

# 3M

## Scotch-Weld™

### Structural Adhesive Film

#### AF 126 • AF 126-4

Technical Data

July, 2001

#### Introduction

3M™ Scotch-Weld™ Structural Adhesive AF 126 is a thermosetting, non-volatile, modified epoxy film adhesive designed for structural bonding of metals. This unique product offers the following advantages:

- Cure at temperatures as low as 225°F (107°C). Optimum results obtained with a cure of 250°F (121°C) for 1 hour.
- Excellent strength in metal-to-metal and honeycomb sandwich applications over a temperature range of -67°F to 250°F (-55°C to 121°C).
- Releases negligible volatile by-products during cure thereby permitting low pressure bonding.
- Low film weight version, 0.03 lb/ft<sup>2</sup> (147 g/m<sup>2</sup>), permits use of high pressure (100 psi, 0.689 MPa) bonding without excessive adhesive flow in metal-to-metal applications.
- Scotch-Weld AF 126 .06 and .08 weights (294 g/m<sup>2</sup> and 392 g/m<sup>2</sup>) with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 are qualified to the requirements of MIL-A-25463 Type I Class 2 and MMM-A-132 Type I Class 2.
- Scotch-Weld AF 126 .03 weight (147 g/m<sup>2</sup>) with Scotch-Weld EC-2320 is qualified to the requirements of MMM-A-132 Type I Class 2.
- High degree of tack in the uncured state.
- Scotch-Weld AF 126 films can be used with 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960.
- Scotch-Weld AF 126 FR .06 wt. (Scotch-Weld AF 126 .06 wt. flame retardant version) is also available.

#### Description

	Scotch-Weld AF 126 (.03 wt, 147 g/m <sup>2</sup> )	Scotch-Weld AF 126 (.06 wt, 294 g/m <sup>2</sup> )	Scotch-Weld AF 126 (.08 wt, 392 g/m <sup>2</sup> )
<b>Form:</b>	Supported film adhesive with protective liners		
<b>Color:</b>	Green	Green	Red
<b>Nominal Weight:</b>	0.030 lb/ft <sup>2</sup> (147.1 g/m <sup>2</sup> )	0.060 lb/ft <sup>2</sup> (294.2 g/m <sup>2</sup> )	0.080 lb/ft <sup>2</sup> (392.3 g/m <sup>2</sup> )
<b>Nominal Caliper:</b>	0.005 in. (0.127 mm)	0.010 in. (0.254 mm)	0.015 in. (0.381 mm)
<b>Volatile Content:</b>	Less than 1%		

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#### Product Performance MMM-A-132 Type I Class 2 Test Data

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

Test Condition	MMM-A-132 Type I Class 2 & 3 Requirement Min. Average		Scotch-Weld AF 126/ EC-2320 .03 wt. (147 g/m <sup>2</sup> )		Scotch-Weld AF 126/ EC-2320 .06 wt. (294 g/m <sup>2</sup> )		Scotch-Weld AF 126/ EC-2320 .08 wt. (392 g/m <sup>2</sup> )	
	psi	MPa	psi	MPa	psi	MPa	psi	MPa
<b>A. Tensile Shear</b>								
1. Normal Temperature, 75°F (24°C)	2500	17.2	4630	31.9	5600	38.6	5347	36.8
2. 10 minutes at 180°F (82°C)	1250	8.6	3850	26.5	3260	22.5	3207	22.1
3. 10 minutes at -67°F (-55°C)	2500	17.2	4850	33.4	4960	34.2	5687	39.2
4. Normal Temperature, 75°F (24°C) After 30 Days Salt Water Spray	2250	15.5	4760	32.8	5170	35.6	5375	37.0
5. Normal Temperature, 75°F (24°C) After 30 Days @ 120°F (49°C) and 95-100% Relative Humidity	2250	15.5	4630	31.9	4980	34.3	5243	36.1
6. Normal Temperature, 75°F (24°C) After 30 Days Immersion in Tap Water	2250	15.5	5230	36.0	5390	37.1	5240	36.1
7. Normal Temperature, 75°F (24°C) After 7 Days Immersion in JP-4 Fuel	2250	15.5	4710	32.5	6120	42.2	5775	39.8
8. Normal Temperature, 75°F (24°C) After 7 Days Immersion in Anti-icing Fog	2250	15.5	4860	33.5	6020	41.5	5552	38.3
9. Normal Temperature, 75°F (24°C) After 7 Days Immersion in Hydraulic Oil	2250	15.5	5000	34.5	6280	43.3	5626	38.8
10. Normal Temperature, 75°F (24°C) After 7 Days Immersion in Type III Hydrocarbon Fluid	2250	15.5	4820	33.2	5070	34.9	5800	40.0

<b>B. Creep Rupture</b>	<b>Maximum Deformation</b>			
11. Normal Temperature, 75°F (24°C) 192 Hours @ 1600 psi (11.0 MPa)	0.015 inches (0.381 microns)	0.0000 inches (0.00 microns)	0.0000 inches (0.0000 microns)	0.0000 inches (0.0000 microns)
12. 180°F (85°C) 192 Hours @ 800 psi (5.5 MPa)	0.015 inches (0.381 microns)	0.0026 inches (0.066 microns)	0.0026 inches (0.066 microns)	0.0026 inches (0.066 microns)

<b>C. Fatigue</b>				
13. Normal Temperature, 75°F (24°C) 750 psi (5.2 MPa) @ 10 <sup>6</sup> Cycles	no glue line failure	no glue line failure	no glue line failure	no glue line failure

<b>D. Other Tests</b>					
14. Normal Temperature 75°F (24°C) T-Peel	Class 2:	15 piw (66.8 N/25mm)	30 piw (133 N/25mm)	43 piw (191.4 N/25mm)	37 piw (164.7 N/25mm)
	Class 3:	None	None	None	None
15. Tensile Shear, 75°F (24°C) Blister Detection	Class 2:	2250 psi (15.5 MPa)	4660 psi (32.1 MPa)	4620 psi (31.8 MPa)	4370 psi (30.1 MPa)
	Class 3:	None	None	None	None

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#### Product Performance MIL-A-25463 Type I Class 1 & 2 Test Data

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

Test Conditions	MIL-A-25463 Type I Requirement Minimum Average		Scotch-Weld AF 126/ EC-2320 .08 wt. (392.3 g/m <sup>2</sup> ) Average	
	1. Normal Temperature Sandwich Peel Strength	8.5 in•lb/in	37.8 mN/m	40.3 in•lb/in
2. 180°F (82°C) Sandwich Peel Strength	5.0 in•lb/in	22.2 mN/m	23.5 in•lb/in	104.5 mN/m
3. -67°F (-55°C) Sandwich Peel Strength	2.0 in•lb/in	8.9 mN/m	26.7 in•lb/in	118.8 mN/m
4. Normal Temperature Flatwise Tensile Strength	450 psi	3.1 MPa	1242 psi	8.6 MPa
5. 180°F (82°C) Flatwise Tensile Strength	270 psi	1.9 MPa	550 psi	3.8 MPa
6. -67°F (-55°C) Flatwise Tensile Strength	350 psi	2.4 MPa	1359 psi	9.4 MPa
7. Normal Temperature Flexural Strength	1750 psi	12.1 MPa	2414 psi	16.6 MPa
8. 180°F (82°C) (short term) Flexural Strength	1200 psi	8.3 MPa	1448 psi	10.0 MPa
9. -67°F (-55°C) Flexural Strength	1750 psi	12.1 MPa	2644 psi	18.2 MPa
10. 180°F (82°C) (long term) Flexural Strength	1000 psi	6.9 MPa	1637 psi	11.3 MPa
11. Normal Temperature Creep Deflection in Flexure after 192 hours under 1000 lbs. (4450 N) load	0.025 in max	0.635 mm max	0.0011 in max	0.0279 mm max
12. 180°F (82°C) Creep Deflection in Flexure after 192 hours under 800 lb (3560 N) load	0.050 in max	1.27 mm max	0.0210 in max	0.5334 mm max
13. Normal Temperature Flexure Strength after 30 days in 90-100% Relative Humidity 120°F (48.9°C)	1500 lb	6675 N	2485 lb	11058 N
14. Normal Temperature Flexure Strength after 30 days in Salt Spray (Fed. Test Method Std. No. 151, method 811)	1500 lb	6675 N	2251 lb	10017 N
15. Normal Temperature Flexure Strength after 30 days Immersion in Hydrocarbon Fluid (Spec. MIL-S-3136 Type III)	1500 lb	6675 N	2456 lb	10969 N

#### Miscellaneous Test Data

#### Storage Life Testing

Average results of Scotch-Weld AF 126/3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 .03 wt. (147 g/m<sup>2</sup>), .06 wt. (294 g/m<sup>2</sup>), and .08 wt. (392 g/m<sup>2</sup>) after storage at 0°F (-17.8°C), 40°F (4.4°C), and 75°F (24°C). Results are overlap shear tests made on 1/2" (12.5 mm) lap joint specimens of 0.064" (1.626 mm) clad 2024 T3 aluminum.

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## 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.

Storage Time and Temperature	Test Condition	Scotch-Weld AF 126/EC-2320 .03 wt. (147 g/m <sup>2</sup> )		Scotch-Weld AF 126/EC-2320 .06 wt. (294 g/m <sup>2</sup> )		Scotch-Weld AF 126/EC-2320 .08 wt. (392 g/m <sup>2</sup> )	
		psi	MPa	psi	MPa	psi	MPa
90 days @ 0°F (-17.8°C)	75°F (24°C) shear	5010	34.5	5525	38.1	5320	36.7
	180°F (82°C) shear	3245	22.4	3252	22.4	3265	22.5
	75°F (24°C) shear after 30 days immersion in salt spray	4805	33.1	5412	37.3	5375	37.0
30 days @ 40°F (4.4°C)	75°F (24°C) shear	4825	33.2	5085	35.0	5170	35.6
	180°F (82°C) shear	3170	21.8	3410	23.5	3463	23.9
	75°F (24°C) shear after 30 days immersion in salt spray	4775	32.9	5150	35.5	5075	35.0
10 days @ 75°F (24°C)	75°F (24°C) shear	4770	32.9	5158	35.5	5212	35.9
	180°F (82°C) shear	3355	23.1	3577	24.6	3263	22.5
	75°F (24°C) shear after 30 days immersion in salt spray	4970	34.2	4990	34.4	5125	35.3

## 3M™ Scotch-Weld™ Structural Adhesive Film AF 126 .06 wt. (294 g/m<sup>2</sup>) 3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 Overlap Shear Strength at Elevated Temperatures

Test Temperature		Overlap Shear Strength	
		psi	MPa
250°F	121°C	1075	7.4
300°F	149°C	510	3.5
350°F	177°C	300	2.1
400°F	204°C	285	2.0
450°F	232°C	185	1.3
500°F	260°C	125	0.9

## Aluminum to Aluminum T-Peel Bonds

The following data shows typical values obtained with the Scotch-Weld AF 126/Scotch-Weld EC-2320 system. T-Peel specimens consist of two 8" x 12" x 0.020" (203 mm x 305 mm x 0.508 mm) sheets of 2024 T3 clad aluminum bonded to each other from which 1" (25.4 mm) wide strips are cut for testing. Jaw separation rate was 3"/minute (75 mm/minute) during testing.

Test Temperature		Scotch-Weld AF 126/EC-2320		Scotch-Weld AF 126/EC-2320		Scotch-Weld AF 126/EC-2320	
		.03 wt.	147 g/m <sup>2</sup>	.06 wt.	294 g/m <sup>2</sup>	.08 wt.	392 g/m <sup>2</sup>
-67°F	-55°C	24 piw	106.8 N/25mm	22 piw	97.9 N/25mm	28 piw	124.6 N/25mm
75°F	24°C	36 piw	160.2 N/25mm	32 piw	142.4 N/25mm	37 piw	164.6 N/25mm
180°F	82°C	22 piw	97.9 N/25mm	26 piw	115.7 N/25mm	20 piw	89 N/25mm

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#### 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.

#### Effect of Cure Variables

The following overlap shear data on Scotch-Weld AF 126 .06 wt. (294 g/m<sup>2</sup>)/3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 shows the effects of varying cure time, pressure, temperature rise rate and primer dry time and temperature. Results are overlap shear tests made on 1/2" (12.5 mm) lap joint specimens of 0.064" (1.626 mm) clad 2024 T3 aluminum.

#### Cure Time Experiment

Adhesive Cure Time (hours)	Overlap Shear Test Results							
	-67°F	-55°C	75°F	24°C	180°F	82°C	250°F	121°C
1	5453 psi	37.6 MPa	5060 psi	34.9 MPa	3160 psi	21.8 MPa	1507 psi	10.4 MPa
1½	5893 psi	40.6 MPa	5387 psi	37.1 MPa	3160 psi	21.8 MPa	1190 psi	8.2 MPa
2	5397 psi	44.1 MPa	5460 psi	37.6 MPa	3447 psi	23.7 Mpa	1591 psi	11.0 MPa
3	5507 psi	37.9 MPa	5560 psi	38.3 MPa	3523 psi	24.3 Mpa	1575 psi	10.9 MPa

Cure Cycle: 6-8°F/minute rise, 225°F, 50 psi, time as stated (3.3-4.4°C/minute rise, 107°C, 0.35 MPa, time as stated).

#### Cure Pressure Experiment

Cure Pressure		Overlap Shear Test Results							
		-67°F	-55°C	73°F	23°C	180°F	82°C	250°F	121°C
25 psi	0.17 MPa	5247 psi	36.2 MPa	5040 psi	34.7 MPa	2960 psi	20.4 MPa	1315 psi	9.1 MPa
50 psi	0.35 MPa	5793 psi	39.9 MPa	5387 psi	37.1 MPa	3160 psi	21.8 MPa	1190 psi	8.2 MPa
100 psi	0.69 MPa	5230 psi	36.0 MPa	5393 psi	37.2 MPa	2940 psi	20.3 Mpa	1387 psi	9.6 MPa

Cure Cycle: 5-8°F/minute rise, 90 minutes @ 225°F, pressure as stated (2.8-4.4°C/minute rise, 90 minutes @ 107°C, pressure as stated).

#### Cure Rise Rate Experiment

Rise Rate °F (°C)/Minute		Overlap Shear Test Results							
		-67°F	-55°C	73°F	23°C	180°F	82°C	250°F	121°C
2	1.1	5377 psi	37.0 MPa	5093 psi	35.1 MPa	3270 psi	22.5 MPa	1472 psi	10.1 MPa
7	3.9	5793 psi	39.9 MPa	5387 psi	37.1 MPa	3160 psi	21.8 MPa	1190 psi	8.2 MPa
12	6.7	5403 psi	37.2 MPa	5333 psi	36.7 MPa	3203 psi	22.1 Mpa	1431 psi	9.9 MPa

Cure Cycle: 90 minutes @ 225°F, 50 psi, rise rate as stated (90 minutes @ 107°C, 0.35 MPa, rise rate as stated).

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## 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.

## Primer Dry Time Experiment

3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 Cure Conditions:

Primer Cure		Overlap Shear Test Results							
Time (hrs)	Temp.	-67°F	-55°C	73°F	23°C	180°F	82°C	250°F	121°C
1	75	5932 psi	40.9 MPa	5800 psi	40.0 MPa	3690 psi	25.4 MPa	2003 psi	13.8 MPa
2	75	5526 psi	38.1 MPa	5697 psi	39.3 MPa	3590 psi	24.7 MPa	1680 psi	11.6 MPa
3	75	5800 psi	40.0 MPa	5540 psi	38.2 MPa	3786 psi	26.1 Mpa	1473 psi	12.2 MPa
1/2	150	5343 psi	36.8 MPa	5076 psi	35.0 MPa	3796 psi	26.2 Mpa	1297 psi	8.9 MPa
1/2	250	6490 psi	45.4 MPa	5700 psi	39.3 MPa	3957 psi	27.3 Mpa	1553 psi	10.7 MPa
1	250	6386 psi	44.0 MPa	6006 psi	41.4 MPa	3977 psi	27.4 Mpa	1433 psi	9.9 MPa
2	250	5466 psi	37.7 MPa	5817 psi	40.1 MPa	4010 psi	27.6 Mpa	1327 psi	9.1 MPa

Includes a 1/2 hour, 75°F (24°C) air dry for those panels given an elevated temperature cure.

Cure Cycle: 6-8°F/minute rise, 250°F, 60 minutes, 50 psi (3.3-4.4°C/minute rise, 121°C, 60 minutes, 0.35 MPa).

A second test was made to determine the effect of primer dry temperature as well as the effect of 75°F (24°C) aging after force drying. The results indicated that 1/2 hour at 200°F (93°C) was close to optimum and that up to 1 week aging after the primer force dry had little effect on 250°F (121°C) overlap shear values.

## Scotch-Weld AF 126 .06 wt. (294 g/m<sup>2</sup>) Scotch-Weld EC-2320 Cryogenic Test

Typical Scotch-Weld EC-2320 primed overlap shear test specimens were cured for 1 hour at 250°F (121°C) and then tested at -323°F (-197°C). Test results were as follows:

Control specimens: 5273 psi at 75°F (36.3 MPa at 24°C)

Test specimens: 4217 psi at -323°F (29.1 MPa at -197.2°C)

## Scotch-Weld AF 126 .06 wt. (294 g/m<sup>2</sup>) on Various Metal Substrates

### Overlap Shear Tests

		Overlap Shear Test Results							
Adherend	Scotch-Weld Primer Used	-67°F	-55°C	75°F	24°C	180°F	82°C	250°F	121°C
		psi	MPa	psi	MPa	psi	MPa	psi	MPa
Aluminum – 63 mil 2024 T3 clad (etched)	EC-2320	5220	36.0	4815	33.2	3080	21.2	1360	9.4
	None	5090	35.1	4955	34.1	2860	19.7	1420	9.8
Magnesium Dow 7 Treated	EC-2320	2260	15.6	2600	17.9	1520	10.5	610	4.2
	None	1840	12.7	4150	28.6	2540	17.5	750	5.2
Titanium Alloy 6-4 50 mil	EC-2320	6270	43.2	4730	32.6	2340	16.1	520	3.6
	EC-3901	6380	44.0	5280	36.4	3650	25.1	Not Tested	Not Tested
	None	8310	57.3	5650	38.9	3100	21.4	1320	9.1
Stainless Steel Type 17-7 50 mil	EC-2320	7597	52.3	6280	43.3	3343	23.0	1040	7.2
	EC-3901	10203	70.3	6310	43.5	3600	24.8	1913	13.2
	None	9877	68.1	6200	42.7	3487	24.0	1480	10.2

Cure Cycle: 250°F, 50 psi, 60 minutes, 6-8°F/minute rise (121°C, 0.35 MPa, 60 minutes, 3.3-4.4°C/minute rise).

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## 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.

### Peel Tests (Stainless Steel #301 half hard, 8 mil) Test @ 75°F (24°C)

Typical 3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 primed overlap shear test specimens were cured for 1 hour at 250°F (121°C) and then tested at -323°F (-197°C). Test results were as follows:

Climbing Drum Peel (Metal to Metal)	51 in•lbs/in (226.9 mN/m)
T-Peel	20 piw (89 N/25 mm)
Honeycomb Peel	13.7 in•lbs/in (60.9 mN/m)

Cure Conditions – EC 3901 Primer

Honeycomb Core – 5052, 7/16" thick, 3/16" cell, 1 mil foil, non-perf. (11.1 mm thick, 4.76 mm cell, 25.4 micron foil)  
Cured 6-8°F/minute rise, 250°F, 60 minutes, 50 psi (cured 3.3-4.4°C/minute rise, 121°C, 60 minutes, 0.35 MPa).

### Scotch-Weld AF 126 .06 wt. (294 g/m<sup>2</sup>)/Scotch-Weld EC-2320 Overlap Shear (Etched Aluminum) After 10 Hour Post Cure at 300°F (149°C)

#### 1. Unaged

Tested @ 75°F (24°C)	6295 psi	43.4 MPa
Tested @ 300°F (149°C)	395 psi	2.7 Mpa

#### 2. 10 Hours @ 300°F (149°C) Aged

Tested @ 75°F (24°C)	6325 psi	43.6 MPa
Tested @ 300°F (149°C)	315 psi	2.2 MPa

Cured 250°F, 50 psi, 60 minutes, 6-8°F/minute rise (121°C, 0.35 MPa, 60 minutes, 3.3-4.4°C/minute rise).

### Scotch-Weld AF 126 .06 wt. (294 g/m<sup>2</sup>)/Scotch-Weld EC-2320 Blister Detection on Chromic Acid Anodized Surfaces

Tested @ -67°F (-55°C)	3900 psi	26.9 MPa
75°F (24°C)	4250 psi	29.3 MPa
180°F (82°C)	2070 psi	14.3 MPa

Cured 60 minutes @ 250°F, 50 psi, 6-8°F/minute rise (cured 60 minutes @ 121°C, 0.35 MPa, 3.3-4.4C/minute rise).

### Scotch-Weld AF 162 .06 wt. (294 g/m<sup>2</sup>) Unprimed Quick Cure Data

Time in Press Minutes	Platen Temperature		Cold Rolled Steel Solvent Wiped		75°F (24°C) Overlap Shear On Aluminum (FPL Etched)	
	°F	(°C)	psi	MPa	psi	MPa
60	250°F	(121°C)	2690 psi	18.5 MPa	5000 psi	34.5 MPa
6	300°F	(149°C)	3180 psi	21.9 MPa	4700 psi	32.4 MPa
2	350°F	(177°C)	3367 psi	23.2 MPa	4800 psi	33.1 MPa
0.5	400°F	(204°C)	3120 psi	21.5 MPa	4000 psi	33.6 MPa

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**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.**

#### Scotch-Weld AF 162 .06 wt. (294 g/m<sup>2</sup>) Overlap Shear Quick Cure Data on Steel

Cure Conditions						Test Temperature					
Temperature		Time Minutes	Press		Primer	-40°F	-40°C	75°C	24°C	180°C	82°C
250°F	121°C	40	25 psi	0.17 MPa	None	3257 psi	22.4 MPa	2689 psi	18.5 MPa	1663 psi	11.5 MPa
250°F	121°C	40	25 psi	0.17 MPa	EC-2320**	3257 psi	22.4 MPa	2820 psi	19.4 MPa	1890 psi	13.0 MPa
300°F	149°C	15	25 psi	0.17 MPa	None	3500 psi	24.1 MPa	3080 psi	21.2 MPa	2005 psi	13.8 MPa
300°F	149°C	12	25 psi	0.17 MPa	None	3850 psi	26.5 MPa	3320 psi	22.9 MPa	2580 psi	17.8 MPa
300°F	149°C	9	25 psi	0.17 MPa	None	3472 psi	23.9 MPa	2953 psi	20.4 MPa	1880 psi	13.0 MPa
300°F	149°C	6	25 psi	0.17 MPa	None	3650 psi	25.2 MPa	3187 psi	22.0 MPa	1960 psi	13.5 MPa
350°F	177°C	8	25 psi	0.17 MPa	None	4125 psi	28.4 MPa	3340 psi	23.0 MPa	1835 psi	12.6 MPa
350°F	177°C	6	25 psi	0.17 MPa	None	3840 psi*	26.5 MPa	3219 psi	22.2 MPa	1795 psi	12.4 MPa
350°F	177°C	4	25 psi	0.17 MPa	None	3550 psi*	24.5 MPa	3173 psi	21.9 MPa	2355 psi	16.2 MPa
350°F	177°C	2	25 psi	0.17 MPa	None	3750 psi*	25.8 MPa	3367 psi	23.2 MPa	2375 psi	13.4 MPa
400°F	204°C	3	25 psi	0.17 MPa	None	3800 psi	26.2 MPa	3120 psi	21.5 MPa	1590 psi	11.0 MPa
400°F	204°C	2	25 psi	0.17 MPa	None	3430 psi	23.6 MPa	2973 psi	20.5 MPa	1730 psi	11.9 MPa
400°F	204°C	0.5	25 psi	0.17 MPa	None	3430 psi	23.6 MPa	3123 psi	21.5 MPa	1600 psi	11.0 MPa

Adherend: Cold Rolled Steel, 0.035", solvent cleaned

Cure: All cures based on hot press entry and removal

\* Metal Failure

\*\* Primer Dry – 24 hours at 75°F (24°C)

#### Scotch-Weld AF 162 .06 wt. (294 g/m<sup>2</sup>)/3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 Overlap Shear on Chromic Acid After Environmental Aging

	Tested at 75°F (24°C)			
	Control		Immersed	
Overlap Shear after 30 days in Salt Spray	5750 psi	39.6 MPa	5320 psi*	36.7 MPa
Overlap Shear after 30 days 100% Relative Humidity	6150 psi	42.4 MPa	5430 psi*	37.4 MPa

Cure Cycle: 60 minutes @ 265°F, 50 psi, 4-5°F/minute rise (60 minutes @ 129°C, 0.35 MPa, 2.2-2.8°C/minute rise).

\*Note: Values are an average of 4 immersed specimens. There was no evidence of undercutting or corrosion on any specimen.

#### Scotch-Weld AF 162 .06 wt. (294 g/m<sup>2</sup>) Tensile, Modulus of Elasticity and Elongation

	Tested @ 75°F (24°C)	
Tensile	6052 psi	41.7 MPa
Modulus of Elasticity	101,900 psi	702.1 MPa
Elongation	23.7%	



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**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.

**Scotch-Weld AF 162 .03 wt. (147 g/m<sup>2</sup>)/3M™ Scotch-Weld™ Structural Adhesive Primer EC-2320 Overlap Shear & T-Peel (Etched Aluminum) Low Temperature Cure**

Bonds Cured @ 180°F (82°C) 50 psi (0.35 MPa) for:		Test Temperature					
		-67°F	(-55°C)	75°F	(24°C)	180°F	(82°C)
3 hours	Shear	712 psi	4.9 MPa	278 psi	1.9 MPa	40 psi	0.3 MPa
	T-Peel	2.5 piw	11.1 N/25mm	21 piw	93.5 N/25mm	4.5 piw	20.0 N/25mm
6 hours	Shear	675 psi	4.7 MPa	1985 psi	13.7 MPa	358 psi	2.5 MPa
	T-Peel	3 piw	13.4 N/25mm	30 piw	133.5 N/25mm	5.5 piw	24.5 N/25mm
9 hours	Shear	4825 psi	33.2 MPa	3885 psi	26.8 MPa	2430 psi	16.7 MPa
	T-Peel	14 piw	62.3 N/25mm	22 piw	97.9 N/25mm	19 piw	84.6 N/25mm
12 hours	Shear	4700 psi	32.4 MPa	3800 psi	26.2 MPa	2765 psi	19.1 MPa
	T-Peel	12 piw	53.4 N/25mm	23 piw	102.3 N/25mm	20 piw	89 N/25mm
24 hours	Shear	4625 psi	31.9 MPa	3810 psi	26.3 MPa	3000 psi	20.7 MPa
	T-Peel	16.5 piw	73.4 N/25mm	22.5 piw	100.1 N/25mm	18 piw	80.1 N/25mm

**Scotch-Weld 162 .06 wt. (294 g/m<sup>2</sup>)/Scotch-Weld EC-2320 L/T Ratios**

L/T Ratio Overlap Length	Test Temperature					
	-67°F	-55°C	75°F	24°C	160°F	71°C
8 (0.50", 12.7 mm)	6640 psi	45.8 MPa	6225 psi	42.9 MPa	4268 psi	29.4 MPa
16 (1.00", 25.4 mm)	3964 psi	27.3 MPa	3902 psi	26.9 MPa	3448 psi	23.8 MPa
24 (1.50", 38.1 mm)	2668 psi	18.4 MPa	2666 psi	18.4 MPa	2493 psi	17.2 MPa
40 (2.50", 63.5 mm)	1695 psi	11.7 MPa	1574 psi	10.9 MPa	1545 psi	10.7 MPa

Cured for 60 minutes @ 250°F, 30 psi, 6-8°F/minute rise (60 minutes @ 121°C, 0.21 MPa, 3.3-4.4°C/minute rise).

**Etched Aluminum Metal to Metal Climbing Drum Peel with Scotch-Weld EC-2320 (20 mil to 40 mil face sheets) [508 microns to 1016 microns face sheets]**

Test Temperature		Test Results			
		.03 wt.	147 g/m <sup>2</sup>	.06 wt.	294 g/m <sup>2</sup>
75°F	24°C	80 in•lbs/in	355.8 mN/m	100 in•lbs/in	444.8 mN/m

Cure – 60 minutes @ 250°F, 50 psi, 6-8°F/minute rise (60 minutes @ 121°C, 0.35 MPa, 3.3-4.4°C/minute rise).

**Chromic Acid Anodized Aluminum Metal to Metal Climbing Drum Peel with Scotch-Weld EC-2320 (20 mil to 40 mil face sheets) [508 to 1016 microns face sheets]**

Test Temperature		Test Results			
		.03 wt.	147 g/m <sup>2</sup>	.06 wt.	294 g/m <sup>2</sup>
75°F	24°C	80 in•lbs/in	355.8 mN/m	100 in•lbs/in	444.8 mN/m

Cure – 60 minutes @ 250°F, 50 psi, 6-8°F/minute rise (60 minutes @ 121°C, 0.35 MPa, 3.3-4.4°C/minute rise).

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**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.**

### Chromic Acid Anodized Aluminum Floating Drum Peel with Scotch-Weld EC-3909 Primer

Test Temperature		Test Results	
		.06 wt.	294 g/m <sup>2</sup>
-67°F	-55°C	70 piw	311.5 mN/m
75°F	24°C	85 piw	378.3 mN/m
180°F	82°C	70 piw	311.5 mN/m

Cure – 60 minutes @ 265°F, 50 psi, 4-5°F/minute rise (60 minutes @ 129°C, 0.75 MPa, 2.2-2.8°C/minute rise).

### Etched Aluminum Overlap Shear with Scotch-Weld EC-3960 Primer

Test Temperature		Test Results	
		.06 wt.	294 g/m <sup>2</sup>
-67°F	-55°C	5325 psi	36.7 MPa
75°F	24°C	5850 psi	40.3 MPa
180°F	82°C	3100 psi	21.4 MPa

Cure – 60 minutes @ 250°F, 40 psi, 6-8°F/minute rise (60 minutes @ 121°C, 0.28 MPa, 3.3-4.4°C/minute rise).

### Etched Aluminum T-Peel with Scotch-Weld EC-3960 Primer

Test Temperature		Test Results	
		.03 wt.	147 g/m <sup>2</sup>
75°F	24°C	31 piw	138.0 mN/m

Cure – 60 minutes @ 250°F, 40 psi, 6-8°F/minute rise (60 minutes @ 121°C, 0.28 MPa, 3.3-4.4°C/minute rise).

### Volatile Condensable Material for Scotch-Weld AF 126-2

As per SP-R-0022 “Specification-Vacuum Stability Requirements for Polymeric Material for Space Craft Application.”

	TWL	VCM
3M AF 126	1.97	.85

TWL = Total weight loss in percent as measured per SP-R-0022A procedure.

VCM = Volatile condensable materials in percent measured using SP-R-0022A procedure.

\*Note: Published by NASA

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### 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, method 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. Suggested Surface Preparation for Aluminum:

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.

Phosphoric acid anodize (3M Test Method C-2780), 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 Company (3M Test method C-2803 or ASTM D 2651)

1. Alkaline Degrease – Oakite\* 164 solution 9-11 oz./gallon water at 190° ± 10°F for 10 to 20 minutes. Rinse immediately in large quantities of cold running water. (3M Test Method C-2802).

\*Available from Oakite, Berkeley Heights, NJ.

2. Optimized FPL Etch Solution (1 liter):

<b>Material</b>	<b>Amount</b>
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

**Note:** Review and follow safety and precautionary information provided by chemical supplier prior to preparation of this etch 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.

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.
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.

#### II. Adhesive Layup

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

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### Product Application (continued)

### III. Film Application

1. Cut portion of film to be used from roll with protective liner in place.
2. Place film on the primed metal using the separating liner as a protective cover.
3. Roll film into position with a rubber roller insuring that no air is trapped between surface and film.
4. Remove protective liner.
5. Assemble parts and cure.

### IV. Primer Application

Priming of bonding surfaces offers two distinct advantages: (1) Priming insures complete wetting of metal surfaces which normally results in superior environmental and low temperature properties and (2) Priming simplifies production by protecting cleaned parts until bonding can be completed. The following system is suggested for spray application. See separate Product Specification Sheet for EC-2320 before using.

Spray Gun	DeVilbiss JGA	
Air Cap	Number 78	
Nozzle	AV-15-FX	
Needle	FX	
Line Pressure	35 pounds	155.7 Newtons
Cup Pressure	1-2 pounds	4.5-8.9 Newtons
Distance from Panel	9 ± 3 inches	22.8 ± 76.2 mm
Primer Thickness (dry)	0.00005-0.0002 inches	0.00127-0.00508 mm

If part design permits, parts may be primed by dipping and draining.

### IV. Dry Cycle

The following dry cycle for Scotch-Weld EC-2320 is suggested for use with “Scotch-Weld” 3M AF 126 films.

Air Dry: Air dry at 75-85°F (24-29.4°C) for a minimum of 30 minutes.

Plus Force Dry: Circulating air oven with part at 200°F (93.3°C) for 30 minutes.

OR

Alternate Dry: Air dry at 75-85°F (24-29°C) for a minimum of 2 hours.

**Product Application**  
*(continued)*

**VI. Cure Cycle**

**General Cure Requirements**

Time, temperature and pressure determine the final bond properties. These properties may also be effected by the type of curing equipment used for each specific application. Curing ovens must be vented to the outdoors. In general, the cure properties of Scotch-Weld AF 126-2 are as follows:

**Cure Pressure**

Pressure is required during cure to keep parts in alignment and to overcome distortion and thermal expansion in the adherends. When bonding honeycomb sandwiches utilizing non-perforated core, pressure is required to overcome the thermal expansion of the air contained in each cell of the honeycomb. Honeycomb sections have been bonded successfully with Scotch-Weld AF 126-2 using perforated or non-perforated core under pressure of 10-25 psi (68.9-172.3 kPa)

**Cure Temperature**

The cure temperature may be varied from 225 to 350°F (107-177°C) depending upon the materials being bonded, equipment available and bond properties desired. The film will soften as temperatures are increased and will wet the surface and fillet the core to which it has been applied. A chemical cure will be initiated between 225°F (107°C) and a low strength gel formed. Continued heating chemically converts this gel into a high strength, solvent resistant bond. Cure temperatures in excess of 350°F (177°C) yield usefully, but lower than optimum strengths.

**Cure Time**

Cure time depends on the cure temperature used, methods of heat application, production, limitations and bond properties required. Since no two bonding operations are exactly alike, it is suggested that a few simple experiments be conducted varying both temperature and cure time to determine optimum conditions for the particular application.

The following cure cycle is suggested to obtain dense glue lines and was used to obtain the strengths reported in the Test Results section:

1. Apply a pressure of 50 psi (0.35 MPa) prior to reaching a bond line temperature of 150°F (65.6°C) and maintain throughout the cure cycle.
2. Raise the bond line temperature from ambient to 250°F (121°C).
3. Cure for 60 minutes at 250°F (121°C).
4. Cool to below 200°F (93.3°C) bond line temperature prior release of pressure.

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### Storage

Scotch-Weld AF 126 must be stored at 0°F (-17.8°C) or lower. Allow this product to return to room temperature before using to prevent moisture condensation on the adhesive surface or cracking during handling. Refrigerated storage at 40°F ± 5°F (4.4°C ± 2.8°C) is suggested for Scotch-Weld EC-2320. Primer should be permitted to thoroughly warm to room temperature before using in order to prevent moisture condensation.

Tentative useful life\* of Scotch-Weld AF 126 is:

1. at 0°F (17.8°C) – 6 months
2. at 40°F (4.4°C) – 30 days
3. at 75°F (24°C) – 10 days
4. at 90°F (32.2°C) – 5 days

\*as measured by peel test values.

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### Precautionary Information

See 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.

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



Aerospace Department  
Engineered Adhesives Division

3M Center, Building 220-8E-05  
St. Paul, MN 55144-1000  
Phone: 1-800-364-3577 or 651/737-6501



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