3M Advanced Technologies for Aerospace Structures

- Structural Composites
- Structural Adhesives
- Protective Products

3M Innovation
A resource of multiple technologies and disciplines focused on your unique needs.

3M Aerospace Central in Springfield, Missouri, was established specifically to help the aerospace industry meet the ever increasing demand for improvements and new ideas. By calling 1-800-235-AERO from anywhere in the United States*, you can get current information on 3M** products and services.

3M PRODUCTS AND TECHNOLOGIES

These are the advanced composites, adhesives, protective products, and expertise that can help you imagine more and accomplish more in design and assembly.**

1-800-235-AERO is also your resource for more than what you'll find in this brochure. With 3M, a multi-billion dollar international company, you can draw on a global multi-technology base and perhaps find what you need in hundreds of other 3M product areas.

3M SERVICES

• Fast response to your requests for 3M product samples.
• Personal technical service to help establish more efficient ways to handle and process 3M aerospace materials in your manufacturing.
• Easy ordering and delivery based on your schedule.
• Technically trained sales specialists for immediate problem solving.

* See back cover for 3M Aerospace global telephone numbers.
** Our customers are responsible for insuring that all regulatory approvals are in place for use of a 3M product on aircraft.

As you can see in the time line, 3M commitment and contributions to aerospace industry progress have been ongoing since the early 50’s. Today, you can find potential applications for 3M products on aircraft from nose to tail worldwide.
Meeting your current material specifications is the minimum you can expect from 3M. Work with us from the start of your design and new materials can be developed for your application. Typically, new 3M aerospace products have been developed with a customer to meet new design requirements.

At 3M research centers in Minnesota and Texas, over 950 PhD’s and more than 5,000 chemists, physicists, engineers and technologists develop new materials or tailor materials for specific characteristics. These efforts are reinforced by research centers in Europe and Japan.

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3M world headquarters and research facilities in St. Paul, Minnesota, U.S.A.


Kevlar is a registered trademark of Dupont.
3M™ Scotch-Weld™ Aerospace Adhesive Products and Services

The brand name “Scotch-Weld” is based on aircraft company conclusions made in the early 1950’s that this class of adhesive exhibited structural strength comparable to welding. Since then, ongoing 3M research and development has continued to provide leading edge performance in adhesive technology for the aerospace industry. But technology is just part of the 3M commitment.

Aligning with aircraft companies

To align with aerospace companies in meeting their bonding requirements, 3M goes beyond technology. This is service and support that helps aerospace designers put that technology to work quickly and effectively.

• **Technical service** – Industry-experienced 3M technical service representatives provide application support, shop training, and troubleshooting on-site and in 3M laboratories.

• **Product development** – Innovation is a 3M tradition. And 3M development chemists have the expertise, corporate resources, and technical capabilities to formulate adhesive products to meet unique aerospace customer specifications.

• **Analytical facilities** – 3M specialized analytical facilities and expertise are available to focus on any aerospace technical problem.

• **Material processing and testing** – 3M can easily meet your needs for qualification testing support and new process development.

• **Manufacturing to highest quality standards** – 3M manufacturing and testing facilities meet or exceed the quality standards of the industry such as ISO-9000 and Boeing D1-9000.

• **Local sales support** – 3M sales representatives provide industry and sales experience on a local, personal basis.

Dead load stress test – Carl Almer started a dead load stress test on one specimen in 1965... and the test was still running in 1999.
Secondary Ion Mass Spectrometry (SIMS) – The team of 3M adhesive scientists and technicians can identify and analyze substrate surfaces for composition and contaminants that affect adhesion.

Phosphoric acid anodizing line for preparation of aluminum test panels.

In depth, personal service — 3M Aerospace sales specialists are trained to help you take full advantage of 3M technology in engineering your application requirements.

Scotch-Weld products include:

- **Structural adhesive films**
  - 250°F (121°C) curing epoxy films.
  - 250°F and 350°F (121°C and 177°C) curing isolating bonding films.
  - Core stabilization film.
  - 350°F (177°C) curing nitrile phenolic and epoxy films.

- **Adhesive primers**
  - Solvent and water-based.

- **Decorative Laminating Adhesive**

- **Low density syntactic films**
  - Composite surfacing films.
  - Composite lightning strike/EMI protective films.
  - Scotch-Core syntactic core material.
  - Core splice adhesive films.

- **Structural paste adhesives**
  - One-part epoxy.
  - Two-part epoxy/urethane.

- **Low density void-filling potting compounds.**

**Autoclave** for heat curing characteristics and preparation of bonded test panels.

From this technology base, hundreds of formulations are possible to tailor-match your design requirements.

Additionally, new products and resin systems are under development to meet increasingly higher expectations for toughness and durability.
AF 163-2 – one of the most widely specified adhesive films

AF 163-2 is the 3M designation for a family of modified epoxy structural adhesive films for applications requiring a service temperature up to 225°F (107°C). With high performance, toughness and hot/wet durability, AF 163-2 has become an industry standard. Plus, at a competitive price, AF 163-2 offers the following unique combination of properties:

- Resists pre-bond shop humidity.
- Bonds "wet" Nomex® honeycomb core without pre-drying.
- Several temperatures – 225°F (107°C) dry Tg; 180°F (82°C) wet Tg.
- Cyclic stress durability. Outlasts similar high peel strength adhesive films.
- Over 3000 psi (20.7 MPa) overlap shear strength at 225°F (107°C).
- High peel strength: 70 piw (12.3 N/mm) floating roller peel.

Replacing mechanical fasteners – AF 126-2 bonds metal stringers in commercial transport fuselage.

Baggage door in the nose area of commercial transport – AF 163-2 bonds aluminum skin to pre-cut metal honeycomb.
**Moisture-resistant AF 163-2 – a solution to the problem of “wet” Nomex® Honeycomb**

**PROBLEM:**

Nomex Honeycomb absorbs ambient humidity which can significantly reduce the durability of the adhesive bond between honeycomb and a composite skin.

To manage the problem, many aircraft manufacturers require shipment and storage of Nomex in poly-wraps to minimize moisture. Often the honeycomb is also dried in ovens prior to usage.

But even with oven drying, Nomex immediately starts absorbing moisture in the bond shop — even at 75°F (24°C) and 50% RH.

The effect of honeycomb moisture is seen easily when testing -67°F (-55°C) honeycomb peel strength or 180°F (82°C) flatwise tensile strength. Strength retention in many adhesives is only 20% of dry Nomex values.

Unfortunately, such tests are not generally part of the received or in-process Quality Control procedures and loss of adhesive durability is missed.

**SOLUTION:**

In the same tests, AF 163-2 retains 90% of its performance. Based on this unique moisture resistance, more and more bond shops depend on AF 163-2 to better control the effects of “wet” Nomex.
AF 563 – 220°F (104°C) hot/wet durability with a unique combination of properties

A novel 3M epoxy backbone chemistry developed for use in AF 563 significantly advances the “wet” and “dry” elevated temperature properties of 3M high-strain-to-failure resins cured at 220-275°F (104-135°C). The chemistry also increases the glass transition temperature (Tg) without decreasing resin toughness.

AF 563 features include:

- Advance in hot/wet retention of properties.
- High strain to failure.
- High peel strength: 62 psi metal-to-metal floating roller.
- 220-350°F (104-177°C) co-cure with prepregs.
- 220°F (104°C) hot/wet durability.
- 300°F (149°C) dry shear strength.
- Resistant to pre-bond humidity in bond shops.

The following graphs show high temperature characteristics of AF 563 that go beyond the industry standard Scotch-Weld AF 163-2.

In comparing AF 563 to AF 163-2, AF 563 WET offers a higher Tg than AF 163-2 DRY. And the wet Tg typical of other systems cured below 275°F (135°C) are well below AF 163-2...often less than 135°F (57°C).

Other structural film adhesives may have the peel strength or the overlap shear strength at high temperatures of AF 563, but AF 563 is the first to provide the same combined performance or hot/wet retention of properties.
**3M™ Scotch-Weld™ Isolating Bonding Films**

**AF 191-G108 and AF 163-2G108 Isolating Bonding Films – solving problems of bonding dissimilar materials**

Bonding dissimilar materials can cause galvanic corrosion or unequal thermal expansion. Galvanic corrosion occurs when dissimilar materials such as carbon epoxy skin and aluminum honeycomb contact in the presence of an electrolyte such as saltwater.

Scotch-Weld Isolating Bonding Films not only bond, but help isolate dissimilar materials with an integral glass scrim. The scrim acts as a barrier to help prevent the contact that leads to a galvanic reaction.

Film toughness also helps overcome stresses of differing thermal expansion rates.

Other features include:

- Tough structural bond.
- Excellent honeycomb peel compared to self-adhering prepreg systems.
- Excellent hot/wet durability.
- Choice of cure temperatures. AF 163-2G108 from 225° to 350°F (107° to 177°C). AF 191-G108 from 275° to 350°F (135° to 177°C).
- Compatible with most epoxy prepreg systems.

**3M™ Scotch-Weld™ Core Stabilization Film**

AF 2622 Core Stabilization Film is designed to meet customer specifications for precision machining of non-metallic honeycomb core. In addition, AF 2622 helps maintain dimensional stability of the core which can change shape due to moisture absorption.

Performance features include:

- Allows vacuum chucking of core to NC machining tables.
- Maintains core dimensions during storage.
- Open scrim weave for easy honeycomb bonding.
- Compatible with 3M AF 191 and AF 563 Adhesive Films.
**3M™ Scotch-Weld™ 350°F (177°C) Curing Nitrile Phenolic Adhesive Films**

**Nitrile phenolic – tough, high service temperature adhesive films**

Scotch-Weld nitrile phenolic formulations have been performance proven for almost 40 years in commercial and military designs. Scotch-Weld AF 10, a nitrile phenolic, was the first adhesive film qualified, and is still widely specified as a “seal/bond” system for an integral fuel tank (see below).

Nitrile phenolics can outperform epoxies at high temperatures. With Scotch-Weld nitrile phenolic AF 31, for example, a long-term service temperature of 500°F (260°C) for greater than 2,000 hours is achieved. Also, as shown in the graph, nitrile phenolic adhesives provide greater strength retention than epoxy at temperatures above 400°F (204°C).

Even today, the most advanced commercial aircraft designs use Scotch-Weld nitrile phenolic films for primary structures requiring sonic fatigue durability and 300°F (149°C) service temperature.

**Scotch-Weld AF 10 – seal/bond for low maintenance**

Scotch-Weld AF 10 is a nitrile phenolic adhesive film with high peel strength at service temperatures from -67°F to 180°F (-55° to 82°C). It was first used to seal/bond the integral fuel tanks of the F102, F106, and Convair 880 and 990. During the lifetimes of these planes, studies by the manufacturers and U.S. Air Force showed significant cost savings in fuel tank maintenance for leakage. One study reported $10 spent on maintenance per 1,000 hours of flight time instead of $5,000-10,000 for polysulfide sealed aircraft.

The AF 10/EC-1290 seal/bond system is used today for fuel containment on the F-16 and various missiles.

Based on the characteristics in the following chart, AF 10 can be considered as the low maintenance alternative to polysulfide sealants.
Scotch-Weld AF 30 – most widely used nitrile phenolic

Scotch-Weld AF 30 has been proven during more than 30 years of continuous use in commercial aircraft production. Today, AF 30 is widely specified to damp metal-to-metal laminates in high sonic fatigue areas of aircraft structure.

Specific key advantages include:

- 300°F (149°C) service temperature with over 1700 psi (11.7 MPa) overlap shear strength.
- T-peel of 40 piw (175 N/25mm).
- Excellent history of corrosion resistance.
- Over 30 years of proven flight experience.
- Film toughness allows stretch forming operations to be done on bonded panels.

Note: The technical information and data on this page should be considered representative or typical only and should not be used for specification purposes.
**3M™ Scotch-Weld™ 350°F (177°C) Curing Epoxy Adhesive Films**

**Long term durability, good peel strength for honeycomb bonding**

The latest 3M research has been to increase peel strength or toughness, as well as long term durability at high temperature. One result of this research is Scotch-Weld AF 191.

**AF 191 – the tough high-strain-to-failure epoxy.**

The degree of toughness as exhibited by high-strain-to-failure and honeycomb peel is unique. And as seen in the chart, high shear strength is maintained even after three years constant exposure to 350ºF (177ºC).

A versatile adhesive film, AF 191 is at work in a variety of applications. With toughness and high overlap shear, AF 191 bonds sound suppression panels in engine nacelles. And for applications in space, Scotch-Weld AF 191 has been tested for low out-gassing and qualified for use on communications satellites.

Among the many performance features, you’ll find:

- High strain to failure.
- Retention of initial OLS at 350ºF (177ºC) even after 34,000 hours.
- Hot/wet durability.
- Good adhesion to thermoplastics.
- 350ºF (177ºC) service temperature and excellent retention of properties after 10,000 hours at 400ºF (204ºC).
- Can be reticulated.

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<th>Overlap Shear Strength (AF-191 K.08 wt/EC-3917 Primer)</th>
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<td>psi (MPa)</td>
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Values were obtained at 350°F (177°C) according to MMM-A-132 on 2024-T3 FPL etched.

**AF 191: High Strain, Tough Adhesive**

**Thick Adherend Stress/Strain**

-67°F (-55°C)
- 75°F (24°C)
- 250°F (121°C)
- 350°F (177°C)

**Sound suppression panels – Scotch-Weld AF 191 can be reticulated for bonding acoustic panels used in engine nacelles.**
AF 143-2 –
high OLS, good composite honeycomb peel

AF 143-2 has been proven on an advanced military bomber, particularly in composite bonding, and on the space shuttle for all metal-to-metal bonding. Primary features include the following:

- Overlap shear strength of 2800 psi (19.3 MPa) at 350°F (177°C).
- 35 in.lb/3 in. honeycomb peel strength.

AF 143 family of films is widely used for composite bonding on an advanced military bomber.

---

Dorsal fin of fighter – For bonding graphite epoxy prepreg to Nomex® honeycomb cores, Scotch-Weld AF 147 Adhesive Film provides 42 in.lb/3 in. (368 N/75 mm) honeycomb peel with 300°F (149°C) service temperature.

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<td>350°F (177°C)</td>
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<td>350°F (177°C)</td>
<td>350°F (177°C)</td>
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<td>OLS @ 75°F (24°C)</td>
<td>2250 psi (15.5 MPa)</td>
<td>2250 psi (15.5 MPa)</td>
<td>2500 psi (17.2 MPa)</td>
<td>4000 psi (27.6 MPa)</td>
<td>4000 psi (27.6 MPa)</td>
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<td>Peel strength (a) Metal/metal floating roller</td>
<td>5 psi (0.9 N/mm)</td>
<td>3 psi (0.5 N/mm)</td>
<td>15 psi (2.6 N/mm)</td>
<td>30 psi (5.3 N/mm)</td>
<td>30 psi (5.3 N/mm)</td>
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<td>10 in/lb (88 N/75 mm)</td>
<td>10 in/lb (88 N/75 mm)</td>
<td>35 in/lb (306 N/75 mm)</td>
<td>45 in/lb (394 N/75 mm)</td>
<td>45 in/lb (394 N/75 mm)</td>
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1. Other weights and scrim/carriers are available.
2. Temperature at which products provide 2000 psi (13.8 MPa) OLS.

Note: The technical information and data on these two pages should be considered representative or typical only and should not be used for specification purposes.
3M™ Scotch-Weld™ Adhesive Primers

Film-matched for optimum adhesive performance

Each Scotch-Weld Primer is formulated to help assure the maximum possible performance from a specific Scotch-Weld Adhesive Film. This film-matched approach gives you a compatible system to stabilize the prepared surface, promote adhesion and bond durability, and protect against corrosion. Both solvent-based and water-based versions are available.

Water-based primers

EC-3963 is a 250°F (121°C) curing epoxy primer that meets industry requirements with less than 250g/liter VOC. Designed to spray and handle like a solvent-based primer, EC-3963 can be substituted in the shop with little or no process change.

- No pre-bake or bake between coats required.
- Excellent performance between .15 – 0.4 mil cured thickness.
- Quick flash dry between coats.
- Tack free.

Water-based EC-3983 performance is similar to EC-3917.

**Helicopter tail boom** – Sprayed on the reinforcing longerons of a helicopter tail boom, EC-3924 B Primer protects against corrosive environments inside and outside the bond line.

**Doubler assembly** – EC-1660 (5%) sprayed on aluminum layers insures complete wetting of AF 30 Adhesive Film in doubler assembly.

**Fuselage skin** – EC-3960 Primer, formulated for efficient spraying, protects skins prior to assembly and resists corrosion in end use.

**Engine nacelle “V” rings** – EC-3917 is a corrosion-inhibiting primer engineered for high temperature applications.

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<tr>
<td>EC-3963</td>
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<td>EC-3983</td>
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</tbody>
</table>

*N.C. – Corrosion Inhibiting
3M™ Decorative Laminating Adhesive

**High strength, removable decorative laminate bonding**

EC-2636 B/A Decorative Laminating Adhesive is a 2-part water-based adhesive designed specifically for adhesion and removal of decorative laminates on aircraft interiors.

Traditionally, removal involves labor intensive stripping with solvents or scrapers that could damage delicate composite panels. With EC-2636 B/A, removal is with a heat gun or heating the panel in an oven at 250°F (121°C). Turnaround is faster, reducing out-of-service time.

Features include the following:

- Less than 6% by weight VOCs.
- Clean up with soap and water.
- Clean removal at 250°F (121°C) with little or no adhesive residue.
- Reliable adhesion with 160°F (71°C) hot performance and 120°F (49°C) hot/wet performance.
- Long shelf and pot life at RT.
- 57% solids for spray coverage of up to 700 sq.ft./gallon.
- Visible color change during air dry.
- EC-2636 B/A heat cure version.
- EC-2636RT B/A room temperature curing version.

**Versatile performance – Interior applications**

Interior applications for EC-2636 B/A range from stowbins and ceilings to sidewalls, bulkheads, closet panels and gallery panels.
Composite Surfacing Film – cost effective alternative to fairing compounds

Composites offer many new options for aircraft designers, but pinholes, weave, and honeycomb mark-off challenge paint shops trying to achieve class “A” finishes. Such surface problems have been hidden with fairing compounds – a messy, expensive, and time-consuming process. But now there is a simple, cost-effective alternative – 3M AF 325 low density syntactic surfacing films.

AF 325 offers the following features:

• Low flow and customized tack for simple, clean lay-up even against vertical mold released tools.

• Co-curing with most prepregs; little or no resin intermingling.

• High cured thickness for greater pinhole filling and defect hiding. Reduces the time and labor of typical “fill and sand” composite finishing.

• 250°F (121°C) or 350°F (177°C) curing.

• Readily sanded and painted.

• Blue film provides visual definition during paint removal, helping minimize chances for damaging the underlying prepreg.

• Reduced moisture ingestion into honeycomb.

Cross section of composite honeycomb panel – Low flow and quick gelling of AF 325 (top layer) helps assure little or no resin intermingling. Extra cured thickness improves pinhole filling and hiding defects.
Lightning Strike/EMI Protection Surfacing Films

By adding a metallic screen, the performance of AF 325 composite surfacing resin is enhanced to include lightning strike/EMI protection.

**AF 325 LS** can be tailored with a variety of aluminum or copper screens for specific applications. Low film weight to thickness ratio helps assure encapsulation of the screen to help prevent screen damage during paint preparation or removal.

Additional features include:

- High cured thickness for greater pinhole filling and defect hiding. Reduces the time and labor of typical “fill and sand” composite finishing.
- Customized tack for easy lay-up even against vertical mold released tools.
- Co-curing with most prepregs; little or no resin intermingling.
- Flexible cures from 225°F (107°C) to 350°F (177°C).
- Film color provides visual definition during paint removal, helping minimize chances for damaging the underlying prepreg.

**EMI shielding** – Depending on the screen, AF 325 LS film provides zone 1, 2, or 3 lightning strike and EMI protection.

**Demonstration panel** – Upper section shows finished panel after painting. Note the pinhole filling and surface quality in upper right with the 3M composite surfacing film.
3M™ Scotch-Core™ Syntactic Film

Lightweight core material for new design alternatives

With 3M microballoons in a structural composite epoxy matrix, Scotch-Core Syntactic Film is a lightweight, cost-effective alternative to multiple ply, solid composite panels.

Self-adhering Scotch-Core Film breaks the 1/4” barrier in sandwich panel designs. You eliminate adhesive film weight and can lay-up precise tolerance plies with film thicknesses ranging from 10 to 125 mils (1/8”). Since Scotch-Core Film is thicker per ply, lay-up is faster and more cost-effective than with prepregs. Plus, you can co-cure Scotch-Core Film with most prepregs.

Features include the following:

- Choice of 250°F (121°C) or 350°F (149°C) curing.
- Glass or aramid scrims available.
- Low density of 39 lbs/ft³ compared to a typical 110 lbs/ft³ for carbon fiber prepregs.
- Low flow, quick gelling resin.
- Dielectric response appropriate for military aircraft.
- Low moisture absorption.
- Resists jet fuel, turbine oil, and Skydrol.
- Low out-gassing for use in space.
- Excellent for thermal insulation applications.

![Low thermal conductivity of Scotch-Core Syntactic Film insulates the nose cone of the space shuttle booster rocket.](image)

<table>
<thead>
<tr>
<th>Test Temp</th>
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<th>SC 250 K</th>
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<tr>
<td></td>
<td>Compression</td>
<td>Short Beam</td>
</tr>
<tr>
<td>-67°F (-55°C)</td>
<td>11283 psi (77.8 MPa)</td>
<td>9033 psi (62.3 MPa)</td>
</tr>
<tr>
<td>72°F (22°C)</td>
<td>9328 psi (64.3 MPa)</td>
<td>3873 psi (26.7 MPa)</td>
</tr>
<tr>
<td>250°F (121°C)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>300°F (149°C)</td>
<td>6070 psi (41.9 MPa)</td>
<td>4685 psi (32.3 MPa)</td>
</tr>
<tr>
<td>350°F (177°C)</td>
<td>4579 psi (31.6 MPa)</td>
<td>3874 psi (26.7 MPa)</td>
</tr>
</tbody>
</table>

Other Scotch-Core Film data is available: 300°F (149°C) cure data for SC 350; space data; dielectric constant; magnetic permeability; flatwise tensile and more.

Add Scotch-Core Film to honeycomb panels – As an alternative in composite skins with more than four to six plies, Scotch-Core Film replaces the center plies of the skin, reducing weight and labor.

![Add Scotch-Core Film to honeycomb panels](image)

Void filling for composite panel "close-outs" is among many possible applications for Scotch-Core Films.
Low density films with a range of expansion ratios

This line of low density films offers a range of expansion ratios from 1.35 to 2.5 for bonding core to close-outs, filling mismatched areas, or splicing honeycomb core. With 3M glass microballoon technology, density after cure is consistently low for each product. For example:

- 35-40 lbs./cu.ft. (0.56-0.64 g/cc) for AF 3002
- 23-25 lbs./cu.ft. (0.37-0.40 g/cc) for AF 3024
- 30 lbs./cu.ft. (0.48 g/cc) for AF 3028

Scotch-Weld Core Splice Films can be cured at 250°F or 350°F (121°C or 177°C). The cure temperature will determine end use performance characteristics. For example, when cured at 250°F (121°C), AF 3002 provides high performance over the -67°F to 250°F (-55°C to 121°C) range. When cured at 350°F (177°C), the range widens from -67°F to 350°F (155°C to 177°C).

Note: The technical information and data on these two pages should be considered representative or typical only and should not be used for specification purposes.
High strength, production flexibility, and more

Since 3M introduced one-part structural paste adhesives in the 1950’s and the first tough two-part formulations in the 1960’s, Scotch-Weld Paste Adhesives have been increasingly at work in a wide range of aerospace applications:

- Primary wing structure.
- Fuselage body seams.
- Missile casings.
- Rocket motors.
- Aircraft interiors.
- Satellite structure.

The reason for the ever-growing acceptance is a combination of features and capabilities that make it easier to put advanced ideas into practical application.

For high strength and toughness, paste formulations are based on the polymer and toughening chemistries of Scotch-Weld Adhesive Films.

With increased use of composites, new paste adhesive applications have been developed. For example, high compression liquid shim adhesives are used to fill mismatched areas and prevent pre-stressing of composite panels when assembled.

Current paste adhesives line:

- One-part heat-curing systems.
- Two-part room-temperature-curing systems.

One-Part Heat-Curing Adhesives

With service temperatures up to 350°F (177°C), one-part systems provide higher temperature resistance than two-part systems. Scotch-Weld adhesives cure in the range of 225°F to 350°F (107°C to 177°C).

Typically, paste adhesives have not been able to equal the performance of film adhesives. 3M research, however, has developed a new generation of paste adhesives with performance close to films.

EC-3448 – compatible with graphite composites

Designed for primary structure composite bonding, Scotch-Weld EC-3448 adheres to nearly every graphite composite formulation. For high performance and reliability in critical structure, EC-3448 provides a unique combination of features:

- 180°F (82°C) hot/wet durability.
- 6,000 psi (41.4 MPa) OLS at room temperature (a break-through rivaling film adhesive).
- 63 piw metal-to-metal floating roller peel (another break-through rivaling films).

After only 60 minutes curing at 250°F (121°C), peel strength is up to three times greater than previous Scotch-Weld 250°F (121°C) curing paste adhesives.

With 180°F (82°C) hot/wet durability, pre-cured composite primary structure can be bonded; for example, composite wingboxes.

NOTE: Products on these two pages represent only a portion of the complete 3M product line. Technical data sheets are available for all products.

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

<table>
<thead>
<tr>
<th>Products</th>
<th>EC-2214R</th>
<th>EC-2214 HT</th>
<th>SW 2214 HTNF</th>
<th>EC-2214 HF</th>
<th>EC-3448</th>
<th>SW 7823</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>250°F (121°C)</td>
<td>350°F (177°C)</td>
<td>350°F (177°C)</td>
<td>180°F (82°C)</td>
<td>225°F (107°C)</td>
<td>248°F (120°C)</td>
</tr>
<tr>
<td>temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS psi/MPa</td>
<td>4500/31</td>
<td>2000/13.8</td>
<td>3191/22</td>
<td>4000/27.6</td>
<td>6000/41.4</td>
<td>4351/30</td>
</tr>
<tr>
<td>75°F (24°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal/metal</td>
<td>5 piw (8.8 N/cm)</td>
<td>2 piw (3.5 N/cm)</td>
<td>–</td>
<td>10 piw (17.5 N/cm)</td>
<td>30 piw (52.5 N/cm)</td>
<td>25.7 piw (46 N/cm)</td>
</tr>
<tr>
<td>T-peel 75°F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(24°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feature</td>
<td>Non-sag</td>
<td>Temperature</td>
<td>Temperature</td>
<td>High flex</td>
<td>Environ. aging</td>
<td>Environ. aging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>resistance</td>
<td>resistance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Two-Part Room-Temperature-Curing Adhesives

3M Scotch-Weld two-part paste adhesive systems help eliminate the time and expense of a heat curing cycle with ovens, UV lamps, or induction heaters.

Formulations include epoxy and urethane chemistries.

### Two-Part Epoxy Adhesives

**EC-2216 B/A – unique 30-40% elongation**

With flexibility, and high shear and peel, 3M EC-2216 B/A is used for a wide variety of applications. For more than 35 years, it has been the industry standard from epoxy adhesives and is still unique with a 30-40% elongation.

**EC-3333 B/A – new generation with high OLS and peel**

3M EC-3333 B/A is the first in a new class of 2-part 3M paste adhesives combining high OLS and peel strength for the most demanding performance requirements.

- Tough, impact resistant bond with outstanding environmental resistance.
- Controlled flow for production efficiency.

**EC-2615 B/A – non-sag viscosity**

3M EC-2615 B/A, EC-2615 LW B/A, and EC-2615 XLW B/A are similar to EC-3333 B/A but with the addition of non-sag viscosity. The three vary in work life from 20 minutes up to seven hours for extensive assembly operations.

### Two-Part Urethane Adhesives

- **EC-2615 B/A** – non-sag viscosity

Use 3M EC-3532 B/A, EC-3535 B/A, and EC-3549 B/A 2-part polyurethane adhesives for tough, impact-resistant bonds. The three vary in work life, cure time, and color.

- Excellent adhesion to many primed or painted metal and plastic substrates.
- Develops sag resistance within 30 seconds of mixing.

### Two-Part Paste Adhesives at a Glance

<table>
<thead>
<tr>
<th>Products</th>
<th>EC-2216 B/A</th>
<th>EC-2615</th>
<th>EC-2615 LW</th>
<th>EC-2615 XLW</th>
<th>EC-3333</th>
<th>SW 9323</th>
<th>SW 9233-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service temperature</td>
<td>160°F (71°C)</td>
<td>180°F (82°C)</td>
<td>180°F (82°C)</td>
<td>180°F (82°C)</td>
<td>180°F (82°C)</td>
<td>180°F (82°C)</td>
<td>180°F (82°C)</td>
</tr>
<tr>
<td>OLS 75°F (24°C) psi/MPa</td>
<td>3300/23</td>
<td>5500/38</td>
<td>5300/37</td>
<td>6000/41</td>
<td>5500/38</td>
<td>5900/41</td>
<td>4400/30</td>
</tr>
<tr>
<td>T-peel 75°F (24°C) piw/N/25mm</td>
<td>35/156</td>
<td>70/311</td>
<td>60/267</td>
<td>50/222</td>
<td>50/222</td>
<td>50/222</td>
<td>25/111</td>
</tr>
<tr>
<td>Bell peel 75°F (24°C) piw/N/25mm</td>
<td>35/156</td>
<td>96/436</td>
<td>96/436</td>
<td>50/222</td>
<td>10/454</td>
<td>50/222</td>
<td>50/222</td>
</tr>
<tr>
<td>Work Life (minutes)</td>
<td>90</td>
<td>20</td>
<td>60</td>
<td>480</td>
<td>20</td>
<td>150</td>
<td>180</td>
</tr>
</tbody>
</table>
For filling voids and reinforcing honeycomb core, Scotch-Weld void fillers/potting compounds provide a pioneering technology with 3M glass balloons. These microscopic spheres are mixed with either one or two-part Scotch-Weld epoxies for a combination of low density and good compression strength.

Applications include the following:
- Densify core around fasteners.
- Honeycomb closeout section.
- Aerodynamic smoothing.

Landing gear door – EC-3500 B/A is a two-part, heat curing formulation with compression strength of 8,510 psi (58.7 MPa) for demanding applications. Service temperature is 350°F (177°C).

Honeycomb close-outs – To stiffen and improve compression strength, two-part room-temperature curing EC-3524 B/A is applied to the exposed edges of honeycomb panels in a bulkhead.

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The products here represent only a portion of the complete 3M product line. Technical data sheets are available for all products.

### Potting Compounds at a Glance

<table>
<thead>
<tr>
<th>Products</th>
<th>One-Part Core Potting Compounds</th>
<th>Two-Part Core Potting Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC-3439 HS</td>
<td>SW 3439 HT AF</td>
</tr>
<tr>
<td>Service temperature</td>
<td>212°F (100°C)</td>
<td>302°F (150°C)</td>
</tr>
<tr>
<td>Cured density</td>
<td>43.7 lb/ft³ (0.70 g/cc)</td>
<td>46.8 lb/ft³ (0.75 g/cc)</td>
</tr>
<tr>
<td>Compression strength psi/MPa 75°F (24°C)</td>
<td>7614/111</td>
<td>8412/106</td>
</tr>
<tr>
<td>Feature</td>
<td>Compression resistance</td>
<td>Temperature resistance</td>
</tr>
</tbody>
</table>
Protective Products
3M™ Polyurethane Protective Tapes

Easy-to-apply protection against abrasion, impact, corrosion, and UV light.

3M Polyurethane Protective Tapes are a high durability thermoplastic elastomer coated on one side with pressure sensitive acrylic adhesive. Application is fast and easy. Performance history is extensive in military, commercial, business and civilian aerospace applications for protecting surfaces from sand, gravel, insects, snow, sleet, rain, UV light, and other sources of surface damage.

Features include the following:

- Abrasion/scratch resistance for long term protection of leading edge surfaces.
- Impact resistance to maintain surface integrity against gravel and other FOD damage.
- Puncture resistance to provide a continuous barrier against liquids that could corrode surfaces.
- Resistance to most aerospace fluids.
- No VOCs released during application.
- Formable into 3-D shapes.
- Conformable to most curved surfaces.

3M™ SJ8665 Protective Boots

3M pre-formed protective boots help protect leading edge structures from erosion and abrasion damage. Protective boots are used extensively in private, commercial, and military aircraft to protect radomes, antennas, wing and stabilizer tips, landing gear pods, composite parts, and other leading edge structures with complex curvatures.

3M manufactures pre-formed boots for most aircraft.

Military aircraft protective boots – 3M polyurethane boots are authorized for a wide variety of military aircraft applications.
Leading Edge Protection

3M 8671, 8672 and 8681 polyurethane tapes are designed to help protect the leading edges of military, commercial and light aircraft. Applications include wings, rotor blades, blade antennas, stabilizers, and struts.

Military aircraft leading edge protection – Polyurethane tape 8681 is authorized to protect a wide range of high performance military aircraft leading edge structures.

Military aircraft horizontal stabilizer application.
3M™ Polyurethane Tapes for Fluid Barriers and Corrosion Resistance

3M 8663 polyurethane tapes over aircraft floor panels establishes a durable puncture resistant barrier that helps prevent water, soda pop, coffee, urine and other liquids from penetrating the floor and becoming a possible source of corrosion.

Problem –
Floor beam corrosion caused by fluid penetration.

Solution –
With pressure sensitive adhesive, 3M 8663 tape application is fast and easy on the floor of entry areas, galleys, and lavatories.

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

Polyurethane Protective Tapes at a Glance

<table>
<thead>
<tr>
<th>Product/ color</th>
<th>Tape Structure (Backing/ Adhesive)</th>
<th>Total Thickness mils (mm)</th>
<th>Adhesion to Aluminum oz./in. (N/100 mm)</th>
<th>Tensile Strength lbs./in. (N/100 mm)</th>
<th>Weight Without Liner (ozs./sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8641 Gray*</td>
<td>Polyurethane/Acrylic Foam</td>
<td>41.0 (.80)</td>
<td>74 (82)</td>
<td>93 (1629)</td>
<td>3.42</td>
</tr>
<tr>
<td>8663 Transparent</td>
<td>Polyurethane/Acrylic Foam</td>
<td>18.0 (.35)</td>
<td>83 (92)</td>
<td>117 (2049)</td>
<td>1.73</td>
</tr>
<tr>
<td>8671 Transparent</td>
<td>Polyurethane/Acrylic Foam</td>
<td>14.0 (.35)</td>
<td>68 (76)</td>
<td>80 (1400)</td>
<td>1.44</td>
</tr>
<tr>
<td>8671HS Transparent</td>
<td>Polyurethane/Acrylic Foam</td>
<td>14.0 (.35)</td>
<td>68 (76)</td>
<td>80 (1400)</td>
<td>1.44</td>
</tr>
<tr>
<td>8672 Transparent</td>
<td>Polyurethane/Acrylic Foam</td>
<td>8.0 (.25)</td>
<td>66 (59)</td>
<td>40 (700)</td>
<td>0.83</td>
</tr>
<tr>
<td>8681HS Transparent**</td>
<td>Polyurethane/Acrylic Foam</td>
<td>14.0 (.35)</td>
<td>68 (76)</td>
<td>87 (1524)</td>
<td>1.44</td>
</tr>
</tbody>
</table>

* Tape 8641 is available in Gray, Gray - 36173, Gray - 36118, Black, White.
** Tape 8681HS is available in Matte Transparent, Gray - 36118, Gray - 36320, Gray - 36173, Gray - 36270.

Easy visual inspection – With the transparency of 3M 8663 tape, the floor can be viewed without removing the tape.
**Impact Protection**

3M 8641 polyurethane tape is an exceptionally tough construction to help protect the fuselage, antennas, wing flaps, landing gear doors, and other structures from gravel, dirt, and rock (FOD) damage. One example is aircraft operating on unimproved runways.

---

**Aircraft Paint Replacement and Drag Reduction (Appliqué Technology)**

Building on over 30 years of experience flying high performance films and adhesive systems on aircraft surfaces, 3M is developing a family of products designed to replace aircraft topcoat paints and reduce aerodynamic drag. The use of pressure sensitive film technology to replace or enhance aircraft topcoat systems has come to be known as *Aircraft Appliqué Technology* ... a 3M innovation.

As of 1999, 3M is flight testing film and adhesive systems designed to replace military, commercial, and private aircraft topcoat paint systems. In addition, flight evaluations of drag reduction films are nearing completion. Look for these innovative 3M products in the very near future.
3M™ Noise and Vibration Control Systems

Flexible solutions with total service.

While the characteristics of noise and vibration are fixed by the laws of physics, noise and vibration control problems vary widely with the specific application. For that reason, 3M offers a family of products to meet a wide range of aerospace noise and vibration damping needs.

3M™ 434, 435, 436 Vibration Damping Tapes

These 3M pressure sensitive tapes are a constrained layer construction designed to control structure born vibration in fuselage panels and support members.

- Low temperature damping.
- Excellent moisture resistance.
- Fatigue resistance for long term performance.
- Pressure sensitive adhesive to facilitate production.

<table>
<thead>
<tr>
<th>Product</th>
<th>Adhesive</th>
<th>Backing Thickness mils (mm)</th>
<th>Total Thickness mils (mm)</th>
<th>Adhesion to Steel oz./in. (N/100 mm)</th>
<th>Tensile Strength lbs./in. (N/100 mm)</th>
<th>Elongation at Break %</th>
<th>Temperature Range °F (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>434</td>
<td>Polyurethane/Acrylic</td>
<td>5.5 (0.14)</td>
<td>7.5 (0.19)</td>
<td>65 (72)</td>
<td>53 (928)</td>
<td>12</td>
<td>-76 to 68°F (-60 to 20°C)</td>
</tr>
<tr>
<td>435</td>
<td>Polyurethane/Acrylic</td>
<td>8.0 (0.20)</td>
<td>13.5 (0.34)</td>
<td>65 (72)</td>
<td>84 (1470)</td>
<td>12</td>
<td>-76 to 68°F (-60 to 20°C)</td>
</tr>
<tr>
<td>436</td>
<td>Polyurethane/Acrylic</td>
<td>12.0 (.31)</td>
<td>17.5 (0.45)</td>
<td>65 (72)</td>
<td>126 (2205)</td>
<td>12</td>
<td>-76 to 68°F (-60 to 20°C)</td>
</tr>
</tbody>
</table>

Technological experience – 3M viscoelastic polymers have been used for more than 15 years on commercial aircraft fuselage skins to reduce unwanted noise and damaging vibration.
3M™ Viscoelastic Polymer Systems

3M™ SJ-2016, Type 1210 viscoelastic polymer is designed to damp resonant vibration and reduce noise in interior compartments where flame retardation is required. When tested as a sandwich between HT70 Divinycell foam panels, SJ-2016 meets the Airworthiness Standards: Transport Category Planes FAR 25.853 vertical flame test for compartment interiors.

3M™ SJ-2052 and SJ-2053 combine viscoelastic polymer with aluminum foil backing. The construction is a constrained layer damper designed to control structure born vibration in the fuselage. The difference between SJ-2052 and SJ-2053 is the polymer. SJ-2053 uses a polymer with a lower temperature range for peak damping (see chart below). Both can be applied to a variety of substrates without additional bonding mediums.

3M™ SJ-2040 Layered Viscoelastic Damping Polymer is a high energy dissipative construction of two polymer layers with an interleaf of 1.4 mils (.036 mm) polyester film. The layered construction controls resonance induced vibration when combined with a metal constraining layer. The interleaf film increases dimensional stability during application. Three liners are available: single, double for die-cutting, and extended for convenient liner removal.

3M™ 4014 Damping Aluminum Foam Sheets

Damping foam sheets are open cell polyurethane with an aluminum constraining layer designed to damp resonant vibration in thin fuselage metal.

- Pressure sensitive adhesive on one side for easy application with only hand pressure.
- Meets Federal Air Regulation Flammability Specifications for acoustic insulation materials (FAR Section 25.853, Paragraph B).
- Excellent damping_installed cost ratio.

### 4014 Typical Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caliper</td>
<td>0.25 in (6.35 mm)</td>
</tr>
<tr>
<td>Weight</td>
<td>0.27 lbs./ft.2 (1.32 kg/m2)</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>0.48 BTU•in./hr./ft.2/F (0.69 Watts/m•°C)</td>
</tr>
<tr>
<td>Moisture Resistance</td>
<td>Less than 0.2% weight gain (when conditioned at 150°F/67°C and 100% RH for one week.)</td>
</tr>
</tbody>
</table>

### Polymer Systems at a Glance

<table>
<thead>
<tr>
<th>Product</th>
<th>Aluminum Backing Thickness</th>
<th>Viscoelastic Thickness</th>
<th>Temperature Range (100Hz)</th>
<th>Liner</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJ2016 Type 1210</td>
<td>10 Mils (0.254 mm)</td>
<td>0° to 60°C (32° to 140°F)</td>
<td>Easy release paper</td>
<td></td>
</tr>
<tr>
<td>SJ2040</td>
<td>10 Mils (0.254 mm) each layer</td>
<td>-46° to 20°C (-40° to 68°F)</td>
<td>White polyethylene</td>
<td></td>
</tr>
<tr>
<td>SJ2052</td>
<td>10 Mils (0.254 mm)</td>
<td>0° to 60°C (32° to 140°F)</td>
<td>Blue polyethylene</td>
<td></td>
</tr>
<tr>
<td>SJ2053</td>
<td>10 Mils (0.254 mm)</td>
<td>-46° to 20°C (-40° to 68°F)</td>
<td>Blue polyethylene</td>
<td></td>
</tr>
</tbody>
</table>

Note: The technical information and data on these two pages should be considered representative or typical only and should not be used for specification purposes.
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Important Notice for 3M Polyurethane Protective Tapes: Due to the potential safety hazard which could result from tape delamination in flight, these products are not recommended for use by general aviation on rotating leading edges such as helicopter rotor blades or aircraft propellers unless specifically authorized by and used in accordance with an OEM specification, OEM service literature, or military tech order. It is the position of 3M that OEM manufacturers and/or the military must satisfy themselves that this product and their specification and application procedures are adequate for their specific blade application. Such use or specification of these products by an OEM manufacturer or the military is undertaken at their sole risk and liability.

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