# **3M** Scotch-Weld<sup>™</sup> Epoxy Adhesives DP460 Off-White and DP460NS

# Technical Data Sheet

September 2017

**Product Description** 

3M™ Scotch-Weld™ Epoxy Adhesives DP460 Off-White and DP460NS are high performance, two-part epoxy adhesives offering outstanding shear and peel adhesion, and very high levels of durability.

**Features** 

• High shear strength

• High peel strength

• 60 minute work life

• Non sag (DP460NS)

Easy mixing

Typical Uncured Physical Properties

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

Product		3M™ Scotch-Weld™ Epoxy Adhesive DP460 Off-White	3M™ Scotch-Weld™ Epoxy Adhesive DP460NS
Viscosity (approx.)	Base	20,000-50,000 cps	150,000-275,000 cps
@ 73°F (23°C)	Accelerator	8,000-14,000 cps	8,000-14,000 cps
Base Resin	Base	epoxy	epoxy
	Accelerator	amine	amine
Color	Base	white	white
	Accelerator	amber	amber
Net Weight	Base	9.3-9.7	9.3-9.7
Lbs./Gallon	Accelerator	8.8-9.2	8.8-9.2
Mix Ratio (B:A)	Volume	2:1	2:1
	Weight	2:0.96	2:0.96
Work life, 73°F (23°C)	20 g mixed	60 minutes	60 minutes
	10 g mixed	75 minutes	60 minutes
	5 g mixed	90 minutes	60 minutes

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

Product	3M™ Scotch-Weld™ Epoxy Adhesive DP460 Off-White	3M™ Scotch-Weld™ Epoxy Adhesive DP460NS
Physical Color	Off-white	Off-white
Shore D Hardness	75-80	78-84
Thermal Coefficient of Below Tg Thermal Expansion Above Tg (in./in./°C)	59 x 10 <sup>-6</sup> 159 x 10 <sup>-6</sup>	74.44 x 10 <sup>-6</sup> 166 x 10 <sup>-6</sup>
Thermal Conductivity (btu - ft./ft.² - hr °F) @ 45°C	0.104	0.104
Electrical Dielectric Strength (ASTM D 149)	1100 volts/mil	727 volts/mil
Volume Resistivity (ASTM D 257)	2.4 x 10 <sup>14</sup> ohm-cm	3.25 x 10 <sup>15</sup> ohm-cm

Typical Curing Characteristics

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

Rate of Strength Build-Up Aluminum, Overlap Shear (7 mil Bondline) (ASTM D 1002-72) Bonds Tested at 73°F (23°C)

## 3M™Scotch-Weld™ Epoxy Adhesive DP460 Off-White

Time in Oven	Cure Temperature		
	73°F (23°C)	120°F¹ (49°C)	140°F¹ (60°C)
30 minutes 60	_ _	<50 1300 4300/60 <sup>2</sup>	3000/60 <sup>2</sup> 4500/60 <sup>2</sup>
90 2 hours		4400/60 <sup>2</sup>	4800
3 5	— 400	4800/60 <sup>2</sup> —	_ _
6 7	1000 3500	<u> </u>	_ _
24	4000/60 <sup>2</sup>		

## 3M™Scotch-Weld™ Epoxy Adhesive DP460NS

Time in Oven	Cure Temperature		
	73°F (23°C)	120°F¹ (49°C)	160°F¹ (71°C)
15 minutes 30	_ _	 10	4860 5250
60	_	2800	5300
2 hours	1	5050	5470
4 6	46 970	5400 5570	5320 5140
24	4500		5210

This represents the oven temperature to which the bonds were subjected for the prescribed time. The average bondline temperature during the cure time will be somewhat lower than the oven temperature.

The value in the denominator is the expected minimum 73°F (23°C) T-peel strength (piw) measured after the indicated cure cycle.

NOTE: The data in this Technical Data Sheet were generated using the 3M<sup>TM</sup> EPX<sup>TM</sup> Applicator System equipped with an EPX static mixer, according to manufacturer's directions. Thorough hand-mixing will afford comparable results.

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

### Substrates and Testing

## A. Overlap Shear (ASTM D 1002-72)

Overlap shear (OLS) strengths were measured on 1 in. wide 1/2 in. overlap specimens. These bonds were made individually using 1 in. x 4 in. pieces of substrate except for aluminum. Two panels 0.063 in. thick, 4 in. x 7 in. of 2024T-3 clad aluminum were bonded and cut into 1 in. wide samples after 24 hours. The thickness of the bondline was 0.005-0.008 in. All strengths were measured at 73°F (23°C) except where noted.

The separation rate of the testing jaws was 0.1 in. per minute for metals, 2 in. per minute for plastics and 20 in. per minute for rubbers. The thickness of the substrates were: steel, 0.060 in.; other metals, 0.05-0.064 in.; rubbers, 0.125 in.; plastics, 0.125 in.

#### B. T-peel (ASTM D 1876-61T)

T-peel strengths were measured on 1 in. wide bonds at 73°F (23°C). The testing jaw separation rate was 20 inches per minute. The substrates were 0.032 in. thick.

#### C. Bell Peel (ASTM D 3167)

Bell peel strengths were measured on 1/2 in. wide bonds at the temperatures noted. The testing jaw separation rate was 6 in. per minute. The bonds are made with 0.064 in. bonded to 0.025 in. thick adherends.

#### D. Cure Cycle

With the exception of Rate of Strength Build-Up Tests, all bonds, were cured 7 days at 73°F (23°C) at 50% RH before testing or subjected to further conditioning or environmental aging.

### Aluminum, Overlap Shear, at Temperature (PSI)

	3M™ Scotch-Weld™ Epoxy Adhesive DP460 Off-White	3M™ Scotch-Weld™ Epoxy Adhesive DP460NS
-67°F (-55°C)	4500	4900
73°F (23°C)	4500	4650
180°F (82°C) (15 min.) <sup>1</sup>	700	1360
(30 min.) <sup>1</sup>	1000	1810
(60 min.) <sup>1</sup>	1400	2630
(4 hr.) <sup>1</sup>	2500	2680
250°F (121°C) (15 min.) <sup>1</sup>	220	420

<sup>&</sup>lt;sup>1</sup>Represents time in test chamber oven before test.

### Metals, Overlap Shear, Tested @ 73°F (23°C) (PSI)

Aluminum	Etched	4500	4500
	Oakite degreased	3200	2300
	MEK/abrade/MEK	3500	2670
Cold Rolled Steel	Oakite degreased	3500	
	MEK/abrade/MEK	2800	3600
Copper	MEK/abrade/MEK	4000	4400
Brass	MEK/abrade/MEK		3400
	CDA 260	4000	—
	Cartridge	4200	—
Stainless Steel	MEK/abrade/MEK	4000	2400
Galvanized Steel -	Oakite degreased Hot dipped Electrodeposited	2000 2100	2480 3000

Typical Adhesive Performance Characteristics

(continued)

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

### Substrates and Testing

Aluminum, T-Peel (PIW), at Temperature Aluminum, etched (17-20 mil bondline)

	3M™ Scotch-Weld™ Epoxy Adhesive DP460 Off-White	3M™ Scotch-Weld™ Epoxy Adhesive DP460NS
-67°F (-55°C)	5-10	3-5
73°F (23°C)	60	60
180°F (82°C)	3-5	20

### Metals, T-Peel, Tested @ 73°F (23°C) (PIW)

Aluminum, etched	17-20 mil bondline 5-8 mil bondline	60 50	not tested
Cold Rolled Steel	17-20 mil bondline Oakite degreased MEK/abrade/MEK	40 25	not tested

## Aluminum Bell Peel (PIW), at Temperature (ASTM D 3167)

Temperature	3M™ Scotch-Weld™ Epoxy Adhesive DP460NS
-67°F (-55°C)	19
73°F (23°C)	77
180°F (82°C)	39

### Other Substrates, Overlap Shear Tested @ 73°F (23°C)

Substrate	Surf. Pre 3M™ Scotch-Weld™ DP460 Off-White	<sup>1</sup> Epoxy Adhesive 3M™ Scotch-Weld™		™ Epoxy Adhesive
ABS	300	345	575	572
PVC	500	815 <sup>3</sup>	350	313 <sup>3</sup>
Polycarbonate	400	380	500	390
Polyacrylic	220	210	330	270
Polystryene	450	320	475 <sup>3</sup>	490
FRP	800	570	1000 <sup>3</sup>	1379 <sup>3</sup>
Phenolic	1400³	1210 <sup>3</sup>	1400 <sup>3</sup>	1231 <sup>3</sup>
SBR/Steel	150³	130	140 <sup>3</sup>	239 <sup>3</sup>
Neoprene/Steel	100	90	120 <sup>3</sup>	114 <sup>3</sup>

<sup>&</sup>lt;sup>1</sup>Isopropyl Alcohol Wipe. See Surface Preparation Section D for additional information.

<sup>&</sup>lt;sup>2</sup>Isopropyl Alcohol/Abrade/Isopropyl Alcohol: See Surface Preparation Section E for additional information.

<sup>&</sup>lt;sup>3</sup>Substrate failure

Typical Adhesive Performance Characteristics (continued) Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

### Substrates and Testing (continued)

Environmental Resistance, Aluminum (Etched)
Measured by Overlap Shear Tested @ 73°F (23°C) (PSI)<sup>1</sup> (ASTM D 1002-72)

		3M™ Scotch-Weld™ Epoxy Adhesive		
Environment	Condition	DP460 Off-White	DP460NS	
73°F (23°C)/50% RH	30 d <sup>2</sup>	5200	5460	
Distilled Water	30 d, i <sup>3</sup>	5100	4550	
Water Vapor	120°F (49°C)/100% RH, 30 d 200°F (93°C)/100% RH, 14 d	4500 3100	3920 3370	
Antifreeze/H <sub>2</sub> O (50/50)	180°F (82°C), 30 d, i	5000	4400	
Isopropyl Alcohol	73°F (23°C), 30 d, i	5700	5320	
Methyl Ethyl Ketone	73°F (23°C), 30 d, i	4200	4000	
Salt Spray (5%)	95°F (35°C), 30 d	5100	5200	
Skydrol LD-4	150°F (66°C), 30 d, i	3700	5250	

<sup>&</sup>lt;sup>1</sup>Data reported are actual values from the lots tested and may be higher than values published elsewhere in this Technical Data Sheet.

# Environmental Resistance, Galvanized Steels Measured by Overlap Shear Tested @ 73°F (23°C) (PSI) (ASTM D 1002-72)

		Hot Dipped		Electrodeposited	
Environment	Condition	3M™ Scote Epoxy A DP460 Off-White			ch-Weld™ Adhesive DP460 NS
73°F (23°C)/50% RH	30 d <sup>3</sup>	2200	not tested	2300	not tested
Distilled Water	30 d, i <sup>4</sup>	2300	not tested	2300	not tested
Water Vapor	120°F (49°C)/100% RH, 30 d 200°F (93°C)/100% RH, 14 d	1900 1500	not tested	2000 1000	not tested
Antifreeze/H <sub>2</sub> O	180°F (82°C), 30 d, i	2000	not tested	1950	not tested
Isopropyl Alcohol	73°F (23°C), 30 d, i	2000	not tested	2200	not tested
Methyl Ethyl Ketone	73°F (23°C), 30 d, i	2000	not tested	2200	not tested
Trichloroethane	73°F (23°C), 30 d, i	2300	not tested	2300	not tested
Salt Spray (5%)	95°F (35°C), 30d	1900	not tested	1500	not tested

Hot dipped or electrodeposited. Galvanized steels may afford a wide spectrum of performance due to the diversity of surfaces available. The user should test to determine specific performance.

<sup>2&</sup>lt;sub>d</sub> = days

<sup>3</sup> i = immersion

<sup>&</sup>lt;sup>2</sup> Data reported are actual values from the lots tested and may be higher than values published elsewhere in this Technical Data Sheet.

d = days

i = immersion

3M™ EPX™ Pneumatic Applicator Delivery Rates 200 ml Applicator - Maximum Pressure 58 psi

Adhesive*	6mm Nozzle gms/minute	10mm Nozzle gms/minute
3M <sup>™</sup> Scotch-Weld <sup>™</sup> Epoxy Adhesive DP460 Off-White	31.1	132.0

<sup>\*</sup>Tests were run at a temperature of 70°F ± 2°F (21°C ± 1°C) and at maximum applicator pressure.

Handling/ Application Information Directions for Use

3M™ Scotch-Weld™ Epoxy Adhesives DP460 Off-White and DP460 NS are supplied in dual syringe plastic duo-pak cartridges as part of the 3M™ EPX™ Applicator System. The duo-pak cartridges are supplied in 37 ml, 200 ml and 400 ml configurations. To use the 37 ml cartridge simply insert the duo-pak cartridge into the EPX applicator and start the plunger into the cylinders using light pressure on the trigger. Next, remove the duo-pak cartridge cap and expel a small amount of adhesive to be sure both sides of the duo-pak cartridge are flowing evenly and freely. If simultaneous mixing of Part A and Part B is desired, attach the EPX mixing nozzle to the duo-pak cartridge and begin dispensing the adhesive.

With the 200 ml and 400 ml cartridges, the nozzle must be attached before dispensing any material to prevent unmixed adhesive from getting into the applicator cartridge holder. A small quantity of material should be discarded until uniform color, consistency of product and even flow is evident.

When mixing Part A and Part B manually, the components must be mixed in the ratio indicated in the typical uncured properties section. Complete mixing of the two components is required to obtain optimum properties.

Two-part mixing/proportioning/dispensing equipment is available for intermittent or production line use. These systems are ideal for line uses because of their variable shot size and flow rate characteristics and are adaptable to most applications.

### **Surface Preparation**

The following surface preparations were used for substrates described in this Technical Data Sheet.

#### A. Aluminum Etch

Optimized FPL Etch - 3M (test method C-2803)

 Alkaline degrease – Oakite 164 solution (9-11 oz./gallon water) at 190°F ± 10°F (88°C ± 5°C) for 10-20 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

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.

Note: Review and follow precautionary information provided by chemical suppliers prior to preparation of this etch solution.

- 3. Rinse immediately in large quantities of clear running tap water.
- 4. Dry air dry approximately 15 minutes followed by force dry at 140°F (60°C) maximum for 10 minutes (minimum).
- 5. Both surface structure and chemistry play a significant role in determining the strength and permanence of bonded structures. It is therefore advisable to bond or prime freshly primed clean surfaces as soon as possible after surface preparation in order to avoid contamination and/or mechanical damage. Please contact your 3M sales representative for primer recommendations.

### B. Oakite Degrease

Oakite 164 solutions (9-11 oz./gallon of water) at  $190^{\circ}F \pm 10^{\circ}F$  (88°C  $\pm 5^{\circ}C$ ) for 2 minutes. Rinse immediately in large quantities of cold running water.

#### C. MEK/Abrade/MEK

Wipe surface with a methyl ethyl ketone (MEK) soaked swab, abrade and wipe with a MEK soaked swab.\* Allow solvent to evaporate before applying adhesive.

### D. Isopropyl Alcohol Wipe

Wipe surface with an isopropyl alcohol soaked swab.\* Allow solvent to evaporate before applying adhesive.

### E. Isopropyl Alcohol/Abrade/Isopropyl Alcohol

Wipe surface with an isopropyl alcohol soaked swab, abrade using clean fine grit abrasives, and wipe with an isopropyl alcohol soaked swab.\* Then allow solvent to evaporate before applying adhesive.

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

Storage Store products at 60-80°F (15-27°C) for maximum shelf life.

Shelf Life These products have a shelf life of 15 months in original containers at room temperature.

These products have a shelf life of 15 months in original containers at room temperature. Bulk containers have a shelf life of 2 years in their unopened containers.

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Industrial Adhesives and Tapes Division

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