	(44.5)	—	—	5.0	(22.2)	—	—

5. Metal to Honeycomb – Flatwise Tensile

All properties were measured on 2" x 2" honeycomb sandwich bonds using the procedure of MIL-A-25463.

Skin: 0.02" thick 2024-T3 bare

Honeycomb Core: 0.50" thick, 1/4" cell, .004" foil, 5052 aluminum

Test Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 psi	(MPa)	Scotch-Weld AF 3109-2U 0.035 Wt. Scotch-Weld EC-3960 psi	(MPa)
75 (23)	1750	(12.1)	1100	(7.6)
300 (149)	275	(1.9)	180	(1.2)

6. Metal to Honeycomb – Beam Flexure

Tested as per MIL-A-25463 method on etched .063" thick 2024-T3 bare metal and 1/4" cell, 5052, 4 mil 1/2" thick core.

Test Temperature °F (°C)	Scotch-Weld AF 3109-2K 0.085 Wt. Scotch-Weld EC-3960 lb	(kN)	Scotch-Weld AF 3109-2U 0.035 Wt. Scotch-Weld EC-3960 lb	(kN)
75 (23)	3500	(15.6)	3000	(13.3)
300 (149)	600	(2.7)	375	(1.7)

7. 3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2K 0.085 Wt./3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960 Fatigue and Creep Resistance

Test procedure per MMM-A-132

Creep Rupture @ 180°F (82°C) and 800 psi for 192 hours — 0.000"

Fatigue @ 75°F (23°C), 750 psi @ 10^6 cycles — No Failures

Typical Product Performance *(continued)*

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

8. Relative Humidity Exposure Before Cure of 3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2U (.035 Wt.)/3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960

Exposure: 50% RH and 77°F (23°C) for specified number of days.

Metal: Overlap shear, 2024-T3 clad 4" x 7" x .063" bare, floating roller peel, 3" x 10" x .025" bonded to 3" x 8" x .063" 2024-T3 bare.

Overlap Shear								
	Control		**5 Days**		**10 Days**		**15 Days**	
	psi	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**
75°F (23°C)	5917	(40.8)	5623	(38.8)	5440	(37.5)	5713	(39.4)
250°F (121°C)	2913	(20.1)	2973	(20.5)	2947	(20.3)	2853	(19.7)
Floating Roller Peel	**piw**	**(N/25mm)**	**piw**	**(N/25mm)**	**piw**	**(N/25mm)**	**piw**	**(N/25mm)**
-67°F (-55°C)	63	(280)	65	(289)	65	(289)	69	(307)
75°F (23°C)	65	(289)	56	(249)	55	(245)	51	(227)

9. Scotch-Weld AF 3109-2U (.035 Wt.)/Scotch-Weld EC-3960 Heat Aging Resistance

Notes: Metal: 2024-T3 bare aluminum, FPL etched, primed with EC-3960.

Overlap Shear aged at	**250°F (121°C)**				**300°F (149°C)**				**350°F (177°C)**			
Tested at:	**75°F (23°C)**		**250°F (121°C)**		**75°F (23°C)**		**300°F (149°C)**		**75°F (23°C)**		**350°F (177°C)**	
	psi	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**	**psi**	**(MPa)**
Control (0 Hours)	6360	(43.9)	3167	(21.8)	6360	(43.9)	1820	(12.5)	6360	(43.9)	527	(3.6)
500 Hours	6040	(41.6)	3307	(22.8)	5713	(39.4)	1660	(11.4)	5427	(37.4)	600	(4.1)
1000 Hours	5660	(39.0)	3767	(26.0)	5103	(35.2)	1987	(13.7)	4983	(34.4)	830	(5.7)
2000 Hours	5673	(39.1)	3697	(25.5)	4480	(30.9)	1813	(12.5)	5147	(35.5)	750	(5.2)
5000 Hours	4500	(31.0)	3267	(22.5)	–	–	–	–	4040	(27.9)	1063	(7.3)
10,000 Hours	4980	(34.3)	3533	(24.4)	4093	(28.2)	1660	(11.4)	4463	(30.8)	760	(5.2)

Typical Product Performance *(continued)*

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

10. 3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2 Cure Cycle parameters

Notes: 2024-T3 bare aluminum FPL etched primed with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960.

Honeycomb: 5052, 1/4 in. cell, 4 mil foil

	Overlap Shear psi (MPa) Tested @				Floating Roller Peel piw (N/25mm) Tested @		H.C. Peel in•lb/in (mN/m) Tested @
Cure Parameters Scotch-Weld AF-3109-2K, .085 wt.	**-67°F (-55°C)**	**75°F (23°C)**	**250°F (121°C)**	**300°F (149°C)**	**75°F (23°C)**	**300°F (149°C)**	**75°F (23°C)**
Cure Cycle							
250°F (121°C), 1 Hour, 40 psi 4-5°F (2-3°C) Rise Rate/Min. (Standard)	5580 (38.5)	6130 (42.3)	2995 (20.6)	1835 (12.7)	57 (254)	34 (151)	28.7 (128)
250°F (121°C), 1 Hour, 40 psi 1°F (0.6°C) Rise Rate/Min.	5188 (35.8)	5960 (41.1)	3385 (23.3)	2152 (14.8)	54 (240)	33 (147)	24.3 (108)
250°F (121°C), 30 Min., 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5825 (40.2)	6210 (42.8)	2928 (20.2)	1625 (11.2)	70 (311)	31 (138)	26.2 (117)
250°F (121°C), 1 Hour, 40 psi 10°F (6°C) Rise Rate/Min.	5624 (38.8)	6072 (41.9)	3212 (22.1)	2174 (15.0)	63 (280)	36 (160)	26.6 (118)
225°F (107°C), 90 Min., 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5392 (37.2)	5982 (41.2)	3010 (20.8)	1848 (12.7)	64 (285)	30 (133)	28.2 (125)
225°F (107°C), 1 Hour, 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5025 (34.6)	6025 (41.5)	2690 (18.5)	1572 (10.8)	64 (285)	29 (129)	25.3 (113)
200°F (93°C), 2 Hours, 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5248 (36.2)	5810 (40.1)	1768 (12.2)	1458 (10.1)	57 (254)	27 (120)	24.7 (110)
300°F (149°C), 1 Hour, 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5784 (39.9)	6139 (42.3)	3600 (24.8)	1948 (13.4)	63 (280)	30 (133)	26.2 (117)
350°F (177°C), 1 Hour, 40 psi 4-5°F (2-3°C) Rise Rate/Min.	5840 (40.3)	5972 (41.2)	3488 (24.0)	2086 (14.4)	70 (311)	33 (148)	26.2 (117)

11. Typical Cured Free Film Properties:

75°F (23°C) Tensile Strength Bulk Modulus, Shear Modulus, and Poisson's Ratio –

Scotch-Weld AF 3109-2K .085 wt. ~ 0.1 inches thick (ASTM D-3039) cure – 60 minutes at 250°F (121°C) – 20 psi, 4-5°F (2-3°C) rise rate/minute.

Tensile Strength	8645 psi (59.6 MPa)
Modulus of Elasticity	390 x 10^3 psi (2689 MPa)
Poisson's Ratio	0.31
Shear Modulus	148 x 10^3 psi (1020 MPa)

Product Application

Surface Preparation

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

A. **Aluminum** (optimized FPL etch – 3M Company, Test Method C-2803 or ASTM D 2651).

1. Alkaline Degrease – Oakite 164 solution 9-11 oz. gallon water at 190 ± 10°F (88 ± 23°C) for 10-20 minutes. Rinse immediately in large quantities of cold running 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 to 1 liter. Heat mixed solution to 66 to 71°C (150 to 160°F). 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 MSDS and other safety recommendations provided by chemical manufacturers prior to preparation of this etch solution.

3. Rinse – Rinse panels in clear running tap water.
4. Dry – Air dry 15 minutes; force dry 10 minutes minimum at 140°F (60°C) maximum.
5. It is advisable to coat the freshly cleaned surface with adhesive or primer within 4 hours after surface preparation.

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 etching solutions for two (2) minutes at 150 ± 5°F (66 ± 20°C). Rinse, air dry and force dry in similar manner to skin panels.

Primer Application

3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960 has been successfully used with 3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2 using the following procedure:

Spray Application: Refer to Scotch-Weld EC-3960 Technical Data Sheet for equipment and technique.

Primer Dry Cycle:

Air Dry:	30 minutes at ambient temperature.
Force Dry:	60 minutes at 250°F (121°C) in an air circulating oven.
Primer Thickness:	Approximately 0.15 mil (3.8 micron) thick (dry).

See Scotch-Weld EC-3960 Technical Data Sheet for application techniques.

Product Application ***(continued)***

Adhesive Layup

Remove film from 0°F (-18°C) storage and allow to warm to room temperature (preferably overnight). While warming to room temperature the adhesive should be allowed to remain in the sealed polyethylene bag to minimize moisture condensation on the adhesive surface.

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

A. **3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2K Application**

1. Cut portion of film to be used from roll with protective liners in place.
2. Place high tack side of film on the primed metal using the separating liner as a protective cover. (High tack side is adjacent to heavy paper liner).
4. Roll film into position with a rubber roller insuring that no air is trapped between surface and film.
5. Remove second protective liner.
6. Assemble parts and cure.

B. **3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2U Application**

1. The area where the adhesive is to be used should be maintained at a temperature of 72-80°F (22-27°C). As an alternative, the film may be warmed briefly to this temperature range using a heat lamp, hot air gun or similar device. At temperatures below 72°F (22°C) the film becomes increasingly brittle and may crack during handling. At temperatures above 80°F (27°C) the tack of the adhesive increases making it more difficult to handle.
2. Cut portion of film to be used from the roll with the protective liners in place.
3. Remove the paper liner from the adhesive keeping the colored polyethylene liner in place. It is suggested that the adhesive film with polyliner be held firmly on a flat surface and that the paper liner be pulled away from the adhesive using a slow steady force. Jerking or sudden increase in the speed of pull may cause the adhesive to crack.
4. After the paper liner is removed, the adhesive film may be placed on the part to be bonded using the polyliner to help in positioning and to act as a protective cover.
5. Remove the polyliner before reticulating or bonding.
6. Any film remaining on the roll should be resealed in its polyethylene bag and returned to 0°F (-18°C) storage as soon as possible. Excessive aging at room temperature will cause the film to become more susceptible to cracking.

Product Application ***(continued)***

Cure Cycle

A cure of 60 minutes at 250°F (121°C) and 40 psi (276 KPa) pressure is suggested when maximum results are desired.

Cure Cycle (Autoclave or Platen Press)

The following cure cycle has been used to obtain dense glue lines.

Cure Cycle (Autoclave or Platen Press)

	Cure Cycle
1. Bonding Pressure: Apply before starting rise rate cycle and maintain throughout cure cycle.	40 psi (276 KPa)
2. Bond line temperature rise rate.	4 to 5°F (2 to 3°C)/min.
3. Cure.	60 minutes at 250°F (121°C)
4. Temperature at which pressure is released	200°F (93°C) or below

Storage and Handling

Storage Stability – Storage at 0°F (-18°C) or below is recommended for 3M™ Scotch-Weld™ Structural Adhesive Film AF 3109-2 to obtain maximum storage life.

Standard Shelf Life for Scotch-Weld AF 3109-2 is 6 months from date of shipment from 3M when stored at 0°F (-18°C) or less.

Note: Scotch-Weld AF 3109-2 films should be permitted to thoroughly warm to room temperature before being used in order to prevent moisture condensation. (Do not open protective container prior to reaching ambient conditions).

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 information call 1-800-235-2376. Our fax number is (417) 869-5219. Address correspondence to 3M Aerospace Central, 3211 E. Chestnut Expressway, Sprintfield. MO 65802.

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ISO 9002

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

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