

# > FM<sup>®</sup> 73 EPOXY FILM ADHESIVE

TECHNICAL DATA SHEET

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## DESCRIPTION

FM<sup>®</sup> 73 film adhesive is a toughened, general purpose aerospace epoxy designed to provide excellent structural performance from -67°F to 180°F (-55°C to 82°C). FM 73 film adhesive is formulated to provide outstanding durability in bonding metals and is also suitable for bonding many structural composite systems.

Extensive testing has proven that FM 73 adhesive meets stringent environmental resistance and bonding durability requirements. To achieve maximum environmental resistance and bonding durability the use of BR<sup>®</sup> 127 corrosion inhibiting primer is recommended in bonding metallic components.

## FEATURES & BENEFITS

- Demonstrates excellent peel strength and structural performance from -67°F to 180°F (-55°C to 82°C)
- Resistant to pre-bond humidity exposure
- Good moisture and corrosion resistance in high humidity
- Shop life of 15 days at 75°F (24°C)

## SUGGESTED APPLICATIONS

- Metal-to-metal bonding
- Composite-to-composite bonding
- Composite-to-metal bonding

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### CHARACTERISTICS

#### General Information

FM 73 adhesive is manufactured as a supported film with either knit or mat carrier, or as an unsupported film. FM 73 adhesive supported with a knit carrier offers optimum mechanical performance while the random mat version, FM 73 M adhesive, provides superior handling characteristics. FM 73 M adhesive can be supplied in a one-side tacky (OST) version which allows bonding of large metal parts without concerns of trapping air during lay-up. In addition, FM 73M OST adhesive film can be manufactured in widths up to 72 inches (183 cm) to accommodate large part fabrication.

A shop life in excess of 30 days at conditions of 75°F (24°C) or below allows the user a great deal of freedom in material handling and inventory control.

Table 1 | Product description

Product Number	Nominal Weight, lb/ft <sup>2</sup> (g/m <sup>2</sup> ) <sup>1</sup>	Nominal Thickness, inches (mm)	Color	Carrier
FM 73 film adhesive	0.045 (210)	0.007 (0.18)	Yellow	Polyester knit, both sides tacky
	0.060 (300)	0.010 (0.25)	Yellow	
	0.085 (420)	0.015 (0.38)	Yellow	
FM 73M film adhesive	0.030 (150)	0.005 (0.13)	Dark Green	Polyester mat, both sides tacky
	0.045 (210)	0.007 (0.18)	Yellow	
	0.060 (300)	0.010 (0.25)	Yellow	
	0.085 (420)	0.015 (0.38)	Yellow	
FM 73M OST film adhesive	0.030 (150)	0.005 (0.13)	Dark Green	Polyester mat, one side tacky
	0.060 (300)	0.010 (0.25)	Yellow	
	0.085 (420)	0.015 (0.38)	Yellow	
FM 73U film adhesive	0.020 (100)	0.0035 (0.09)	Green	Unsupported
	0.030 (150)	0.005 (0.13)	Yellow	

<sup>1</sup> Weight tolerance equals nominal weight ± 0.005 lb/ft<sup>2</sup> (± 25 g/m<sup>2</sup>)

Table 2 | Handling properties

Volatiles	1.25% maximum
Outgassing properties (after complete cure)	0.78% TWL and 0.00% CVCM (NASA Reference Publication 1124, Rev. 8/87)
Recommended storage	Store at or below 0°F (-18°C)
Shelf life	12 months from date of shipment at recommended storage conditions
Shop life	15 days at or below 75°F (24°C)

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**Table 3 | Product description: BR 127 corrosion inhibiting primer**

<b>Color</b>	Yellow
<b>Solids</b>	10% ± 1% sprayable
<b>Density</b>	7.3 lb/gal (875 g/liter)
<b>Shop life</b>	10 days at 90°F (32°C)
<b>Shelf life</b>	12 months from date of shipment at recommended storage conditions
<b>Recommended storage</b>	Store at or below 0°F (-18°C)

The following products are recommended for use with FM 73 film adhesive:

- BR<sup>®</sup> 127 corrosion inhibiting primer
- FM<sup>®</sup> 410 -1 and FM<sup>®</sup> 490A core splice foam adhesives for honeycomb splicing and bonding to spars
- CYCOM<sup>®</sup> 919 advanced composites
- CYCOM<sup>®</sup> 950 advanced composites

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### PROPERTIES

Table 4 | Mechanical Performance: Metal-to-Metal<sup>1</sup>

Property and Test Condition <sup>2</sup>	FM 73M 0.03 lb/ft <sup>2</sup> (150 g/m <sup>2</sup> )	FM 73M OST 0.03 lb/ft <sup>2</sup> (150 g/m <sup>2</sup> )	FM 73M 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )
<b>Tensile shear, psi (MPa)</b>			
-67°F (-55°C)	5890 (40.6)	6130 (42.3)	6340 (43.7)
75°F (24°C)	5770 (39.8)	6200 (42.8)	6680 (46.1)
180°F (82°C)	4050 (27.9)	3760 (25.9)	4400 (30.4)
<b>Blister detection, psi (MPa)</b>			
-67°F (-55°C)	5290 (36.5)	5100 (35.2)	5210 (36.0)
75°F (24°C)	4860 (33.5)	4700 (32.4)	4890 (33.7)
180°F (82°C)	3650 (25.2)	3580 (24.7)	3760 (25.9)
<b>Climbing drum metal-to-metal peel, in-lb/in (Nm/m)</b>			
-67°F (-55°C)	55 (220)	61 (270)	68 (300)
75°F (24°C)	66 (290)	73 (330)	87 (390)
180°F (82°C)	85 (380)	91 (410)	130 (570)
<b>ASTM D-1781-76</b>			
<b>Floating roller peel, lb/in (KN/m)</b>			
-67°F (-55°C)	56 (9.8)	51 (8.9)	44 (7.7)
75°F (24°C)	64 (11.2)	63 (11.0)	73 (12.8)
180°F (82°C)	55 (9.6)	49 (8.6)	76 (13.3)
<b>ASTM-D-3167-76</b>			

<sup>1</sup> Typical average results with BR 127 primer and recommended cure cycle:

- 30 minutes to 250°F (120°C)
- 60 minutes at 250 ± 5°F (120 ± 3°C) under 40 ± 5 psi (0.28 ± 0.03 MPa) pressure
- FPL etch was used for cleaning aluminum skins prior to bonding

<sup>2</sup> Materials:

- Tensile shear: 0.063 in. (1.60 mm) 2024-T3 clad
- Blister detection: 0.064 in (1.63 mm) 2024-T3 bare
- Climbing drum peel: 0.020 in to 0.040 in (0.51 mm to 1.03 mm) 2024-T3 clad
- Floating roller peel: 0.025 in to 0.063 in (0.64 mm to 1.60 mm) 2024-T3 bare

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**Table 5 | Mechanical Performance: Metal-to-Metal (continued)<sup>1</sup>**

Property and Test Condition <sup>2</sup>	FM 73M OST 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )	FM 73 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )	FM 73 0.085 lb/ft <sup>2</sup> (425 g/m <sup>2</sup> )
<b>Tensile shear, psi (MPa)</b>			
-67°F (-55°C)	6680 (46.1)	6650 (45.9)	6770 (46.7)
75°F (24°C)	6580 (45.4)	6500 (44.9)	6840 (47.2)
180°F (82°C)	4540 (31.3)	4340 (30.0)	4770 (32.9)
<b>Blister detection, psi (MPa)</b>			
-67°F (-55°C)	5420 (37.4)	5460 (37.7)	5290 (36.5)
75°F (24°C)	4900 (33.8)	5100 (35.2)	5050 (34.8)
180°F (82°C)	4350 (30.0)	4080 (28.2)	4120 (28.4)
<b>Climbing drum metal-to-metal peel, in-lb/in (Nm/m)</b>			
-67°F (-55°C)	65 (290)	73 (330)	88 (390)
75°F (24°C)	83 (370)	95 (420)	150 (650)
180°F (82°C)	130 (580)	130 (560)	160 (690)
<b>ASTM D-1781-76</b>			
<b>Floating roller peel, lb/in (KN/m)</b>			
-67°F (-55°C)	58 (10.2)	66 (11.6)	52 (9.1)
75°F (24°C)	65 (11.4)	65 (11.4)	79 (13.8)
180°F (82°C)	95 (16.6)	96 (16.9)	110 (20.0)
<b>ASTM-D-3167-76</b>			

<sup>1</sup>Typical average results with BR 127 primer and recommended cure cycle:

- 30 minutes to 250°F (120°C)
- 60 minutes at 250 ± 5°F (120 ± 3°C) under 40 ± 5 psi (0.28 ± 0.03 MPa) pressure
- FPL etch was used for cleaning aluminum skins prior to bonding

<sup>2</sup>Materials:

- Tensile shear: 0.063 in. (1.60 mm) 2024-T3 clad
- Blister detection: 0.064 in (1.63 mm) 2024-T3 bare
- Climbing drum peel: 0.020 in to 0.040 in (0.51 mm to 1.03 mm) 2024-T3 clad
- Floating roller peel: 0.025 in to 0.063 in (0.64 mm to 1.60 mm) 2024-T3 bare

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**Table 6 | Mechanical Performance: Metallic Structural Sandwich<sup>1</sup>**

Property and Test Condition <sup>2</sup>	FM 73M 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )	FM 73M OST 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )	FM 73 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )
<b>Sandwich peel, in-lb/3 in (Nm/m)</b>			
-67°F (-55°C)	50 (74)	46 (68)	53 (79)
75°F (24°C)	86 (130)	83 (120)	95 (140)
180°F (82°C)	38 (56)	33 (49)	41 (61)
<b>Flatwise tensile, psi (MPa)</b>			
-67°F (-55°C)	1500 (10.4)	1450 (10.0)	1680 (11.6)
75°F (24°C)	1050 (7.3)	1080 (7.4)	1300 (8.9)
180°F (82°C)	720 (5.4)	660 (4.6)	660 (4.6)

**Table 7 | Mechanical Performance: Metallic Structural Sandwich (continued)<sup>1</sup>**

Property and Test Condition <sup>2</sup>	FM 73M 0.085 lb/ft <sup>2</sup> (425 g/m <sup>2</sup> )	FM 73M OST 0.85 lb/ft <sup>2</sup> (425 g/m <sup>2</sup> )	FM 73 0.085 lb/ft <sup>2</sup> (425 g/m <sup>2</sup> )
<b>Sandwich peel, in-lb/3 in (Nm/m)</b>			
-67°F (-55°C)	70 (100)	75 (110)	87 (130)
75°F (24°C)	120 (180)	128 (190)	145 (220)
180°F (82°C)	40 (59)	55 (82)	65 (96)
<b>Flatwise tensile, psi (MPa)</b>			
-67°F (-55°C)	1580 (10.9)	1680 (11.6)	1730 (11.9)
75°F (24°C)	1450 (10.0)	1400 (9.7)	1400 (9.7)
180°F (82°C)	830 (5.7)	780 (5.5)	880 (6.0)

<sup>1</sup>Typical average results with BR 127 primer and recommended cure cycle:

- 30 minutes to 250°F (120°C)
- 60 minutes at 250 ± 5°F (120 ± 3°C) under 40 ± 5 psi (0.28 ± 0.03 MPa) pressure
- FPL etch was used for cleaning aluminum skins prior to bonding

<sup>2</sup>Materials:

- Skins: 0.020 in (0.5mm) 2024-T3 clad
- Core: 0.25 in (6.35 mm) 0.004 NP 5052

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**Table 8 | Mechanical Performance after Environmental Exposure<sup>1</sup>**

Property and Test Condition	FM 73M 0.03 lb/ft <sup>2</sup> (150 g/m <sup>2</sup> )	FM 73M 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )	FM 73 0.06 lb/ft <sup>2</sup> (300 g/m <sup>2</sup> )
<b>Tensile shear, psi (MPa) after:</b>			
<b>30 days at 120°F (50°C) and 95 – 100% R.H.</b>	4960 (34.2)	4990 (34.4)	5140 (35.5)
<b>30 days salt spray</b>	4790 (33.1)	4930 (33.9)	5240 (36.1)
<b>7 days immersion in JP-4 fuel (MIL-J-5624)</b>	4780 (33.0)	4980 (34.4)	5270 (36.3)
<b>7 days immersion in hydrocarbon fluid (TT-S-735)</b>	4880 (33.6)	5040 (34.8)	5230 (36.1)
<b>7 days in Skydrol 500*</b>	4770 (32.9)	5060 (34.9)	5140 (35.5)

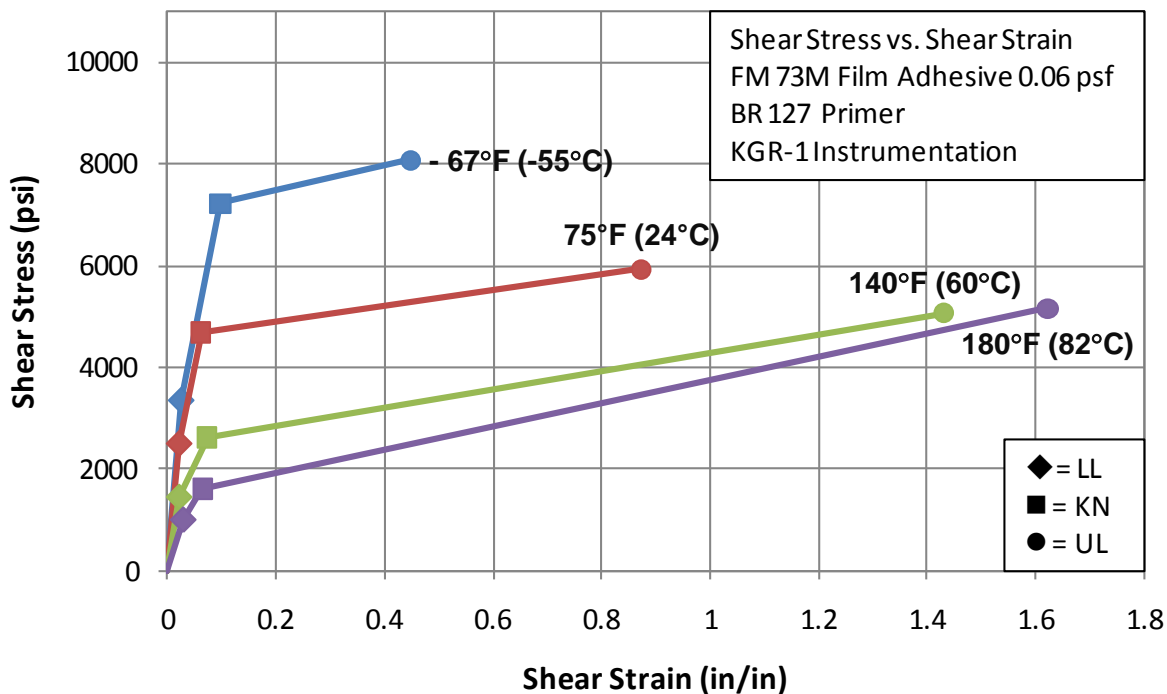
<sup>1</sup> Fluid exposure coupons are individual blister detection coupons with cut edges exposed and tested at 75 ± 5°F (24 ± 3°C)

\* Product of Solutia Inc.

**Table 9 | KGR-1 Stress Strain Data for FM 73M Adhesive Film, 0.06 lb/ft<sup>2</sup> (300 g/m<sup>2</sup>) with BR 127 Corrosion Inhibiting Primer with no Prebond or Postbond Exposure**

[f = Shear Stress, psi (MPa), Σ = Shear Strain, in/in, G = Shear Modulus, psi (Mpa)]

Test Temperature	Linear Limit (LL)			Knee (KN)		Ultimate Failure (UL)	
	f	Σ	G	f	Σ	f	Σ
-67°F (-55°C)	3350 (23.1)	0.026	131,000 (904)	7220 (49.8)	0.097	8080 (55.7)	0.447
75°F (24°C)	2510 (17.3)	0.021	122,000 (842)	4690 (32.4)	0.062	5930 (40.9)	0.873
140°F (60°C)	1460 (10.1)	0.022	65,900 (455)	2620 (18.1)	0.073	5060 (34.9)	1.430
180°F (82°C)	980 (6.8)	0.028	37,800 (261)	1600 (11.0)	0.064	5150 (35.5)	1.623

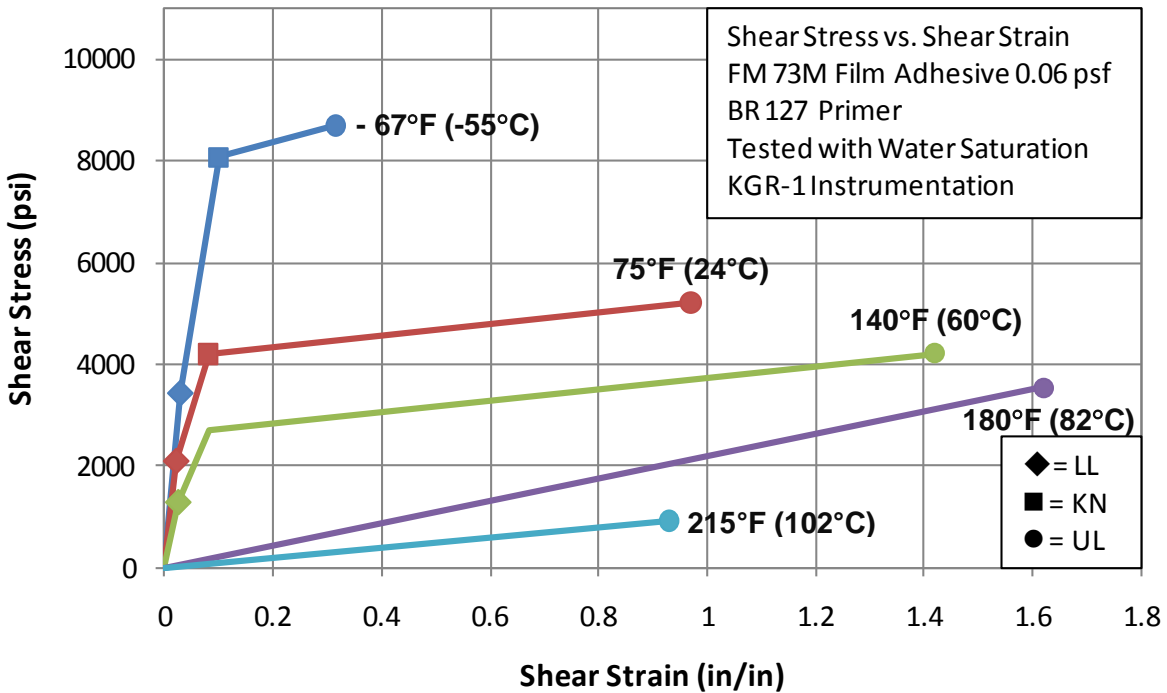


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**Table 10 | KGR-1 Stress Strain Data for FM 73M Adhesive Film, 0.06 lb/ft<sup>2</sup> (300 g/m<sup>2</sup>) with BR 127 Corrosion Inhibiting Primer with Postbond Exposure of 100% R.H. at 140°F (60°C) until Saturated**  
 [f = Shear Stress, psi (MPa), Σ = Shear Strain, in/in, G = Shear Modulus, psi (Mpa)]

Test Temperature	Linear Limit (LL)			Knee (KN)		Ultimate Failure (UL)	
	f	Σ	G	f	Σ	f	Σ
-67°F (-55°C)	3440 (23.7)	0.028	123,000 (849)	8070 (55.7)	0.100	8700 (60.0)	0.315
75°F (24°C)	2100 (14.5)	0.022	95,000 (655)	4200 (29.0)	0.081	5210 (35.9)	0.970
140°F (60°C)	1290 (8.9)	0.026	53,200 (368)	-	-	4210 (29.0)	1.420
180°F (82°C)	-	-	-	-	-	3540 (24.4)	1.620
215°F (102°C)	-	-	-	-	-	910 (6.3)	0.930





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### APPLICATION NOTES

#### Preparation of Aluminum

A clean, dry, grease-free surface is required for optimum performance. A recommended procedure for cleaning aluminum skins prior to priming or bonding is the FPL cleaning method:

1. Vapor degrease, alkaline clean, rinse and check for water break
2. Prepare a sodium dichromate/sulfuric acid solution as follows:
  - a. Mix the following ingredients:

Sodium Dichromate	34 grams	FED-O-S-595A
Water	700 ml	Deionized water recommended
Sulfuric Acid	304 grams	FED-O-A-115, Class A, Grade 2
  - b. Add additional water to make one liter

This solution will dissolve 1.5 grams of 2024 clad aluminum per liter.

**NOTE:** Chromic acid is highly corrosive. All contact with skin and tissues must be prevented. Wear impervious apron, boots and gloves as well as splash-proof goggles and face shield when preparing and/or using chromic acid. If airborne concentration of chromic acid exceeds the 8-hr TWA established by OSHA, respirators approved by NIOSH must be worn.

Chromic acid solutions should be prepared and handled only in fume hoods or other adequately ventilated areas even when the TWA is not exceeded. Traces of chromyl chloride may occur in the vapors above heated chromic acid solutions prepared from chlorinated water.

3. Immerse aluminum part in sodium dichromate/sulfuric acid solution at  $155 \pm 5^\circ\text{F}$  ( $68 \pm 3^\circ\text{C}$ ) for 10 minutes (clad aluminum) or 5 minutes (bare aluminum)
4. Spray rinse with water at or below  $75^\circ\text{F}$  ( $24^\circ\text{C}$ )
5. Immerse in cold water
6. Repeat spray rinse checking for water break
7. Dry in a vented oven below  $150^\circ\text{F}$  ( $65^\circ\text{C}$ )

In addition to the FPL etch cleaning method for aluminum, the phosphoric acid anodizing (PAA) surface treatment<sup>1</sup> is now being used by a large number of aircraft manufacturers due to the improved surface bond durability provided by the PAA treatment.

#### Primer Application

Although not mandatory, BR 127 corrosion inhibiting primer is recommended for use with FM 73 film adhesive in bonding of aluminum details. BR 127 primer offers superior durability and resistance to hostile environments within the bond line and also may be used as a protective coating outside the bonded areas. Apply BR 127 as follows:

1. Allow BR 127 material to warm to room temperature prior to opening container
2. Thoroughly mix before application and agitate during application
3. Spray or brush coat to a dry primer thickness of 0.0001 inch (0.0025 mm) nominal with a 0.0002 inch (0.0050 mm) maximum thickness. For protective coating applications increase primer thickness to 0.0004 to 0.0010 inch (0.0102 to 0.025 mm).
4. Air dry 30 minutes minimum prior to using
5. Oven cure 30 minutes at  $250 \pm 10^\circ\text{F}$  ( $120 \pm 6^\circ\text{C}$ )

<sup>1</sup> Boeing patent 4,085,012; April 18, 1978

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### Bonding Procedure

Primer assemblies which have been dried and wrapped with a protective covering such as Kraft paper may be stored at 75°F (24°C) for six months and longer without fear of degradation of the final bond.

Before bonding, detail parts and adhesive film must be properly assembled. Patterns of FM 73 film adhesive should be cut as required before removal of the protective covering which is easily stripped from the film at room temperature. Apply the film adhesive smoothly to the parts. For addition tack, warm to approximately 110 °F (43°C) with a heat gun or tack table.

After assembly of the details, apply pressure and cure using the standard cure cycle below:

1. Apply pressure at 40 ± 5 psi (0.28 ± 0.03 MPa)
2. Heat up to 250°F (120°C) in 30 minutes
3. Hold at 250 ± 5°F (120 ± 3°C) for 60 minutes

### PRODUCT HANDLING AND SAFETY

Cytec Engineered Materials recommends wearing clean, impervious gloves when working with epoxy resin systems to reduce skin contact and to avoid contamination of the product.

Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec Engineered Materials Office.

### DISPOSAL OF SCRAP MATERIAL

Disposal of scrap material should be in accordance with local, state, and federal regulations.

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