3M

# Scotch-Weld™

# Structural Adhesive Film

## AF 163-2

**Technical Datasheet** **November 2009**

**Introduction**

3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2 designates a family of thermosetting modified epoxy structural adhesives in film form which are available in a variety of weights with or without a supporting carrier. Scotch-Weld AF 163-2 Films are designed for both solid panel and honeycomb sandwich constructions.

**Advantages**

- High bond strength from -67°F to 250°F
- High fracture toughness and peel strength
- Excellent resistance to high moisture environments before and after curing
- Short cure time at 225°F (90 minutes)
- Capable of low pressure bonding
- Vacuum cure capability
- X-ray opaque (allows use of x-ray NDI methods)
- Excellent shop open time and long shelf life
- Scotch-Weld AF 163-3M Film is a higher tack version of Scotch-Weld AF 163-2 Film
- Isolating version available (Scotch-Weld AF 163-2G108 Film) for bonding dissimilar substrates
- Unsupported versions available for reticulation (Scotch-Weld AF 163-2U Film)

**Description**

The following Scotch-Weld AF 163 Films are included in this data sheet:

| Product | Weight (± .005) Lb/ft$^2$ | Color | Nominal Thickness - mils |
|---|---|---|---|
| Scotch-Weld AF 163-2G108 Film | 0.100 | Pink | 16 |
| Scotch-Weld AF 163-2K Film | 0.045 | Yellow | 7.5 |
| Scotch-Weld AF 163-2K Film | 0.060 | Red | 9.5 |
| Scotch-Weld AF 163-2K Film | 0.085 | Blue | 13 |
| Scotch-Weld AF 163-2L Film | 0.030 | Pink | 5.5 |
| Scotch-Weld AF 163-2M Film | 0.045 | Yellow | 7.5 |
| Scotch-Weld AF 163-2M Film | 0.060 | Red | 9.5 |
| Scotch-Weld AF 163-2M Film | 0.085 | Blue | 13 |
| Scotch-Weld AF 163-2OST Film | 0.030 | Green | 5.5 |
| Scotch-Weld AF 163-2OST Film | 0.045 | Green | 5.5 |
| Scotch-Weld AF 163-2OST Film | 0.060 | Red | 9.5 |
| Scotch-Weld AF 163-2U Film | 0.015 | Red | 2.5 |
| Scotch-Weld AF 163-2U Film | 0.030 | Red | 5.5 |
| Scotch-Weld AF 163-2U Film | 0.060 | Red | 9.5 |
| Scotch-Weld AF 163-3M Film | 0.030 | Green | 5.5 |

**Code:** G = fiberglass scrim
K = knit supporting carrier
L = light weight non-woven supporting carrier (Matte)
M = non-woven supporting carrier (Matte)
OST = one side tacky with non-woven carrier (Matte) on low tack surface
U = unsupported film

# 3M™ Scotch-Weld™
## Structural Adhesive Film AF 163-2
Technical Datasheet

**Product Performance**

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

### I. Typical 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2 Cured Free Film (unsupported) Properties: (cured 60 minutes at 250°F)

| Property | Typical Value | Method |
|---|---|---|
| Glass Transition (Tg) Temperature<br>Dry<br>Wet (14 days in 70°C water) | <br>226°F (108°C)<br>180°F (82°C) | <br>DuPont 1090 DMA<br>@ 5°C/min ramp |
| Thermal Conductivity @ 43°C | .096 $\frac{\text{btu-ft}}{\text{ft}^2\ \text{hr}\ °\text{F}}$ | ASTM C-177 |
| Thermal Coefficient of Expansion<br>@ -30 to 50°C | $90 \times 10^{-6}\ \frac{\text{in}}{\text{in}\ °\text{C}}$ | TMA @ 5°C/min |
| Volume Resistivity | $4.4 \times 10^{14}$ ohm-cm | ASTM D-257 |
| Dielectric Strength @<br>1 KHz @ 75°F (23°C) | <br>1800 volt/mil | <br>ASTM D-149 |

| Dielectric Constant and Dissipation Factor<br>ASTM D 150 | | |
|---|---|---|
| **Frequency** | **Dissipation Factor @ 75° (23°C)** | **Dielectric Constant @ 75° (23°C)** |
| **Scotch-Weld AF 163-2U Film** | | |
| 100 Hz | .008 | 4.8 |
| 1 KHz | .012 | 4.7 |
| 10 KHz | .016 | 4.6 |
| 100 KHz | .026 | 4.5 |
| 1 MHz | .039 | 4.3 |
| **Scotch-Weld AF 163-2K Film** | | |
| 8-12.4 GHz | .033 | 3.08 |
| 12.4-18 GHz | .029 | 3.01 |
| **Scotch-Weld AF 163-2M Film** | | |
| 8-12.4 GHz | .037 | 2.91 |
| 12.4-18 GHz | .029 | 2.74 |

**Tensile Strength and Modulus (ASTM D 638)**

**Cured:** Free Film Strips approx. 1/4" x 3" x .01" thick

**Cure:** 90 minutes at 235°F

| Temperature | Ultimate Strength (psi) | Modulus (psi) |
|---|---|---|
| -67°F | 11,000 | $2.3 \times 10^5$ |
| 75°F | 7,000 | $1.6 \times 10^5$ |
| 180°F | 3,000 | $6 \times 10^4$ |

**A. 75°F Bulk Modulus, Shear Modulus, and Poisson's Ratio – knit supported**

17 ply laminate ~ 0.1 inches thick (ASTM D 3039) cure – 60 minutes at 250°F

| | |
|---|---|
| Modulus Elasticity | $161 \times 10^3$ psi |
| Shear Modulus | $60 \times 10^3$ psi |
| Poisson's Ratio | 0.34 |

**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.**

**B. Self extinguishing Characteristics: knit supported.**

**Method:** FAR 25.853 – **Sample:** 1/4" x 1/2" x 4"

**Cure:** 60 minutes at 250°F

| Sample Orientation | Flame Exposure Time (Seconds) | Self-Extinguishing Time (Seconds) |
|---|---|---|
| 1. 4" length horizontal and 1/2" dimension vertical | 15 | 0.5 |
| 2. Same as (1.) | 60 | 3.7 |
| 3. 4" length vertical | 15 | 6.3 |
| 4. Same as (3.) | 60 | 70 |

## II. Typical Cured Bond Properties

### A. 75°F Fracture Toughness – 3M Test Method C-295

**Cure Cycle:** 235°F, 90 minutes, 35 psi, 5°F/min.

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960

**Metal:** 2024 T-3 Bare 1/2" thick aluminum – FPL etched and Phosphoric Acid Anodize

| | | 3M™ Scotch-Weld™ Structural Adhesive Film | | | |
|---|---|---|---|---|---|
| | | AF 163-2K (.06 lb/ft²) | AF 163-2OST (.03 lb/ft²) | AF 163-2OST (.06 lb/ft²) | AF 163-3M (.03 lb/ft²) |
| $G_{IC}$ | $\frac{\text{IN LBS}}{\text{IN}^2}$ | 25 | 22 | 21 | 17 |
| $G_{IA}$ | $\frac{\text{IN LBS}}{\text{IN}^2}$ | 15 | 13 | 13 | 10 |

### B. Thick Adherend Shear Properties – ASTM D5656

**Cure Cycle:** 270°F, 60 minutes, 40 psi, 1°F/min.

**Adherends:** 2024 T-3 Bare 0.25" thick aluminum – FPL etched

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

| Test Temp. | Ultimate Shear (psi) | Ultimate Elong. (in) | Yield Stress (psi) | Yield Elong. (in) | Shear Modulus (psi) |
|---|---|---|---|---|---|
| 75°F | 6950 | .0052 | 5255 | .00074 | 63,685 |
| 180°F | 5780 | .0114 | 3075 | .00079 | 26,495 |

**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.**

**C. Metal to Metal Wide Area Blister Detection Shear Strength (psi) – 3M Test Method C-2232**

**Cure:** 235°F, 90 minutes, 35 psi, 5°F/min.

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960

**Metal:** 2024 T-3 Bare .063" thick – FPL etched

| Test Temp. | 3M™ Scotch-Weld™ Structural Adhesive Film | | | | | |
|---|---|---|---|---|---|---|
| | AF 163-2OST | | AF 163-2M | AF 163-2K | | AF 163-3M |
| | .03 lb/ft² | .06 lb/ft² | .06 lb/ft² | .06 lb/ft² | .085 lb/ft² | .03 lb/ft² |
| -67°F | 5500 | 4800 | 5200 | 5400 | 5100 | 5400 |
| 75°F | 5400 | 5400 | 5100 | 5100 | 5000 | 4800 |
| 180°F | 3700 | 3800 | 3700 | 3500 | 3400 | 3400 |
| 250°F | 2400 | 2400 | 2400 | 2400 | 2200 | 2600 |

**D. Metal to Metal Overlap Shear Strength (psi) – 3M Test Method C-244 or ASTM D 1002**

**1. Cure Cycle:** 250°F, 60 minutes, 20 psi, 1°F/minute rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917

**Metal:** 2024 T-3 ALCLAD .063" thick – unsealed Chromic Acid Anodized

| Test Temp. | Scotch-Weld AF 163-2OST Film | Scotch-Weld AF 163-2M Film | Scotch-Weld AF 163-2K Film | |
|---|---|---|---|---|
| | .03 lb/ft² | .06 lb/ft² | .06 lb/ft² | .085 lb/ft² |
| -67°F | 5400 | 6400 | 6200 | 5100 |
| 75°F | 5200 | 5700 | 5800 | 5400 |
| 180°F | 3200 | 3600 | 3800 | 3800 |

**2. Cure Cycle:** 250°F, 90 minutes, 25 psi, 4°F/minute rise rate

**Primer:** None

**Metal:** 2024 T-3 Bare .063" thick – FPL etched

| Temperature | Scotch-Weld AF 163-2L Film .03 lb/ft² | Scotch-Weld AF 163-2K Film .085 lb/ft² |
|---|---|---|
| -67°F | 5970 | 6430 |
| 75°F | 5290 | 5990 |
| 180°F | 4200 | 4600 |

**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.**

**E. Metal to Metal Blister Detection Shear (psi) – 3M Test Method C-265**

**Cure Cycle:** 270°F, 60 minutes, 40 psi, 1°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal:** 2024 T-3 Bare 0.063" thick – FPL etched

| | 3M™ Scotch-Weld™ Structural Adhesive Film | |
|---|---|---|
| **Temperature** | **AF 163-2K .06 lb/ft²** | **AF 163-2M .06 lb/ft²** |
| -67°F | 6900 | 7000 |
| 75°F | 5100 | 5000 |
| 180°F | 3600 | 3600 |

**F. Metal to Metal T-Peel Strength (piw) – 3M Test Method C-252**

**Cure Cycle:** 250°F, 60 minutes, 20 psig, 1°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
**Metal:** 2024 T-3 clad .020 in. thick aluminum – unsealed Chromic Acid Anodized
**Peel Rate:** 20"/min.

| **Test Temp.** | **Scotch-Weld AF 163-2OST Film** | **Scotch-Weld AF 163-2M Film** | **Scotch-Weld AF 163-2K Film** | |
|---|---|---|---|---|
| | **.03 lb/ft²** | **.06 lb/ft²** | **.06 lb/ft²** | **.085 lb/ft²** |
| -67°F | 25 | 25 | 33 | 29 |
| 75°F | 29 | 44 | 45 | 41 |
| 180°F | 24 | 40 | 38 | 35 |
| 250°F | 20 | 30 | 28 | 20 |

**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.**

**G. Metal to Metal Floating Roller (Bell) Peel Strength (piw) – 3M Test Method C-260**

**1. Cure Cycle:** 270°F, 60 minutes, 50 psi, 1°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal:** 2024 T-3 Bare FPL etched .025" to .063" aluminum
**Peel Rate:** 6"/min.

| | 3M™ Scotch-Weld™ Structural Adhesive Film | |
|---|---|---|
| **Temperature** | **AF 163-2K .06 lb/ft²** | **AF 163-2M .06 lb/ft²** |
| -67°F | 78 piw | 58 piw |
| 75°F | 78 piw | 79 piw |
| 180°F | 76 piw | 76 piw |

**2. Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal:** 7075-T6 clad Chromic Acid Anodize, .025" to .063" Aluminum
**Peel Rate:** 6"/min.

| | Scotch-Weld AF 163-2M Film | | Scotch-Weld AF 163-2K Film |
|---|---|---|---|
| **Test Temperature** | **.045 lb/ft²** | **.085 lb/ft²** | **.045 lb/ft²** |
| -67°F | 57 | 55 | — |
| 75°F | 55 | 63 | 55 |
| 160°F | 46 | 45 | — |

**H. Metal to Metal Climbing Drum Peel Strength (in•lb/in) – 3M Test Method C-2222**

**Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** 2024 T-3 Clad aluminum .020" to .040" FPL etched
**Peel Rate:** 3"/min. (cross head speed)
**Test Temperature:** 75 ± 5°F

| Adhesive | Peel Strength (in•lb/in) |
|---|---|
| Scotch-Weld AF 163-2OST Film (.03 lb/ft²) | 70 |
| Scotch-Weld AF 163-2OST Film (.06 lb/ft²) | 75 |
| Scotch-Weld AF 163-2K Film (.06 lb/ft²) | 80 |
| Scotch-Weld AF 163-2M Film (.06 lb/f²) | 80 |
| Scotch-Weld AF 163-3M Film (.03 lb/ft²) | 60 |

**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.**

**I. Metal to Honeycomb Climbing Drum Peel Strength (in•lb/in) – 3M Test Method C-245**

**1. Cure Cycle:** 250°F, 60 minutes, 20 psi, 1°F/min. rise rate
**Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
**Skins:** 2024 T-3 0.020" thick aluminum – Chromic Acid Anodized
**Core:** 1/4" cell – 1/2" thick – 4 mil foil – 5052 alloy – non perforated
**Test Rate:** 1.0"/min. (cross head speed)

| | Peel Strength (in•lb/in) | |
|---|---|---|
| | 3M™ Scotch-Weld™ Structural Adhesive Film | |
| | AF 163-2K | AF 163-2M |
| Test Temperature | .06 lb/ft² | .06 lb/ft² |
| -67°F | 20 | 17 |
| 75°F | 23 | 26 |
| 180°F | 18 | 19 |
| 250°F | 9 | 9 |

**2. Cure Cycle:** 250°F, 60 minutes, 30 psi, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Skin and Core:** Same as (1.) above
**Test Rate:** 1.0"/min. (cross head speed)

| | Peel Strength (in•lb/in) | | |
|---|---|---|---|
| | Scotch-Weld AF 163-2K Film | Scotch-Weld AF 163-2M Film | Scotch-Weld AF 163-2M Film |
| Test Temperature | .045 lb/ft² | .045 lb/ft² | .085 lb/ft² |
| -67°F | – | 15 | 33 |
| 75°F | 15 | 15 | 39 |
| 160°F | – | 12 | 34 |

**3. Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min.
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Skins:** 2024 T-3 0.020" aluminum – FPL etched
**Core:** Same as (1.) above
**Test Rate:** 3"/min. (cross head speed)

| Adhesive | 75°F Peel Strength (in•lb/in) |
|---|---|
| Scotch-Weld AF 163-2K Film (.06 lb/ft²) | 22 |
| Scotch-Weld AF 163-2K Film (.085 lb/ft²) | 35 |
| Scotch-Weld AF 163-2M Film (.06 lb/ft²) | 24 |
| Scotch-Weld AF 163-2M Film (.085 lb/ft²) | 35 |
| Scotch-Weld AF 163-2OST Film (.06 lb/ft²) | 20 |

**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. Cure Cycle:** 270°F, 60 minutes, 50 psi, 1°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Skins:** Same as (3.) above
**Core:** 3/16" cell – 1/2" thick – 5052 alloy – non perforated
**Test Rate:** 1.0"/min. (cross head speed)

| | Peel Strength (in•lb/in) | | |
|---|---|---|---|
| | 3M™ Scotch-Weld™ Structural Adhesive Film | | |
| | AF 163-2U | | AF 163-2K |
| Test Temperature | .03 lb/ft² | .06 lb/ft² | .06 lb/ft² |
| -67°F | – | – | 33 |
| 75°F | 15 | 36 | 31 |
| 160°F | – | – | 24 |

**J. Metal to Honeycomb Flatwise Tensile (psi) – 3M Test Method C-251**

**1. Cure Cycle:** 250°F, 60 minutes, 20 psig, 1°F/min. rise rate
**Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
**Metal:** Skins: 2024 T-3 aluminum – Chromic Acid Anodized
**Core:** 1/4" cell – 1/2" thick – 4 mil foil – 5052 alloy – non perforated

| | Flatwise Tensile Strength (psi) | |
|---|---|---|
| | Scotch-Weld AF 163-2K Film | |
| Test Temperature | .06 lb/ft² | .085 lb/ft² |
| -67°F | 1700 | 1800 |
| 75°F | 1200 | 1400 |
| 180°F | 700 | 800 |
| 250°F | 260 | 290 |

**2. Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate
**Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal & Core:** same as (1.) above

| | Flatwise Tensile Strength (psi) | | |
|---|---|---|---|
| | Scotch-Weld AF 163-2M Film | | |
| Test Temperature | .045 lb/ft² | .06 lb/ft² | .085 lb/ft² |
| -67°F | 1400 | – | 1900 |
| 75°F | 935 | 1150 | 1500 |
| 160°F | 625 | 750 | 990 |

**3. Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min. rise rate
**Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** Skins; 2024 T-3 aluminum – FPL etched
**Core:** same as (1.) above

| | Flatwise Tensile Strength (psi) | | | | |
|---|---|---|---|---|---|
| | Scotch-Weld AF 163-2U Film | | Scotch-Weld AF 163-2K Film | | Scotch-Weld AF 163-2OST Film |
| Test Temperature | .03 lb/ft² | .06 lb/ft² | .06 lb/ft² | .085 lb/ft² | .06lb/ft² |
| 75°F | 800 | 1200 | 1150 | 1350 | 1150 |
| 180°F | 500 | 700 | 650 | 800 | 625 |
| 250°F | – | – | 250 | 275 | 250 |

**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.**

**K. Metal to Honeycomb Beam Flexure Strength (lbs) – 3M Test Method C-250**
**Cure Cycle:** 250°F, 60 minutes, 30 psi, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal:** 2024 T-3 Bare 0.063" thick aluminum – Chromic Acid Anodized
**Core:** 1/4" cell – 1/2" thick – 5052 Alloy – 4 mil foil – non perforated

| Test Temperature | Scotch-Weld AF 163-2M Film | | |
|---|---|---|---|
| | .045 lb/ft² | .06 lb/ft² | .085 lb/ft² |
| -67°F | 3050 | 3150 | 3200 |
| 75°F | 2850 | 3160 | 3200 |
| 160°F | 2100 | 2600 | 2860 |

**L. Typical Metal to Metal Fatigue Resistance:**

**1. Wide Area Blister Shear Type Specimens (psi) – 3M Test Method C 2232 (1/4" overlap)**
**Cure Cycle:** 235°F, 90 minutes, 35 psi, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** 2024 T-3 Bare .063" thick aluminum – FPL etched
**Max. Stress:** 1500 psi **Stress Ratio:** 0.1 **Rate:** 1800 cycles/min.
**Test Temperature:** 75 ± 5°F
**Results:** Under these conditions Scotch-Weld AF 163-2 Films have yielded greater than $10^7$ cycles without adhesive failure

**2. Double Lap Strap:** 6, 4 Titanium Specimens
**Cure Cycle:** 250°F, 60 min., 20 psig, 1°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917 **Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2K (.06 lb/ft²)
**Metal:** 6, 4 Titanium alloy – phosphate fluoride etched
Center Adherends 1" x 4 5/8" x 0.125"
Straps 1" x 1 5/8" x .063"
**Stress Ratio** = 0.1 Rate = 1800 cycles/min. Test temp. = 75°F ± 5°F
**Shear Area** – 1.5 in²

| Max. Stress (psi) | Avg. Life (Cycles) |
|---|---|
| 4500 | $1.58 \times 10^4$ |
| 4000 | $5.28 \times 10^4$ |
| 3500 | $4.75 \times 10^5$ |
| 3000 | $2.67 \times 10^6$ |
| 2200 | $1.03 \times 10^7$ + (No failure; test discontinued) |

**M. Typical Creep Resistance**

**1. Metal to Metal Wide Area Shear Specimens (psi) – 3M Test Method C-2232**
**Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** 2024 T-3 Bare .063" thick aluminum – FPL etched

| Adhesive | | Creep after 192 hours | |
|---|---|---|---|
| | | 75°F @ 1600 psi | 180°F @ 800 psi |
| Scotch-Weld F 163-2K Film | .06 lb/ft²<br>.085 lb/ft² | Less than 0.0003"<br>Less than 0.0003" | < .0012"<br>< .0015" |
| Scotch-Weld AF 163-2OST Film | .03 lb/ft²<br>.06 lb/ft² | Less than 0.0003"<br>Less than 0.0003" | Less than 0.0003"<br>Less than 0.0003" |

**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.**

**2. Metal to Metal Overlap Shear Specimens (psi) – 3M Test Method C-244**

**Cure Cycle:** 250°F, 60 minutes, 30 psi, 5°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal:** 7075 T-6 Clad .063" thick aluminum – Chromic Acid Anodized

| | Creep after 192 hours | |
|---|---|---|
| **Adhesive** | **75°F @ 1600 psi** | **160°F @ 1200 psi** |
| Scotch-Weld AF 163-2M Film .085 | Less than 0.0003" | Less than 0.0003" |

**3. Metal to Honeycomb Creep Deflection in Flexure – (Mil-A-25463 method)**

**Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal:** 2024 T-3 Bare 0.063" thick aluminum – Chromic Acid Anodized

**Core:** 1/4" cell – 1/2" thick – 5052 Alloy – 4 mil foil – non perforated

| | Deflection after 192 hours | | | | | |
|---|---|---|---|---|---|---|
| | 75°F Test | | 160°F Test | | 180°F Test | |
| **Adhesive Load:** | **970 lbs.** | **1500 lbs.** | **970 lbs.** | **1500 lbs.** | **970 lbs.** | **1500 lbs.** |
| Scotch-Weld AF 163-2M Film (.045 lb/ft$^2$) | .0005" | – | .003" | – | .005" | – |
| (.085 lb/ft$^2$) | – | 0.0011" | – | .006" | – | .017" |

**N. Typical Bond Strengths on Other Substrates**

**Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2M Wt. .045

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

| | 3M Test Method C-244 L/T = 8 Shear (psi) | | 3M Test Method C-260 6"/min. Floating Roller Bell Peel (piw) |
|---|---|---|---|
| **Substrates** | **75°F** | **180°F** | **75°F** |
| 7575 T6 Clad | .063" Thick Metal | | .025" Thick Metal Peel Skin |
| FPL - Etch | 6050 | 3500 | 65 |
| 6, 4 Titanium | .063" Thick Metal | | .014" Thick Metal Peel Skin |
| Phosphate Fluoride Etch | 6825 | 3650 | 45 |
| 301 Stainless Steel | .063" Thick Metal | | .020" Thick Metal Peel Skin |
| Phosphate Fluoride Etch | 6260 | 3750 | 60 |
| Epoxy FRP ("Scotchply" Brand Type 116) | 0.150" Thick Skin | | – |
| Abrade & degrease - unprimed | 4300* | 2300* | – |

*Interlaminar adherend failure

**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.**

## O. MMM-A-132B Type I Test Data

Cure Cycle: 250°F – 90 minutes – 25 psig – 4 to 5°F per minute rise rate.

| MMM-A-132B Test | MMM-A-132B Type I Class 2 Requirements | Scotch-Weld AF 163-2U Film (.06 lb/ft²) with Scotch-Weld EC-3960 Primer |
|---|---|---|
| 75°F shear | 3500 psi | 6377 psi |
| 180°F shear | 2000 psi | 4003 psi |
| -67°F shear | 3500 psi | 6600 psi |
| 75°F shear after 30 days at 120°F and 95-100% RH | 3500 psi | 6067 psi |
| 75°F shear after immersion | | |
| a.) 7 days in MIL-H-83282 | 3250 psi | 6067 psi |
| b.) 7 days in MIL-T-5624 | 3250 psi | 6190 psi |
| 75°F Fatigue | 750 psi $10^6$ | No Failure |
| 75°F creep, 1600 psi – 192 hours | 0.015" maximum | 0 |
| 180°F creep, 800 psi – 192 hours | 0.015" maximum | 0.0002" |
| Blister Detection @ 75°F | 3250 psi | 5057 psi |
| T-Peel @ 75°F | 20 lb/in | 38 lb/in |

## P. MIL-A-25463B Type I Test Data

| Description Test Number | MIL-A-25463B Type I Class 2 Requirements | Scotch-Weld AF 163-2U Film (.06 lb/ft²) with Scotch-Weld EC-3960 Primer |
|---|---|---|
| Sandwich Peel (in•lb/in) | | |
| Normal Temp. | 12.5 | 27.6 |
| 180 ± 2°F | 10 | 23.8 |
| -67 ± 2°F | 10 | 24.0 |
| Flatwise Tensile Strength (psi) | | |
| Normal Temp. | 750 | 1408 |
| 180 ± 5°F | 400 | 743 |
| -67 ± 2°F | 800 | 1858 |
| Flexural Strength (lbs) | | |
| Normal Temp. | 2100 | 3202 |
| 180 ± 5°F | 1275 | 2263 |
| -67 ± 2°F | 2150 | 3163 |
| Flexural Strength after 192 hours Exposure (lbs) | | |
| 180 ± 5°F | 1500 | 2648 |
| Creep Deflection flexure when loaded for max. 192 hours max. deflection (inch) | | |
| Normal Temp. 1000 lbs. load (inch) | 0.025 | 0.006 |
| 180 ± 5°F/800 lbs. load (inch) | 0.05 | 0.0033 |
| Flexure Strength after 30 days exposure (lbs) | | |
| To 95 to 100% RH at 120 ± 2°F | 1800 | 3082 |
| To turbine fuel JP-4 of MIL-T-5624 | 1800 | 3162 |

**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.**

### III. Typical Performance after Environmental Exposure

#### A. Metal to Metal Overlap Shear Strength (psi) – 3M Test Method C-244

**Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal:** 7075 T-6 Clad 0.063" thick – Chromic Acid Anodized

**Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2M (.085 lb/ft$^2$)

**Specimens:** Precut to 1" width prior to exposure

**Test Temperature:** 75°F

| Environmental Exposure | Shear Strength (psi) |
|---|---|
| 1. Control (No Exposure) | 6345 |
| 2. 7 day immersion in JP-4 | 6570 |
| 3. 7 day immersion in Mil-F-5566 | 6365 |
| 4. 7 day immersion in Mil-H-5606 | 6465 |
| 5. 7 day immersion in Type III Hydrocarbon | 6510 |
| 6. 30 day water immersion | 5860 |
| 7. 30 day 5% Salt Spray Exposure | 5930 |
| 8. Cyclic Humidity Exposure a) 15 Cycles<br>b) 30 Cycles<br>c) 45 Cycles | 6245<br>5510<br>5655 |

*Each Cycle: 16 hours @ 125°F at 95-100% RH followed by 8 hours at -67°F.

#### B. Metal to Metal Blister Detection Shear (psi) – 3M Test Method C-265

**Cure Cycle:** 270°F, 40 psi, 60 minutes, 1°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal:** 2024 T-3 Base .063" thick aluminum – FPL etch

**Adhesive:** Scotch-Weld AF 163-2K Film (.06 lb/ft$^2$)

**Specimens:** Precut to 1.0" width and notched prior to exposure

**Test Temperature:** 75°F

| Environmental Exposure | Shear Strength (psi) |
|---|---|
| 1. Control (No Exposure) | 5095 |
| 2. 7 day immersion in JP-4 | 5065 |
| 3. 7 day immersion in Mil-F-5606 | 5050 |
| 4. 7 day immersion in Mil-L-7808 | 5005 |
| 5. 30 day Exp. 120°F – 95 to 100% RH | 4980 |
| 6. 30 day Exp. to 5% Salt Spray | 5030 |

**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.**

**C. Metal to Metal Floating Roller (Bell) Peel (piw) – 3M Test Method C-260**
**Cure Cycle:** (same as B.)
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
**Metal:** 2024 T-3 Bare .025" thick to .063" thick aluminum – FPL etched
**Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2K (.06 lb/ft$^2$)
**Specimens:** Precut to 1" wide before exposure
**Test Temperature:** 75°F
**Peel Rate:** 6"/min.

| Environmental Exposure | Peel Strength (piw) |
|---|---|
| 1. Control (No Exposure) | 82 |
| 2. 7 day immersion in JP-4 | 83 |
| 3. 7 day immersion in Mil-H-5606 | 85 |
| 4. 7 day immersion in Mil-L-7808 | 85 |
| 5. 30 day Exposure 120°F and 95 to 100% RH | 80 |
| 6. 30 day 5% Salt Spray Exposure | 82 |

**D. Metal to Metal Wide Area Blister Detection Shear (psi) – 3M Test Method C-2232**
**Cure Cycle:** 235°F, 90 minutes, 35 psi, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** 2024 T-3 Bare .063" thick – FPL etched
**Specimens:** Precut to 1" width and notched prior to exposure
**Test Temperature:** 75°F

| | Shear Strength (psi) | | | |
|---|---|---|---|---|
| | Scotch-Weld AF 163-2OST Film | | Scotch-Weld AF 163-2K Film | |
| Environmental Exposure | .03 lb/ft$^2$ | .06 lb/ft$^2$ | .06 lb/ft$^2$ | .085 lb/ft$^2$ |
| 1. Control (No Exposure) | 5405 | 5280 | 5105 | 5115 |
| 2. 7 day JP-4 minimum (75°F) | 5345 | 5255 | 5225 | 5079 |
| 3. 7 day Type III Hydrocarbon immersion (75°F) | 5340 | 5315 | 5255 | 5160 |
| 4. 7 day Skydrol 500B immersion (150°F) | 5400 | 5470 | 5214 | 5135 |
| 5. 30 day 5% Salt Spray | 5330 | 5105 | 4865 | 4635 |
| 6. 30 day 120°F 95-100% RH | 5360 | 5200 | 4940 | 4735 |

**E. Metal to Metal $G_{I_{SCC}}$ – Crack Extension at 140°F and 95-100% RH – 3M Test Method C-295**
**Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min. rise rate
**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
**Metal:** 2024 T-3 Bare 0.5" thick aluminum – phosphoric acid anodized
**Specimen:** DCB specimen precut to 1" width prior to exposure

| | (in•lb/in$^2$) | | | |
|---|---|---|---|---|
| | Scotch-Weld AF 163-2OST Film | | Scotch-Weld AF 163-2K Film | |
| Exposure | | | | |
| Film Weight (lb/ft$^2$) | .03 | .06 | 7.2 | 8.5 |
| 2500 hours | 6.4 | 7.5 | 7.2 | 8.5 |

**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.**

**F. Metal to Honeycomb Beam Flexure Strength (lb) – 3M Test Method C-250**

**Cure Cycle:** 250°F, 60 minutes, 30 psi, 5°F/min.

**Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal Skins:** 2024 T-3 Bare .063" thick aluminum – Chromic Acid Anodized

**Core:** 1/4" cell – 1/2" thick – 4 mil foil – 5052 Alloy – non perforated

**Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2M (.045 lb/ft$^2$)

| Environmental Exposure | 75°F Flexural Strength (lb) |
|---|---|
| 1. Control (No Exposure) | 2850 |
| 2. 30 day immersion in Type III Hydrocarbon | 2800 |
| 3. 30 day 5% Salt Spray | 2800 |
| 4. *Cyclic Exposure – 45 Cycles | 2900 |

**G. Metal to Honeycomb Flatwise Tensile Strength – 3M Test Method C-251 conditions as per (F.) above**

| Environmental Exposure | 75°F Flatwise Tensile Strength (psi) |
|---|---|
| 1. Control (No Exposure) | 935 |
| 2. Cyclic Exposure: 15 Cycles*<br>45 Cycles* | 865<br>870 |

*Each Cycle: 16 hours at 125°F and 95-100% RH followed by 8 hours at -67°F.

**IV. Typical Performance after Open Time at 90°F and 75% RH**

**Cure Cycle:** 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

**Metal Skin Prep:** Chromic Acid Anodize

**Core:** 1/4" cell – 1/2" thick – 4 mil foil – 5052 Alloy – non-perforated

**Exposure Method:** Adhesive applied to Primed Skin with liners removed and exposed open face

**A. 75°F Overlap Shear on 7075-T6 Clad .063" Thick – 3M Test Method C-244**

| Exposure Time | Scotch-Weld AF 163-2M Film (.045 lb/ft$^2$) |
|---|---|
| 0 | 6300 psi |
| 7 days | 6400 psi |
| 15 days | 6500 psi |

**B. Floating Roller (Bell) Peel on 7075 T-6 Clad .025" to .063" aluminum – 3M Test Method C-260**

| Exposure Time | Scotch-Weld AF 163-2M Film (.045 lb/ft$^2$) | | |
|---|---|---|---|
| | -67°F Test | 75°F Test | 160°F Test |
| 0 | 57 piw | 55 piw | 46 piw |
| 7 days | 55 piw | 61 piw | 50 piw |
| 15 days | 59 piw | 55 piw | 44 piw |

**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.**

**C. 75°F Honeycomb Peel 2024 T-3 Bare .020 Aluminum Skins (in•lb/in) – 3M Test Method C-245**

| Exposure Time | 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2M | |
|---|---|---|
| | .045 lb/ft² | .085 lb/ft² |
| 0 | 15 in•lb/in | 39 in•lb/in |
| 7 days | 15 in•lb/in | 31 in•lb/in |
| 15 days | 11 in•lb/in | 26 in•lb/in |

**D. 75°F Honeycomb Flatwise Tensile 2024 T-3 Bare Aluminum Skins (psi) – 3M Test Method C-251**

| Exposure Time | Scotch-Weld AF 163-2M Film | |
|---|---|---|
| | .045 lb/ft² | .085 lb/ft² |
| 0 | 935 | 1500 |
| 7 days | 1050 | 1600 |
| 15 days | 1000 | 1570 |

**V. Typical Metal to Metal 200°F Cure Performance:**

**Cure Cycle:** 200° ± 5°F, 50 psi, 1°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

| Cure Time | Scotch-Weld AF 163-2K Film (.06 lb/ft²) | | |
|---|---|---|---|
| | Blister Detection Shear 3M Test Method C-265 | | Floating Roller (Bell) Peel 3M Test Method C-260 |
| | 75°F | 180°F | 75°F |
| A. 2 hours | 4120 psi | 1750 psi | 68 piw |
| B. 4 hours | 4580 psi | 2880 psi | 76 piw |
| C. 6 hours | 4700 psi | 3280 psi | 77 piw |

**VI. Typical Vacuum Cure Performance**

**Cure:** 250°F, 60 minutes, 5°F/min. rise rate

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960

**Overlap Shear:** 3M Test Method C-244: 2024 T-2 .063" thick aluminum

**Honeycomb Peel:** 3M Test Method C-245: 1/4" cell Core – 2024 T-3 .020" thick aluminum skins

**Peel Rate:** 3"/min. (cross head speed)

| Pressure or Vacuum | Scotch-Weld AF 163-2K Film .06 | | Scotch-Weld AF 163-2M Film .06 | | Scotch-Weld AF 163-2OST Film .03 |
|---|---|---|---|---|---|
| | Overlap Shear 75°F (psi) | Honeycomb Peel 75°F (in•lb/3") | Overlap Shear 75°F (psi) | Honeycomb Peel 75°F (in•lb/3") | Overlap Shear 75°F (psi) |
| A. 25 psig positive pressure | 5700 | 77 | 6200 | 74 | 5600 |
| B. 9-11 Inches Hg | 5700 | 65 | 6000 | 75 | 5200 |
| C. 16-18 Inches Hg | 3800 | 54 | 6000 | 67 | 5500 |
| D. 24-26 Inches Hg | 3300 | 45 | 4800 | 59 | 5200 |

**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.**

**VII. Effect of rise rate on Typical Metal to Metal Properties**

**Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
**Metal Prep:** Chromic Acid Anodize
**Metal:** T-Peel 3M Test Method C-252: 2024 T-3 Clad .020" aluminum
OLS 3M Test Method C-244: 2024 T-3 Clad .063" aluminum
**T-Peel Rate:** 20"/min.
**Adhesive:** 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2K .06

| | | | |
|---|---|---|---|
| **Cure Temperature** | 250°F | 250°F | 250°F |
| **Cure Time** | 60 min | 60 min | 60 min |
| **Cure Pressure** | 20 psig | 20 psig | 50 psig |
| **Rise Rate** | 1°F/min | 8°F/min | 20°F/min |
| **75°F Overlap Shear** | 5760 psi | 5840 psi | 5460 psi |
| **75°F T-Peel** | 45 piw | 46 piw | 45 piw |

**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. 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), 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® Aluminum Cleaner 164 solution 9-11 oz./gallon of water at 190° ± 10°F for 10 to 20 minutes. Rinse immediately in large quantities of cold running water (3M Test Method C-2802).
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 |

**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°F (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.

**Product Application**
***(continued)***

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 (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.

**B. Aluminum Honeycomb Core**

1. Soak in clean aliphatic naphtha (conforming to TT-N-95A) for five minutes at room temperature. Dry 10 minutes at 140°F (maximum).
2. Optional – Immerse in etching solution above for 2 minutes 155 ± 5°F. Rinse, air dry and force dry in a similar manner to skins.

**C. Titanium CP or 6AI 4V** both Turco® 5578-L and improved phosphate fluoride processing have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2.

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 ± 5°F in the following bath:
   Turco® 5578-L – 420 grams
   Distilled water – Balance to make 1 liter
4. Immerse for 1 minute in 170 ± 5°F distilled water.
5. Spray rinse for 5 minutes in hot tap water ~ 130°F.
6. Air dry for 10 to 20 minutes.
7. Force dry for 15 minutes at 140°F (maximum).
8. It is advisable to bond or prime freshly cleaned surfaces within four hours.

**D. Stainless Steel – Type 301**

1. Vapor hone 140 grit in water.
2. Rinse thoroughly in clear running tap water.
3. Alkaline degrease – see procedure above.
4. Rinse thoroughly in clear running tap water.
5. Immerse for 10 minutes at 75 ± 5°F in the following bath:

| | |
|---|---|
| Distilled Water | 73-95 oz/gal |
| Nitric Acid 42° Be | 30-50 oz/gal |
| Hydrofluoric Acid 70% | 3-5 oz/gal |

6. Rinse thoroughly in clear running tap water.
7. Air dry for 10-20 minutes.
8. Force dry for 15 minutes at 150°F.
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 paper or Scotch-Brite™ Pad (do not cut through resin into reinforcing fibers).
2. Degrease using acetone or MEK/MIBK* or equivalent type solvent using an unsized cheesecloth pad.
3. Air dry for two hours minimum.

***Note:** When using sovlents, extinguish all ignition sources, and follow manufacturers directions and precautions for use.

**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, EC-3980 and EC-3917 have all been successfully used with 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2. Because of its characteristics which allow both spray and brush application methods, Scotch-Weld EC-3924B Primer is normally suggested for use with Scotch-Weld AF 163-2 Films. For suggested application techniques, refer to the respective primer data sheets.

**III. Primer Coverage**

For the primers noted above, the optimum mechanical property test performance with Scotch-Weld AF 163-2 Film will normally be found with a uniform primer coverage in the 1-3 g/m$^2$ range (dry weight). This is approximately 0.1 mils as measured by an isometer or equivalent thin film measuring instrument. As the primer weight is increased a gradual decrease in low temperature peel strength will be found along with increasing levels of cohesive fracture in the primer layer (exception: properly controlled 180° T-Peel does not normally show this effect). Where specific tests and required strength levels are involved, a few simple experiments with varied primer coverage will be required to establish an allowable primer coverage range. Further applications can then be controlled by correlating color or thickness standards for the acceptable range.

**IV. Primer Dry**

The following cycle is suggested for these primers when used with Scotch-Weld AF 163-2 films:

Air dry: 60 minutes followed by a
Force dry: 60 minutes at 250° to 300°F.

Normally optimum performances will be found at the higher end of the force dry temperature range when used with Scotch-Weld AF 163-2 Films.

**Note:** Use of these primers without a force dry is not recommended in conjunction with Scotch-Weld AF 163-2 Films and is subject to very strict limitations. Consult your 3M Sales Representative.

**V. Adhesive Film Application**

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

**Layup:**

**A. Scotch-Weld AF 163-2U, M, or K 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.

**Product Application** ***(continued)***

**B. 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2OST**

Scotch-Weld OST Films are designed to facilitate the removal of air from large area solid panel construction. Application of vacuum to the assembly prior to and during the initial heat cycle is normally required (see cure conditions below).

1. Cut a portion of film sufficient for the application with the liner in place.
2. Remove the protective liner and apply the high tack side of the film against the substrate (high tack side is adjacent to the liner).
3. Position the film and rub out all air between the adhesive and the substrate (use of a rubber and roller will facilitate this process).
4. Complete assembly and cure.

## VI. Cure Conditions & Characteristics

Scotch-Weld AF 163-2 Films are designed to provide short cure times in the 225 to 300°F temperature range. While performance outside this cure temperature range has not been fully investigated, limited results suggest that cure temperatures as high as 350°F may be used as well as longer cure times at 200°F (6 hrs.) to obtain useful performance.

**A. Weight Loss During Cure (3M Test Method C-274):** Less than 1% (60 min at 250°F)

**B. Gel Time:** The following times are typically required to convert the Scotch-Weld AF 163-2 Film resin system to a low strength, rubbery solid on a pre-heated stage.

| Temperature | Gel Time |
|---|---|
| 200°F | 103 minutes |
| 225°F | 47.5 minutes |
| 250°F | 20.5 minutes |
| 275°F | 10 minutes |
| 300°F | 5.5 minutes |

**C. Flow During Cure (3M Test Method C-261):**

The following levels are typical averages for Scotch-Weld AF 163-2 and Scotch-Weld AF 163-3M Films using a cure of 235°F, 30 minutes, 35 psig, 5°F/min rise rate

| Adhesive | % Flow (area increases) |
|---|---|
| Scotch-Weld AF 163-3M Film (.03 lb/ft$^2$) | 250% |
| Scotch-Weld AF 163-2OST Film (.03 lb/ft$^2$) | 225% |
| Scotch-Weld AF 163-2K Film (.06 lb/ft$^2$) | 350% |
| Scotch-Weld AF 163-2M Film (.06lb/ft$^2$) | 400% |
| Scotch-Weld AF 163-2K Film (.085 lb/ft$^2$) | 450% |

**D. Cure Time and Temperature**

1. For temperatures from 250°F to 300°F, a cure time of 60 minutes at temperature is suggested.
2. For temperatures between 225°F and 250°F, a cure time of 90 minutes at temperature is suggested.
3. A cure temperature of 350°F for 2 hours did not result in an overcure (gave equivalent performance to a 1 hour at 250°F cure).

Following cure, it is suggested that pressure be maintained until the assembly has been cooled to 150°F or below.

**E. Heat up rate**

Bond line temperature rise rates between 1°F/min. and 20°F/min. have been used successfully with Scotch-Weld AF 163-2 Films. It must be noted that hot entry cures at 300°F and above can be expected to produce reduced performance due to formation of bond line porosity.

**Product Application** ***(continued)***

**F. Cure Pressure**

**1. 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. Positive pressure between 20 and 80 psi have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AF 163-2. For very small area bonds, however, pressures at the higher end of this range 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 to further assist in providing void free bonds.

**Note:** When using Scotch-Weld AF 163-2OST Films it is essential that these suggested vacuum application steps be included to gain the full effect of the air removal potential of the OST construction.

**2. Vacuum Curing**

Scotch-Weld AF 163-2 Films can be successfully cured using vacuum cure techniques. For performance comparable to positive pressure cures, Scotch-Weld AF 163-2K Films should be cured using a vacuum level in the range of 8-12 inches of mercury. Higher vacuum levels yield excessive porosity and corresponding strength reductions. Scotch-Weld AF 163-2M and OST Film versions have shown a high level of performance retention across the 10-25 inches of mercury vacuum level range.

**Storage**

Storage Stability – Storage at 0°F or below is recommended for Scotch-Weld AF 163-2 Films to obtain maximum storage life. Scotch-Weld AF 163-2 Films can be left out of cold storage (80°F maximum) for 20 days without adversely affecting its performance.

**Shelf Life**

Standard shelf life of Scotch-Weld AF 163-2 Film at 0°F or below is 12 months from date of shipment in the original unopened container.

**Note:** Scotch-Weld AF 163-2 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).

# 3M™ Scotch-Weld™
## Structural Adhesive Film AF 163-2
Technical Datasheet

**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, please visit www.3M.com/msds or call 1-800-364-3577 or (651) 737-6501.

**For Additional Information**

In the U.S., call toll free 1-800-235-2376, or fax 1-800-435-3082 or 651-737-2171. For U.S. Military, call 1-866-556-5714. If you are outside of the U.S., please contact your nearest 3M office or one of the following branches:

| | | | |
|---|---|---|---|
| **Australia** | **Austria** | **Brazil** | **Canada** |
| 61-2-498-9711 tel | 01-86686-298 tel | 55 19 3838-7876 tel | 800-410-6880 ext. 6018 tel |
| 61-2-498-9710 fax | 01-86686-229 fax | 55 19 3838-6892 fax | 800-263-3489 fax |
| **China** | **Denmark** | **France** | **Germany** |
| 86-21-62753535 tel | 45-43-480100 tel | 0810-331-300 tel | 02131-14-2344 tel |
| 86-21-62190698 fax | 45-43-968596 fax | 30-31-6195 fax | 02131-14-3647 fax |
| **Italy** | **Japan** | **Korea** | **Netherlands** |
| 02-7035-2177 tel | 03-3709-8245 tel | 02-3771-4114 tel | 31-71-5-450-272 tel |
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