Scotch-Weld™
Structural Adhesive
EC-3448

Technical Data **October, 2004**

Introduction

3M™ Scotch-Weld™ Structural Adhesive EC-3448 is a structural paste designed for improved hot-wet conditions after cure. Structurally bonds metal to metal and precured fiber reinforced epoxy composite laminates. It is a one-component epoxy adhesive that cures at a temperature of 250°F for 60 minutes.

Advantages

- Designed to bond precured graphite epoxy composites
- Excellent performance from -67°F (55°C) to 225°F (107°C)
- Unusually high 180°F hot/wet durability
- Thixotropic for non-sag properties during cure

Description

Color	Light Tan
Base	Modified Epoxy Resin
Solids	100%
Viscosity at 77°F	Approximately 5000 poise (Brookfield HBF #6 at 10 RPM)
Weight	Approximately 9.5 lbs/gallon
Storage	0°F or lower storage is required

Product Performance

Overlap Shear – Aluminum to Aluminum

All properties were measured on 1" wide 1/2" overlap specimens cut from .063" thick 4" x 7" bonded panels of 2024T-3 clad aluminum. Tests conducted according to MMM-A-132 methods.

Test Temperature	Overlap Shear Strength
-67°F	5500 psi
75°F	6000 psi
180°F	4700 psi
250°F	2000 psi

T-Peel – Aluminum to Aluminum

T-Peel specimens were prepared from .020" thick x 8" x 8" bonded panels of 2024T-3 clad aluminum from which 1" wide strips were cut for testing. Tests conducted according to MMM-A-132.

Test Temperature	T-Peel Strength
75°F	30 lb./inch

Floating Roller Peel – Aluminum to Aluminum

Roller Peel specimens were prepared from .025" thick and .063" thick panels of 2024T-3 bare aluminum from which 1/2" wide strips were cut for testing. Tests conducted according to ASTM D-3167.

Test Temperature	Roller Peel Strength
-67°F	63 lb./inch
75°F	63 lb./inch
200°F	64 lb./inch

Hot/Wet Strength – Graphite to Graphite Laminate Bonds

Hot/Wet Exposure: 1 inch wide bonded specimens were placed in a humidity cabinet at 160°F for the time and humidity specified below. Water boil specimens were immersed in boiling water.

Overlap Shear Strength After Hot/Wet Exposure				
Test Temperature	**Control**	**100% R.H. for 18 Weeks**	**90% R.H. for 9 weeks**	**48 Hours Water Boil**
-67°F	2980 psi	3270 psi	2840 psi	
75°F	4550 psi	3685 psi	4110 psi	
160°F	4130 psi	2050 psi	2680 psi	
180°F	3360 psi	1140 psi	1120 psi	2010 psi
weight gain of specimens		2.06%	1.18%	

Substrates: Woven graphite epoxy laminate, .062 inch thick.

Surface Preparation: Nylon peel ply was removed from surface followed by light sanding with 180 grit sandpaper and rinsed with methyl ethyl ketone*

***Note:** When using solvents, extinguish all ignition sources and follow the manufacturer's precautions and directions for use.

Layup: 0.5 inch overlap shear with a thin nylon knit scrim in the bondline as a spacer.

Cure: 250°F for 90 minutes, 10 psi pressure, 10°F rise rate/minute.

Test: Specimens were tested immediately upon removal from the humidity cabinet at 0.05 inches/minute.

Product Performance ***(continued)***

Hot/Wet Strength – Aluminum to Aluminum Bonds

Hot/Wet Exposure: One inch wide overlap shear specimens were placed in a 100% R.H. cabinet for 14 days at 180°F.

Overlap Shear Strength After Hot/Wet Exposure				
Test Temperature	Unprimed		EC-3924B Primed	
	Control	Exposed	Control	Exposed
180°F	4480 psi	1495 psi	4840 psi	2575 psi

Substrates: 2024T-3 alclad aluminum, 0.063 inches thick.
Surface Preparation: Optimize FPL etch.
Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B.
Primer Application: One brush coat.
Primer Dry: 30 minutes minimum air dry, plus 60 minutes at 260°F.
Cure Cycle: 260°F for 60 minutes, 10 psi pressure, 10°F rise rate/minute.
Test: Tested immediately upon removal from R.H. cabinet at 180°F according to MMM-A-132.

Glass Transition Temperature, Tg.

Procedure: Cured pieces of 3M™ Scotch-Weld™ Structural Adhesive EC-3448, 3.2 mm x 10 mm x 60 mm were conditioned for 147 days at 100% R.H. and 120°F. After conditioning, the specimens were submitted for DMA determination of Tg.

Cure	Tg Before Conditioning	Tg After Conditioning
250°F for 90 minutes	250°F	190°F
290°F for 60 minutes	255°F	187°F

Pre bond Shop Out – Time Relative Humidity Exposure

Test	Control	5 Hours @ 60% R.H.	24 Hours @ 60% R.H.
Overlap Shear			
@ 75°F	6200 psi	6110 psi	5970 psi
@ 180°F	5380 psi	4800 psi	4340 psi
@ 250°F	3640 psi	1600 psi	1140 psi
T-Peel @ 75°F	39 piw	41 piw	44 piw

Adherends: 2024T-3 alclad aluminum (.020" thick for T-Peel).
Surface Preparation: Optimized FPL etch.
Layup: Adhesive was spread on one adherend and exposed to 60% relative humidity at 79°F for time specified before assembly.
Cure Cycle: 260°F for 60 minutes, 5 psi, 10°F rise rate/minute.
Test Speed: Overlap shear at 0.1"/minute; T-Peel at 3"/minute.
Test Procedure: According to MMM-A-132.

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.

Test Results to the Requirements of MMM-A-132A, Type 1, Class 2, Form P, Group 3

Property	Test Conditions	Min. Average Requirements	Average Values
Tensile shear	@ 75°F	3500 psi	5545 psi
Tensile shear	10 min. @ 180°F	2000 psi	5082 psi
Tensile shear	10 min. @ -67°F	3500 psi	5697 psi
Tensile shear	75°F after 30 days @ 120°F and 100% R.H.	3500 psi	4238 psi
Tensile shear	75°F after 7 days in:		
a,	Hydraulic oil @ RT	3250 psi	5591 psi
b,	JP-4 @ RT	3250 psi	5647 psi
T-Peel	@ 75°F	20 piw	35 piw
Blister Detection	@ 75°F	3250 psi	3683 psi
Fatigue	750 psi, 10⁶ cycles	No failures	No failures
Creep rupture	75°F @ 1600 psi	0.015 inches max.	0.000 inch
Creep rupture	180°F @ 800 psi	0.015 inches max.	0.000 inch

Procedures: According to MMM-A-132A
Surface Preparation: Optimized FPL etch
Cure Cycle: 260°F for 60 minutes, 10°F rise rate/minute, 10 psi

Product Application

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

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: Optimized FPL Etch – 3M Company (AdhD method C-2803) or ASTM D2651 Method G.

1. Vapor degrease – perchloroethylene condensing vapors for 5-10 minutes.
2. Alkaline degrease – Oakite 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 (AdhD method C-2802).
3. Acid Etch – Immerse panels in the following solution for 10 minutes at 150 ± 5°F:

Sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$)	4.1-4.9 oz./gallon
Sulfuric Acid 66° Be	38.5-41.5 oz./gallon
2024T-3 aluminum (dissolved)	0.2 oz./gal. minimum
Tap Water	Balance

4. Rinse immediately in large quantities of clear running tap water.

Product Application ***(continued)***

5. Dry – Air dry approximately 15 minutes followed by a force dry at 150° ± 10°F for 10 minutes.
6. 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. Fiber Reinforced Epoxy Laminate Surfaces

1. Abrade surfaces to be bonded with 180 grit sandpaper or 3M™ Scotch-Brite™ Cleaning Pad (do not cut through resin into reinforcing fibers).
2. Wipe with clean rag or paper towel soaked with Ketone type solvent such as methyl ethyl ketone.**

****NOTE:** When using solvents, extinguish all ignition sources and follow manufacturer's precautions and directions for use.

3. Thoroughly dry before application of adhesive.

C. Primer Application

Although3M™ Scotch-Weld™ Structural Adhesive EC-3448 gives excellent performance on unprimed surfaces, the use of 3M™ Scotch-Weld™ EC-3960 Primer and 3M™ Scotch-Weld™ EC-3924B Primer are suggested for maximum long-term durability and environmental resistance. See EC-3960 and EC-3924B data sheets for complete application instructions.

Adhesive Layup

Care should be taken to avoid contaminating adhesive and cleaned aluminum. Contamination could hinder wetting action and cause inferior results.

A. Adhesive Application

EC-3448 can be applied by a spatula, knife coat, notched trowel, or by extruding into place. At least a 0.010 inch thick layer of EC-3448 should be applied.

B. Conditions

After application of the adhesive, assemble bonds as soon as possible. Exposure of EC-3448 to humidities of 50% or higher can result in the adhesive absorbing moisture from the air. This in turn can result in lowered performance and blown or porous bondlines after cure.

Cure Cycle

The data reported For Aluminum To Aluminum Bonds Under Product Performance was developed with a cure cycle using 2-5 psi bonding pressure applied by a press and heated for 60 minutes at 250°F. Rise rate from ambient to cure temperature was at 10°F per minute. Surface preparation was optimized FPL etch.

EC-3448 requires a minimum cure temperature of 250°F for at least 60 minutes. EC-3448 can be cured at higher temperatures for shorter periods of time; however, performance at these cure conditions has not been fully investigated. The only pressure needed during cure is to maintain alignment and contact of the parts during cure. Curing ovens must be vented. Excessive pressures should be avoided because too much adhesive might be squeezed out of the bondline. Bondlines in the .003 to .010 inch range are generally satisfactory.

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Storage

3M™ Scotch-Weld™ Structural Adhesive EC-3448 must be stored at temperatures of 0°F or lower. At ambient conditions (70-80°F), will gradually increase in viscosity becoming too difficult to apply in approximately five days. Moderate increases in viscosity will not adversely affect the cured performance of EC-3448.

Caution: EC-3448 should be warmed to room temperature before opening the container to prevent moisture condensation on the EC-3448 surface.

Precautionary Information

Refer to Product Label and Material Safety Data Sheet for health and safety information before using this product. For additional health and safety information, call 1-800-364-3577 or (651) 737-6501.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free (800) 235-2376. Address correspondence to: 3M Aerospace and Aircraft Maintenance Division, 3M Center, Building 220-9W-14, St. Paul, MN 55144. If you are outside of the U.S., please contact your nearest 3M office or branch.

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AS9100

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