

3M

Scotch-Weld™

Structural Adhesive Film

AF 563

Technical Data

September, 2002

Introduction

3M™ Scotch-Weld™ Structural Adhesive Film AF 563 designates a family of moderate cure temperature thermosetting structural adhesive films. Scotch-Weld AF 563 is similar to 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2 except that Scotch-Weld AF 563 extends the service temperature range and hot and wet durability of Scotch-Weld AF 163-2. Test results indicate Scotch-Weld AF 563 offers the following advantages:

- High bond strengths from -67° to 300°F (-55° to 149°C)
- High toughness and peel strength
- Excellent durability in hot and wet environments and designed for applications where hot and wet service is required.
- Can be cured as low as 250°F (121°C)
- Can be cured with low pressure or vacuum
- Designed for honeycomb sandwich and solid panel constructions typically found in high performance aircraft structures.

Product Description

Product Identification	Scotch-Weld AF 563
Reinforcing Carrier	Lightweight knit (K) or matte (M) scrim
Weight	.10 ± .005 lb/ft ² (488 ± 24.4 g/m ²) .06 ± .005 lb/ft ² (293 ± 24.4 g/m ²)
Color	Red
Nominal Thickness	Scotch-Weld AF 563M (.06 wt.) 10 mils (.254 mm) Scotch-Weld AF 563K (.10 wt.) 17 mils (.432 mm)

Scotch-Weld™ Structural Adhesive Film AF 563

Product Performance

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

% Flow (250°F [121°C] Cure – 60 minutes – 45 psi)

3M™ Scotch-Weld™ Structural Adhesive Film AF 563M (.06 wt)	3M™ Scotch-Weld™ Structural Adhesive Film AF 563K (.10 wt)
300-360%	450-525%

Volatiles: less than .5%

Thick Adherend Shear (Cured at 250°F [121°C])

Test Temperature °F (°C)	Scotch-Weld AF 563K (.10 wt)			
	Shear Stress		Shear Modulus	
	psi	MPa	psi	MPa
-67 (-55)	10,100	69.6	168,000	1157.5
75 (24)	6,010	41.4	91,250	628.7
220 (104)	2,600	17.9	44,700	308.0
250 (121)	2,840	19.6	13,800	95.1
275 (135)	1,905	13.1	2,625	18.1
300 (149)	473	3.3	500	3.4
Wet conditioned for 30 days @ 160°F (71°C)/100% relative humidity prior to testing				
220 (104)	3,135	21.6	13,300	91.6
220 (104)*	2,920*	20.1*	10,833*	74.6*
275 (135)	607	4.2	685	4.7

7075-T651 Aluminum

Primed with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917

Adhesive cured 250°F for 60 minutes under vacuum pressure

Test Rate: .02"/min

*Cured in autoclave at 45 psi positive pressure

Thick Adherend Shear (Cured at 275°F [135°C])

Test Temperature °F (°C)	Scotch-Weld AF 563K (.10 wt)			
	Shear Stress		Shear Modulus	
	psi	MPa	psi	MPa
220 (104)	2,793	19.2	12,700	87.5
Wet conditioned for 30 days @ 160°F/100% relative humidity prior to testing				
220 (104)	2,793	19.2	12,700	87.5

Scotch-Weld™ Structural Adhesive Film AF 563

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.

**3M™ Scotch-Weld™ Structural Adhesive Film AF 563
(250°F [121°C] cure – 45 psi – 90 minutes)**

Overlap Shear

Test Temperature °F (°C)	Scotch-Weld AF 563K (.10 wt)	
	psi	MPa
-67 (-55)	5,522	38.1
75 (24)	6,133	42.3
225 (107)	3,705	25.5
250 (121)	3,013	20.8
275 (135)	2,165	14.9
300 (149)	1,604	11.1

Test Method: 3M C-244 or ASTM D 1002
 2024-T3 alclad aluminum (4" x 7" x .063")
 Opt. FPL Etch + Phosphoric Acid Anodize
 Primed with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
 Test at .1"/min (2.5 mm/min)

Floating Roller Peel Strength

Test Temperature °F (°C)	Scotch-Weld AF 563M (.06 wt) piw	Scotch-Weld AF 563K (.10 wt) piw
75 (24)	58	68

Test Method: 3M C-260
 2024-T3 bare Peeling skin - .025" thick + backing skin - .063" thick
 Opt. FPL Etch + Phosphoric Acid Anodize
 Tested at 6"/min (15.2 cm/min)

Honeycomb Climbing Drum Peel

Test Temperature °F (°C)	Scotch-Weld AF 563M (.06 wt)	
	in lb/3 in	mN/m
-67 (-55)	88	130.5
75 (24)	88	130.5
300 (149)	132	195.7

Test Method: 3M C-245
 Peeling Skin: 2024-T3 alclad aluminum .020" (.5 mm) thick
 Honeycomb Core 5052 – 1.8" cell – 1/2" thick – 2 mi Cl
 Opt. FPL Etch
 Tested at 3"/min (7.6 cm/min)

Scotch-Weld™ Structural Adhesive Film AF 563

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.

RDA Information

Rheometrics RDA II
Gap Setting - .5 mm
2 layers of AF 563K (.10 wt)
Frequency – 10 rad/sec
Strain – 10%

Ramp Rate	Hold Temp	Min. Visc	Time to Min. Visc	Time to Gel (10 ⁵ P)
1°F/min	250°F	11,860 P	106.1 min	131 minutes
3°F/min	250°F	5,635 P	44.1 min	53.3 minutes
5°F/min	250°F	2,733 P	31.1 min	37.5 minutes
3°F/min	180°F	11,470 P	36.4 min	101.4 minutes
3°F/min	200°F	3,420P	39.4 min	80.4 minutes
3°F/min	225°F	9,193 P	41.1 min	54.5 minutes

3M™ Scotch-Weld™ Structural Adhesive Film AF 563
(250°F [121°C] cure – 50 psi – 120 minutes)

Overlap Shear on Different 3M™ Scotch-Weld™ Structural Adhesive Primers

Test Temperature °F (°C)	Scotch-Weld AF 563K (.10 wt)			
	3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960		3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917	
	psi	MPa	psi	MPa
-67 (-55)	5,720	39.4	5,500	37.9
75 (24)	6,120	42.2	5,990	41.3
225 (107)	3,500	24.1	3,675	25.3
250 (121)	2,690	18.5	2,780	19.2
275 (135)	2,110	14.5	2,180	15.0
300 (149)	1,430	9.9	1,575	10.9
300 (149) Pinned	1,775	12.2	1,855	12.8

Test Method: 3M C-244 or ASTM D 1002
2024-T3 alclad aluminum (4" x 7" x .063")
Opt. FPL Etch + Phosphoric Acid Anodize
Pressure – 50 psi (345 kN)
Ramp Rate – 3 to 4°F/minute
Tested at .1"/min (2.5 mm/min)

Flatwise Tensile Strength

Test Temperature °F (°C)	250°F (121°C)/120 minutes			
	Scotch-Weld AF 563M (.06 wt)		Scotch-Weld AF 563K (.10 wt)	
	psi	MPa	psi	MPa
75 (24)	2,226	15.3	2,375	16.4
225 (107)	1,182	8.1	1,347	9.3
250 (121)	—	—	820	5.6

Core: 1/8" cell size – 3 mil aluminum
Test Speed: .05"/min (1.25 mm/minute)
Pressure: 50 psi (345 kN)
Ramp Rate: 3 to 4°F/minute (5.4 to 7.2°C/minute)

Scotch-Weld™ Structural Adhesive Film AF 563

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.

Beam Flexure Strength

Test Temperature °F (°C)	3M™ Scotch-Weld™ Structural Adhesive Film AF 563M (.06 wt)		3M™ Scotch-Weld™ Structural Adhesive Film AF 563K (.10 wt)	
	lbs	N	lbs	N
75 (24)	6,633	29,517	6,578	29,272
220 (104)	4,654	20,710	5,738	25,534

Core: 1/8" cell size – 3 mil foil – 5/8" thick aluminum
Test Rate: .04"/min (1 mm/minute)

Effect of Slow rise rate and 30 minutes/60 minutes primer cure cycles

Autoclave Heat up Rate	3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917							
	(30 min. Cure) Overlap Shear Strength				(60 min. Cure) Overlap Shear Strength			
	75°F (24°C)		250°F (121°C)		75°F (24°C)		250°F (121°C)	
	psi	MPa	psi	MPa	psi	MPa	psi	MPa
4°F/min	7,480	51.5	2,370	16.3	7,350	50.6	2,845	19.6
1°F/min	7,400	51.0	3,020	20.8	7,240	49.9	3,033	20.9

Metal – 2024-T81 aluminum .063" thick
Surface Prep – Optimized FPL per ASTM D 2651
Primer – Scotch-Weld EC-3917 applied at .1 mil thick. Primer was air dried for 30 minutes at 75°F before curing.
Adhesive – Scotch-Weld AF 563K (.10 wt)
Cure cycles: 4°F/min 250°F (121°C) for 90 minutes and 45 psi (310 kN)
1°F/min 255°F (124°C) for 120 minutes and 40 psi (276 kN)

**Overlap Shear Strength Comparison [Test Temp 250°F (121°C)]
Scotch-Weld AF 563K (.10 wt)**

Test Speed	Load Method	250°F Overlap Shear Strength	
		Lot #1	Lot #2
.05"/min	Jaw Grips	2,130	2,267
.10"/min	Jaw Grips	2,510	2,480
.05"/min	Pins	2,795	2,847
.10"/min	Pins	3,005	2,987

Scotch-Weld™
Structural Adhesive Film
AF 563

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.

3M™ Scotch-Weld™ Structural Adhesive Film AF 563K (.06 wt) with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B (Applied by Brush)

Test Temperature °F (°C)	Blister Shear		Bell Peel		H/C Peel	
	psi	MPa	psi	MPa	in•lb/in	mN/m
-67 (-55)	4,864	33.5	71.0	0.5	18.8	83.6
75 (24)	5,748	39.6	63.5	0.4	17.7	78.7
225 (107)	3,084	21.2	51.8	0.4	15.2	67.6
250 (121)	2,880	19.8	48.8	0.3	14.0	62.3
275 (135)	2,780	19.2	44.5	0.3	13.2	58.7
300 (149)	2,476	17.1	40.3	0.3	6.6	29.4

Test Method: Opt. FPL Etch

Primed with Scotch-Weld EC-3924B brushed and cured for 60 minutes at 280°F
 Adhesive cured at 275°F for 90 minutes under 50 psi pressure and 1°F/min rise rate
 Adhesive tested after 15 days out time

Scotch-Weld AF 563K (.10 wt) on Glass Reinforced BMI Composite Substrates

Cure Cycle:						
Temp	250°F (121°C)		275°F (135°C)		250°F (121°C)	
Time	120 min		90 min		120 min	
Pressure	20 to 25 in Hg		20 to 25 in Hg		45 psi (310 kN)	
Heat up	2°F/min (1.1°C/min)		2°F/min (1.1°C/min)		2°F/min (1.1°C/min)	
Test Temperature (L/T Dry = 8)						
°F (°C)	psi	MPa	psi	MPa	psi	MPa
75 (24)	2,253	15.5	—	—	4,167	28.7
220 (104)	1,761	12.1	—	—	3,650	25.1
275 (135)	1,111	7.7	1,283	8.8	1,859	12.8
300 (149)	783	5.4	844	5.8	1,117	7.7
After Environmental Conditioning (30 days at 160°F/100% relative humidity)						
Test Temperature (L/T Wet = 32)						
°F (°C)	psi	MPa	psi	MPa	psi	MPa
220 (104)	1,433	9.9	1,306	9.0	1,363	9.4
275 (135)	605	4.2	617	4.3	—	—

Scotch-Weld™
Structural Adhesive Film
 AF 563

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.

IM-7/5250-4 Carbon Fiber Composite to 6,4 Titanium Double Overlap Shear with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3983

Test Temperature	psi	MPa
75°F (24°C)	9,000+*	62.0+*
*Testing stopped to prevent damage to load cell		
Wet Conditioning (72 hour boiling water submersion)		
220°F (104°C)	2,690	18.5
250°F (121°C)	1,854	12.8

AM-355 Stainless Steel Overlap Shear with Scotch-Weld EC-3983

Test Temperature	psi	MPa
75°F (24°C)	6,422	44.2
220°F (104°C)	3,278	22.6

IM-7/5250-4 Carbon Fiber Composite to 6,4 Titanium Double Overlap Shear with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917

Wet Double Overlap Shear (72 hour water boil + 30 days at 160°F/100% relative humidity)

Test Temperature	psi	MPa
220°F (104°C)	2,313	15.9
250°F (121°C)	1,209	8.3

IM-7/5250-4 Carbon Fiber Composite Flatwise Tensile Strength

Wet Flatwise Tensile Strength (72 hour water boil + 30 days at 160°F/100% relative humidity)

Test Temperature	psi	MPa
220°F (104°C)	812	5.6
250°F (121°C)	342	2.4

All primer on 6,4 titanium was cured for 60 minutes at 250°F and adhesive was cured for 120 minutes at 250°F.

Product Application

Note: While this information is provided as a general application guideline based upon typical conditions, it is recognized that no two applications are identical due to differing assemblies, methods of heat and pressure application, production equipment and other limitations. It is therefore suggested that experiments be run, within the actual constraints imposed, to determine optimum conditions for your specific application and to determine suitability of product for particular intended use.

I. Surface Preparation

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

A. Aluminum

Phosphoric acid anodize (3M Test Method C-2780 or ASTM D 3933), Chromic acid anodize with or without a chromate seal (3M Test Methods C-2801 or C-2782) are preferred for maximum joint durability in moist environments. Optimized FPL Etch has also demonstrated improved durability performance.

Optimized FPL Etch – (3M Test Method C-2803 or ASTM D 2651)

1. Alkaline degrease – Oakite 164* solution 9-11 oz./gallon of water at 190°F (87°C) ± 10°F (± 5.6°C) for 10-20 minutes. Rinse immediately in large quantities of cold running water.

*Available from Oakite, Berkeley Heights, NJ

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.

Note: Review and follow safety and handling recommendations provided by chemical suppliers prior to preparation of this etch solution.

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

3. Rinse immediately in large quantities of clear running tap water.
4. Dry – Air dry approximately 15 minutes followed by a force dry at 140°F (60°C) maximum for 10 minutes (minimum).
5. Current theory suggests that both surface structure and chemistry play a significant role in determining the strength and permanence of bonded structure. It is therefore advisable to bond or prime freshly cleaned surfaces as early as possible after preparing to avoid contamination and/or mechanical damage.

Scotch-Weld™

Structural Adhesive Film

AF 563

Product Application (continued)

B. Aluminum Honeycomb Core

1. Soak in clean aliphatic naphtha (conforming to TT-N-95A) for five minutes at room temperature. Dry 10 minutes (minimum) at 140°F (60°C) maximum.
2. Optional – Immerse in acid etching solution above for 2 minutes at 150°F (65°C) ± 5°F (± 2.8°C). Rinse, air dry and force dry in a similar manner to skins.

C. Titanium CP or 6A14V

Both Turco 5578* and improved phosphate fluoride processing have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AF 563.

1. Vapor hone 140 grit in water – rinse thoroughly with clear running tap water.
2. Degrease – solvent or alkaline process.
3. Immerse for 15 minutes at 185°F (85°C) ± 5°F (± 2.8°C) in the following bath: Turco 5578 – 420 grams, distilled water – balance to make 1 liter.
4. Immerse for 1 minute in 170°F (76°C) ± 5°F (± 2.8°C) distilled water.
5. Spray rinse for 5 minutes in hot tap water ~130°F (54°C).
6. Air dry for 10 to 20 minutes.
7. Force dry for 15 minutes at 150°F (65°C).
8. It is advisable to bond or prime freshly cleaned surfaces within four hours.

*Available from Turco Products.

D. Stainless Steel – Type 301 Type

1. Vapor hone 140 grit in water.
2. Rinse thoroughly in clear running tap water.
3. Alkaline degrease – see A2 procedure above.
4. Rinse thoroughly in clear running tap water.
5. Immerse for 10 minutes at 75°F (60°C) ± 5°F (± 2.8°C) in the following bath:
Distilled Water
Nitric Acid 42° Be, 30-50 oz./gallon
Hydrofluoric Acid 70%, 30-50 oz./gallon
Distilled Water (Balance)
6. Rinse thoroughly in clear running tap water.
7. Air dry for 10-20 minutes.
8. Force dry for 15 minutes at 150°F (65°C).
9. Bond or prime within four hours after preparing.

E. Cured Fiberglass or Carbon Fiber Reinforced Epoxy Resin Based Reinforced Plastic.

1. Abrade with 180 grit sandpaper or 3M™ Scotch-Brite™ Scour Pad (do not cut through resin into reinforcing fibers).
2. Degrease using acetone or methylethyl ketone (MEK) using an unsized cheesecloth pad.
3. Air dry for two hours minimum.

Scotch-Weld™

Structural Adhesive Film

AF 563

Product Application (continued)

II. Primers

For most applications, use of a corrosion inhibiting primer is suggested to obtain maximum bond durability in moist, corrosive environments. 3M™ Scotch-Weld™ Structural Adhesive Primers EC-3924B, EC-3960, and EC-3983 have been successfully used with 3M™ Scotch-Weld™ Structural Adhesive Film AF 563.

A. Primer Coverage

For the primers noted above, the optimum property test performance with Scotch-Weld AF 563 will normally be found with a uniform primer coverage in the 1-3 g/m² range (dry weight). This is approximately 0.1 mils as measured by an Isometer.

B. Primer Dry

The following cycle is suggested for these primers when used with Scotch-Weld AF 563 films:

Air dry: 60 minutes followed by forced air dry.

Force dry: 60 minutes at 250°-300°F (121°-149°C).

Normally optimum performances will be found at the higher end of the force dry temperature range when used with Scotch-Weld AF 563 films.

Note: Use of these primers without a force dry has not been evaluated in conjunction with Scotch-Weld AF 563 films. Consult with your 3M representative if further information is required.

III. Adhesive Film Application

Care should be taken during application to avoid contamination of the adhesive and substrates by any substance which will interfere with the wetting action of the adhesive.

A. Layup – Scotch-Weld AF 563 Films

1. Cut a portion of film sufficient for the assembly from the stock roll with protective liner(s) in place.
2. If the film has one protective liner, place the exposed adhesive against the substrate using the liner as a protective cover. If two liners are present, remove one and follow as above.
3. Position film and rub out all air between the adhesive and the substrate. Use of a rubber roller will facilitate this process.
4. Remove protective liner.
5. Complete assembly being careful to avoid trapping air and cure.

Scotch-Weld™ Structural Adhesive Film AF 563

Product Application
*(continued)***B. Cure Cycle**

3M™ Scotch-Weld™ Structural Adhesive Films AF 563 are designed to provide cure temperatures below 300°F (149°C). The following cycle has been used successfully in the 3M laboratories:

- 1. Cure temperature**
275° ± 5°F (135° ± 3°C)
- 2. Time**
90 minutes
- 3. Heat up rate**
5°F (3°C)/minute
- 4. Pressure**
30 ± 5 psig (20.7 N/cm²)

Further information on cure cycle variables will be reported in the future.

5. Positive Pressure Cures

During cure, pressure is required to keep parts in alignment and to overcome distortions and thermal expansion of the adherends. When bonding honeycomb assemblies with non-perforated core, pressure is required to overcome the thermal expansion of air in the honeycomb cells. For very small area bonds, high pressure may produce excessive squeeze out and adhesive bond line starvation. For large solid panel constructions which are autoclave cured, application of vacuum for 15 to 20 minutes prior to application of heat and pressure is suggested to assist in removing any residual air trapped in the assembly. Normally, the vacuum is released following application of positive pressure. For problem assemblies, maintain the vacuum during the heatup cycle to about 130°F (54°C) to further assist in providing void free bonds.

Storage

Storage Stability – Storage at 0°F (-18°C) or below is recommended for Scotch-Weld AF 563 to obtain maximum storage life.

Allow film to be thoroughly warm to room temperature before being used in order to prevent moisture condensation. (Do not open protective container prior to reaching ambient conditions.)

Shelf Life

Standard Shelf Life of Scotch-Weld AF 563 is 6 months from date of shipment when stored at 0°F (-18°C) or below.

Scotch-Weld™

Structural Adhesive Film

AF 563

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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