

# 3M Scotch-Weld™ Epoxy Adhesive EC-1386

Technical Data

June, 2002

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**Product Description** 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 is a one-part, 100% solids, thermosetting liquid adhesive.

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- Features**
- Exceptionally high strength properties at service temperatures from -70 to 250°F (-57 to 121°C).
  - Higher impact, peel and bond strength properties than normally attainable in many epoxy based adhesives.
  - Little or no volatile by-products given off during cure. This unique property makes Scotch-Weld EC-1386 particularly useful for bonding many impervious surfaces and enables curing under little or no pressure.
  - Only pressure sufficient to ensure contact between mating surfaces is required.
  - Easy application by knife coating, trowel, rollercoating, pump and high pressure injection methods.
  - Excellent retention of strength after aging in many environments.
  - Scotch-Weld EC-1386 conforms to MIL-A-8623A Type III.

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**Typical Uncured Properties**

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

|                    |  |
|--------------------|--|
| <b>Color:</b>      | Light Cream  |
| <b>Solvent:</b>    | None   |
| <b>Base:</b>       | Modified Epoxy Resin   |
| <b>Net Weight:</b> | 9.4 - 9.8 lbs./gallon  |
| <b>Viscosity:</b>  | 75,000 - 175,000 cps<br>(Brookfield RVF No. 7 Spindle @ 4 rpm) |

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## Handling/Application Information

### Directions for Use

Proper adhesive application is as important as proper bond design and adhesive choice to obtain maximum joint properties. Improper adhesive application techniques can result in partial or complete failure of an assembly.

3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 can give excellent properties under many application conditions. The product performance data reported in the Test Results section which follows here developed using the following suggested procedures. Variations from these procedures should be fully evaluated to ensure bond properties sufficient to meet the requirements of the user's particular assembly.

### 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. Surface preparations should be fully evaluated with the adhesive, especially if resistance to specific environments are anticipated.

### Suggested Cleaning Procedure for Aluminum:

1. Vapor Degrease – Perchloroethylene condensing vapors for 5-10 minutes.
2. Alkaline Degrease – Oakite 164 solution (9-11 oz./gallon of water) at  $190 \pm 10^\circ\text{F}$  ( $87 \pm 5^\circ\text{C}$ ) for 10-20 minutes. Rinse immediately in large quantities of cold running water.
3. Acid Etch – Place panels in the following solution for 10 minutes at  $150 \pm 5^\circ\text{F}$  ( $66 \pm 5^\circ\text{C}$ ).\*

|  |                        |
|--|------------------------|
| Sodium Dichromate ( $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ ) | 4.1 - 4.9 oz./gallon   |
| Sulfuric Acid, 66° Be  | 38.5 - 41.5 oz./gallon |
| 2024T-3 aluminum (dissolved)   | 0.2 oz./gallon minimum |
| Tap Water as needed to balance   |                        |

**\*Note:** When using etch solutions, be sure to follow the chemical manufacturer's precautions and directions for use when handling such chemicals.

4. Rinse – Rinse panels in clear running water.
5. Dry – Air dry 15 minutes.  
Force dry 10 minutes at  $150 \pm 10^\circ\text{F}$  ( $66 \pm 5^\circ\text{C}$ ).
6. It is advisable to coat the freshly cleaned surfaces with primer within 4 hours after surface preparation.

### Adhesive Layup

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

### Adhesive Application

**Note:** Appropriate application equipment can enhance adhesive performance. The user is responsible for evaluating application equipment in light of the user's particular purpose and method of application.

Scotch-Weld EC-1386 can be applied by a spatula, knife coat, notched trowel, or by extruding into places. Standard equipment is available which allows pumping directly from five-gallon pails. When extruded through a Pyles-Semco cartridge ( $3/32$ " orifice 70 psi line pressure), the delivery rate at  $72^\circ\text{F}$  ( $22^\circ\text{C}$ ) is approximately 20 grams/minute. A lower viscosity for ease of application can be obtained by warming Scotch-Weld EC-1386 to  $100 - 120^\circ\text{F}$  ( $38 - 49^\circ\text{C}$ ). **Note:** Scotch-Weld EC-1386 may start to thicken if held at  $120^\circ\text{F}$  ( $49^\circ\text{C}$ ) for more than 4 hours.

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## Handling/Application Information (*continued*)

**Important:** Care should be taken not to incorporate air into the adhesive during application. Included air can expand during cure which can cause a porous and weakened bond.

### Bond Line Thickness

Optimum performance is obtained with a 2-5 mil cured bond line thickness.

### Clean-up

Excess adhesive and equipment may be cleaned up, prior to curing with Ketone type solvents.\*

**\*Note:** When using solvents extinguish all ignition source and follow manufacturer's precautions and directions for use for handling such materials.

### Cure Cycle

#### General Cure Requirements

Time, temperature and pressure determine the final bond properties. These properties may also be affected by the type of curing equipment used for the specific application. In general, the cure properties of 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 are as follows.

#### Flow and Cure Initiation Temperatures

Normal flow and cure initiation temperatures for Scotch-Weld EC-1386 are as follows:

Flow Temperature: 60°F (16°C)  
Cure Initiation Temperature: 325-335°F (163-168°C)

#### Cure Pressure

The pressure needed during the cure of Scotch-Weld EC-1386 is typically that required to keep parts in alignment and to overcome distortion and thermal expansion in the adherends.

#### Cure Temperature

The cure temperature may be varied from 330 to 500°F (166 to 260°C) depending on the materials being bonded, equipment available and bond properties desired. Scotch-Weld EC-1386 will wet the surface to which it has been applied. Heating at temperatures above 325°F (163°C) will chemically convert the adhesive into a high strength solvent-resistant bond.

The following is a guide to the effect of bondline temperature during cure on 75°F (24°C) overlap shear strengths:

| <u>Bond Line Temperature</u> | <u>Time at Temperature</u> | <u>75°F (24°C) Shear Strength</u> |
|------------------------------|----------------------------|-----------------------------------|
| 350°F (177°C)                | 40-60 minutes              | 5500 psi                          |
| 375°F (191°C)                | 20-30 minutes              | 5500 psi                          |
| 400°F (204°C)                | 15-20 minutes              | 5300 psi                          |
| 425°F (218°C)                | 10-15 minutes              | 4300 psi                          |
| 450°F (232°C)                | 5-7 minutes                | 3500 psi                          |

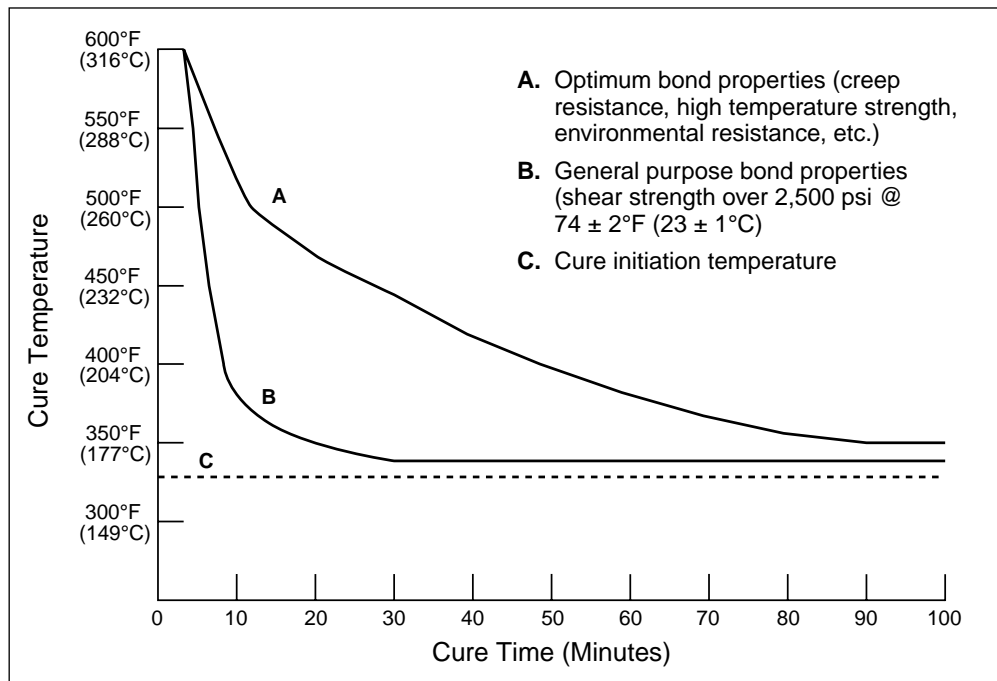
The time required to reach the specified bond line temperature is not included. Time lag for the parts to reach temperature will depend on relative mass and efficiency of the heat source. Temperature of the bond line should be determined experimentally by thermocouple measurements. Cure temperatures in excess of 400°F (204°C) yield useful, but lower than optimum strengths. At these temperatures the indicated time cycles should not be exceeded.

**Handling/Curing**  
**Information (continued)**

**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. Figure 1 is a guide from which an approximate cure cycle can be taken for various cure times or temperatures.

**Figure 1 – Curing Temperature vs Curing Time for 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386**



**B. Suggested Cure Cycle**

The following press 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 25 psi prior to reaching a bond line temperature of 150°F (66°C) and maintain throughout the press cure cycle. (Pressure was used to ensure flat test panels.)
2. Raise the bond line temperature from ambient to 350°F (177°C) at a rate of 10 ± 2°F (-12 ± 1°C).
3. Cure for 60 ± 1 minutes at 350 ± 2°F (177 ± 1°C).
4. Cool to below 200°F (93°C) bond line temperature prior to release to pressure. (In 3M laboratory tests, panels have been removed at 350°F (177°C) with no adverse effects.)

**Scotch-Weld™**  
**Epoxy Adhesive**  
**EC-1386**

**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.**

**1. Aluminum to Aluminum Bonds**

The following data show typical values obtained with 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 in aluminum bonds. All properties were measured on 1 in. wide 1/2 in. overlap specimens cut from .063 in. thick 4 in. x 7 in. bonded panels of 2043-T3 clad aluminum except as noted. Tests conducted according to MMM-A-132 or MIL-A-8623 methods.

**A. Original Properties**

Shear, Creep, Fatigue, Bend, Impact and Cleavage Strengths

| Test  | Test Temperature      | Minimum MMM-A-132 Requirement         | Minimum MIL-A-8623 Type III Requirement | Average                     | Type Failure |
|---|-----------------------|---------------------------------------|---|-----------------------------|--------------|
| <b>Shear Strength</b>                       | -67 ± 2°F (-55 ± 1°C) | 2500 psi                              | 2500 psi                                | 3000 psi                    | Cohesive     |
|   | 74 ± 2°F (23 ± 1°C)   | 2500 psi                              | 2500 psi                                | 5500 psi                    | Cohesive     |
|   | 180 ± 2°F (82 ± 1°C)  | 1250 psi                              | 1500 psi                                | 4600 psi                    | Cohesive     |
|   | 250 ± 2°F (121 ± 1°C) | None                                  | None                                    | 2800 psi                    | Cohesive     |
| <b>Creep Rupture</b>                        | 74 ± 2°F (23 ± 1°C)   | .015 in max. creep (1600 psi load)    |   | .0007 in.                   | No Failure   |
|   | 180 ± 2°F (82 ± 1°C)  | .015 in. max. creep (800 psi load)    |   | .0008 in.                   | No Failure   |
| <b>Creep Rupture</b>                        | 74 ± 2°F (23 ± 1°C)   |                                       | No Creep (1600 psi load)                |                             | No Creep     |
|   | 180 ± 2°F (82 ± 1°C)  |                                       | No Creep (300 psi load)                 |                             | No Creep     |
| <b>Fatigue (3/8 in. overlap)</b>            | 74 ± 2°F (23 ± 1°C)   | 10 <sup>7</sup> cycles (600 psi load) | 10 <sup>7</sup> cycles (600 psi load)   | Over 10 <sup>7</sup> cycles | No Failure   |
| <b>Bend Strength</b>                        | 74 ± 2°F (23 ± 1°C)   | None                                  | None                                    | 200 lbs.                    | Cohesive     |
| <b>Impact Strength (FED STD- MMM-A-175)</b> | 74 ± 2°F (23 ± 1°C)   | None                                  | 5 ft./lbs.                              | 6.3 ft./lbs.                | Cohesive     |
| <b>Cleavage Strength (ASTM D 1062-49T)</b>  | 74 ± 2°F (23 ± 1°C)   | None                                  | 1500 lbs.                               | 3730 lbs.                   | Cohesive     |

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**Typical Adhesive  
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Characteristics**  
*(continued)*

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**Storage Life Testing**

The following is an indication of the aging stability at 75 ± 5°F (24 ± 2°C) of uncured 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 as measured by overlap shear strength and work life per MIL-A-8623 Type III with a cure cycle of 25 psi bonding pressure applied by a platen press, a 10 ± 2°F (-12 ± 1°C) / minute bond line temperature rise from 80 to 350°F (26 to 177°C) with 60 ± 1 minutes at 350 ± 2°F (177 ± 1°C).

| Test  | Test Temperature                            | Minimum MIL-A-8623 Type III Requirement | Average  | Range                          | Type Failure         |
|---|---|---|--|--------------------------------|----------------------|
| Shear Strength (Control)                    | 74 ± 2°F (23 ± 1°C)<br>180 ± 2°F (82 ± 1°C) | 2500 psi<br>1500 psi                    | 4184 psi<br>3996 psi                             | 3700-4900 psi<br>3640-4590 psi | Cohesive<br>Cohesive |
| Shear Strength (1 year 75 ± 5°F) [24 ± 2°C] | 74 ± 2°F (23 ± 1°C)<br>180 ± 2°F (82 ± 1°C) | 2500 psi<br>1500 psi                    | 4260 psi<br>3496 psi                             | 3690-4480 psi<br>3000-4900 psi | Cohesive<br>Cohesive |
| Work Life                                   |   | 1 year                                  | Satisfactory handling properties after 18 months |                                |                      |

**Etched Aluminum Overlap Shear Strength at Elevated Temperatures**

| <u>Test Temperatures</u> | <u>Test Results</u> |
|--------------------------|---------------------|
| 250°F (121°C)            | 2620 psi            |
| 300°F (149°C)            | 650 psi             |
| 350°F (177°C)            | 405 psi             |

**Cure Cycle:** 60 minutes @ 350°F (177°C), 25 psi

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**Typical Adhesive  
Performance  
Characteristics**  
*(continued)*

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**Etched Aluminum Overlap Shear Strength After Environmental Aging**

| <b>Environment</b>                                     | <b>Environment Temperature</b> | <b>Immersion Time</b> | <b>Minimum MIL-A-8623 Type III Requirement</b> | <b>Average</b> | <b>Type Failure</b> |
|--|--------------------------------|-----------------------|--|----------------|---------------------|
| Tap Water  | 75 ± 5°F (24 ± 2°C)            | 30 days               |  | 5700 psi       | Cohesive            |
| Tap Water  | 120 ± 2°F (49 ± 1°C)           | 30 days               |  | 4744 psi       | Cohesive            |
| Tap Water  | 150 ± 2°F (66 ± 1°C)           | 30 days               |  | 4252 psi       | Cohesive            |
| Tap Water  | 180 ± 2°F (82 ± 1°C)           | 30 days               |  | 2760 psi       | Cohesive            |
| 28.6% Ethylene Glycol<br>71.4% Tap Water Blend         | 180 ± 2°F (82 ± 1°C)           | 30 days               |  | 3650 psi       | Cohesive            |
| .8% (Rust Inhibitor)<br>99.2% Tap Water                | 180 ± 2°F (82 ± 1°C)           | 30 days               |  | 1950 psi       | Cohesive            |
| 26% Methyl Alcohol<br>74% Tap Water                    | 180 ± 2°F (82 ± 1°C)           | 30 days               |  | 2440 psi       | Cohesive            |
| 1.2% (Radiator Conditioner)<br>98.9% Tap Water         | 180 ± 2°F (82 ± 1°C)           | 30 days               |  | 1390 psi       | Cohesive            |
| Salt Spray (FED STD TT-P-141 Method 606.1)             | 92 ± 97°F (33 ± 36°C)          | 250 hours             | 2000 psi                                       | 4220 psi       | Cohesive            |
| Accelerated Weathering (FED STD TT-P-141 Method 615.2) | 145 ± 5°F (63 ± 2°C)           | 60 hours              | 2000 psi                                       | 4234 psi       | Cohesive            |
| Type III Hydrocarbon Fluid (MIL-H-3136)                | 75 ± 5°F (24 ± 2°C)            | 7 days                | 2500 psi                                       | 4208 psi       | Cohesive            |

**Etched Aluminum T-Peel Strength**

T-Peel bonds consist of 1 in. x 7 in. bonded areas made from two 1 in. x 8 in. x .020 in. clad 2024 T3 aluminum panels. 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 was applied in a thin coat (.003 in. - .005 in. thick) on both surfaces. T-Peel panels peeled at a 90° angle to the bond line with a jaw separation rate of 2 in. per minute.

**Test Temperature                      Average                      Type Failure**

74 ± 2°F (23 ± 1°C)                      10 lbs. per inch width                      Cohesive

**Cure Cycle: 1 hour @ 350°F (177°C), 25 psi, 10°F (-12°C) / minute rise**

# Scotch-Weld™ Epoxy Adhesive EC-1386

**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.**

### Etched Aluminum Climbing Drum Peel Strength

Climbing Drum Peel bonds consist of 3 in. x 8 in. bonded areas made from one 3 in. x 10 in. x .020 clad 2024 T3 aluminum panel bonded to one 3 in. x 8 in. .064 in. clad 2024 T3 aluminum panel. 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 was applied in a thin coat (.003 in. - .005 in. thick) on both surfaces. Climbing Drum Peel strength was measured per MIL-A-25463 (Para. 4.6.1-4.6.3) methods. This method subtracts the force required to bend the 20 mil face sheet and the force required to lift the drum from the peel ( $\mp$ ) value.

$$\mp \text{ (lb.-in./1 in. width) = } \frac{\text{Machine Load (lbs./3 in. width) - 33}}{6}$$

| <u>Test Temperature</u> | <u><math>\mp</math> (lb.-in./in. width)</u> |
|-------------------------|---|
| 74 ± 2°F (23 ± 1°C)     | 30  |

**Cure Cycle:** 1 hour @ 350°F (177°C), 25 psi, 10°F (-4°C) / minute rise

### Overlap Shear Strength on Anodized Aluminum

| <u>Test Temperature</u> | <u>Test Results</u> |
|-------------------------|---------------------|
| 75°F (24°C)             | 3898 psi            |

**Cure Cycle:** 1 hour @ 350°F (177°C), 1 psi

### Tensile Strength

| <u>Test Temperature</u> | <u>Tensile</u> |
|-------------------------|----------------|
| -40°F (-40°C)           | 8293 psi       |
| 75°F (24°C)             | 10189 psi      |
| 180°F (82°C)            | 3178 psi       |

**Cure Cycle:** 1 hour @ 350°F (177°C)

### Coefficient of Thermal Expansion

4.65 x 10<sup>-5</sup>/°F between -40 and 112°F (-40 and 44°C)  
4.96 x 10<sup>-5</sup>/°F between 112 and 240°F (44 and 116°C)

**Cure Cycle:** 4½ hours @ 280°F (138°C) plus 1 hour @ 350°F (177°C)

### Impact Strength

Impact strength was measured according to ASTM D 950-54 (Izod Impact Tester - 30 lbs. wt.) methods using 1/2 in. x 1/2 in. square specimens of 2024 T3 aluminum. Scotch-Weld EC-1386 was applied in a thin coat (.003 in. x .005 in. thick) on both surfaces.

| <u>Test Temperature</u> | <u>Average</u> | <u>Type Failure</u> |
|-------------------------|----------------|---------------------|
| 75°F ± 5°F (24 ± 2°C)   | 45 ft./lbs.    | Cohesive            |



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**Typical Adhesive  
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*(continued)*

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**Electrical Properties**

1. Dielectric Strength – In excess of 400 volts/mil
2. Dielectric Constant –

|               |      |
|---------------|------|
| 73°F (23°C)   | 5.11 |
| 140°F (60°C)  | 5.28 |
| 194°F (90°C)  | 5.55 |
| 221°F (105°C) | 6.07 |
| 248°F (120°C) | 7.35 |
| 275°F (135°C) | 8.37 |
3. Dissipation Factor –

|               |      |
|---------------|------|
| 73°F (23°C)   | .057 |
| 140°F (60°C)  | .059 |
| 194°F (90°C)  | .101 |
| 221°F (105°C) | .129 |
| 248°F (120°C) | .138 |
| 275°F (135°C) | .183 |

**Etched Aluminum Overlap Shear Strength Quick Cure Data**

| <u>Cure Temperature</u> | <u>Cure Time at Temperature</u> | <u>Test Results</u> |
|-------------------------|---------------------------------|---------------------|
| 350°F (177°C)           | 10 minutes                      | 4322 psi            |
| 400°F (204°C)           | 5 minutes                       | 4663 psi            |
| 425°F (218°C)           | 1 minute                        | 3325 psi            |
| 450°F (232°C)           | 1 minute                        | 4260 psi            |
| 500°F (260°C)           | 10 seconds                      | 2208 psi            |
| 550°F (288°C)           | 3 seconds                       | 2025 psi            |
| 600°F (316°C)           | 2 seconds                       | 2620 psi            |

**Storage and Shelf Life**

Store 3M™ Scotch-Weld™ Epoxy Adhesive EC-1386 at 40°F (4°C) or lower for optimum storage life. Scotch-Weld EC-1386 should be permitted to thoroughly warm to room temperature before opening in order to prevent moisture condensation of the adhesive surface. Rotate stock on a “first in-first out” basis. Scotch-Weld EC-1386 has a shelf life of 15 months when stored at 40°F (4°C) and 24 months when stored at 0°F (-17°C) or below in original, unopened container.

# Scotch-Weld™ Epoxy Adhesive EC-1386

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## 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.

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## For Additional Information

To request additional product information or to arrange for sales assistance, call toll free 1-800-362-3550 or visit [www.3M.com/adhesives](http://www.3M.com/adhesives). Address correspondence to: 3M Engineered Adhesives Division, 3M Center, Building 220-7E-01, St. Paul, MN 55144-1000. Our fax number is 651-733-9175. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-787-750-3000. In Mexico, phone: 52-70-04-00.

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3M MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's method of application. Please remember that many factors can affect the use and performance of a 3M product in a particular application. The materials to be bonded with the product, the surface preparation of those materials, the product selected for use, the conditions in which the product is used, and the time and environmental conditions in which the product is expected to perform are among the many factors that can affect the use and performance of a 3M product. Given the variety of factors that can affect the use and performance of a 3M product, some of which are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

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## Limitation of Remedies and Liability

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