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SL 104
SL 077/56-001
PPG Heated Windshield Seal

NOTE

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MU – 2

SERVICE LETTER

MITSUBISHI HEAVY INDUSTRIES, LTD.
NAGOYA AEROSPACE SYSTEMS WORKS
10 OYE-CHO, MINATO-KU, NAGOYA, JAPAN

JCAB T.C. : No. 104 DATE: November 16, 2018

FAA T.C. : No. 077/56-001

SUBJECT: PPG Heated Windshield Seal

MODELS AFFECTED: All MU-2B Airplanes with PPG Heated Windshields

Mitsubishi Heavy Industries America, Inc. (MHIA) received a report from the field about a cracked outer layer of a PPG heated windshield. No direct cause of the crack has been determined at this time; however, there were signs of water ingress into the edges of the windshield indicating a faulty seal (commonly called the “hump seal”). Detailed examination revealed the hump seal exhibited gouges, indents, and cracks and there was separation between the hump seal and the exterior glass. These conditions apparently allowed moisture penetration inside the protected edge, promoting fogging, and may have contributed to eventual failure of the windshield.

PPG Industries, Inc., the original manufacturer of the heated windshield, recommends inspecting the windshield moisture seal every four months or every 1,000 flight hours, whichever occurs first, for signs of erosion, degradation or cracking. Pilots should inspect the condition of the windshield and hump seal during pre-fight walk-around. Keeping the seal in good condition can prevent damage to the windshield due to water ingress. PPG Aerospace offers a Hump Seal Repair Kit designed for repair of the seals. See attachments for more information on PPG Aerospace Hump Seal Repair Kit and Visual Inspection Guide.

For any questions regarding PPG Aerospace Hump Seal Repair Kit and Visual Inspection Guide, please contact PPG at the following contact information:

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Huntsville, Alabama 35811
Phone: +1-256-851-7001
Website: www.ppgaerospace.com

PPG Aerospace
Transparencies

TRANSPARENCY TOPICS

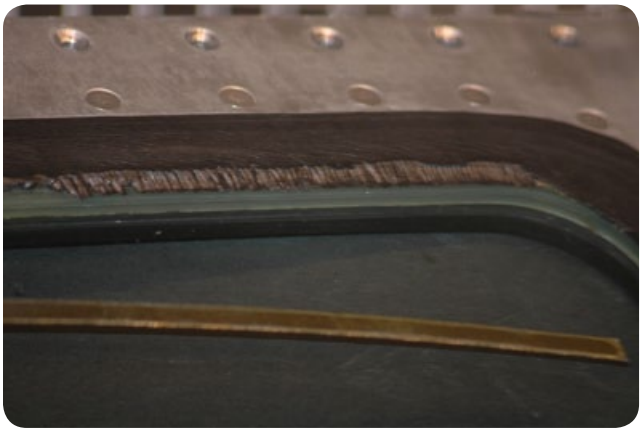
HUMP SEAL REPAIR

Using PPG Aerospace Hump Seal Repair Kit

An aircraft windshield's sealant system is the most critical element in extending windshield service life. The outboard moisture, or weather, seal protects against moisture ingress, which can cause delamination, interlayer degradation and windshield heating system damage. Commonly called a hump seal because of its appearance, this seal also acts as an aerodynamic smoother and covers the outboard edge of the transparency. Because it is subjected to the effects of wind and rain erosion and UV exposure, a hump seal can degrade over time. It is important to maintain the seal.

PPG Aerospace – Transparencies makes it easy to repair a hump seal in the field with hump seal repair kits designed for windshields on commercial and general aviation aircraft. The kits contain everything needed to repair a hump seal on a windshield, including new PR-1425CF chromate-free sealant by PPG Aerospace. Because PR-1425CF sealant cures in less than half the time of PR-1425 sealant, hump seal repairs can be done overnight on the line or during a minor maintenance check in the hangar. Contact the nearest PPG Aerospace application support center for more information and to purchase hump seal repair kits.

Hump seal repair procedures for most windshields are outlined in the applicable Aircraft Maintenance Manual (AMM) or PPG Abbreviated Component Maintenance Manual (ACMM). PPG recommends inspecting the windshield moisture seal every four months or every 1,000 flight hours, whichever occurs first, for signs of erosion, degradation or cracking.



This hump seal shows evidence of wind and rain erosion, and it should be repaired.

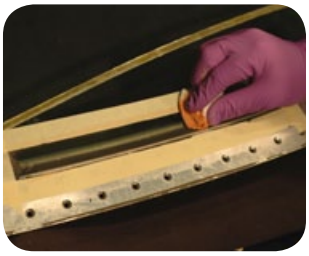
On the back are easy-to-follow steps for repairing a hump seal using the PPG Aerospace Hump Seal Repair Kit for the applicable windshield. This information is intended as a general guide only and does not replace or supersede the recommendations provided by the OEM in either the AMM or ACMM. Please consult the applicable AMM or ACMM for the specific hump seal repair procedure.

The PPG hump seal repair kit contains everything needed to repair the seal on a windshield:

- Cleaning compound
- Forming tool for specific windshield
- PR-1861 adhesion promoter
- PR-1425CF chromate-free windshield sealant
- Task wipers
- *Semco*® scraper
- Gloves
- Masking tape
- Gauze
- Razor blades
- Squirt bottle
- Sponges
- Butt guide

USING PPG AEROSPACE HUMP SEAL REPAIR KIT


Step 1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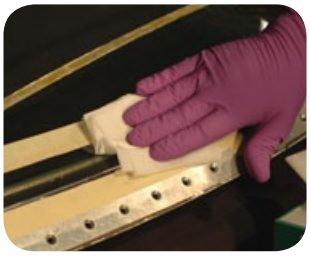
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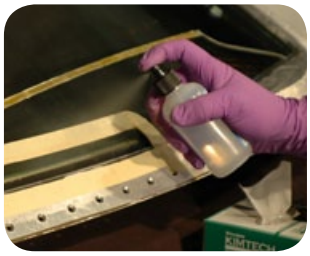
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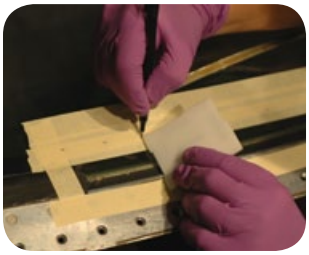
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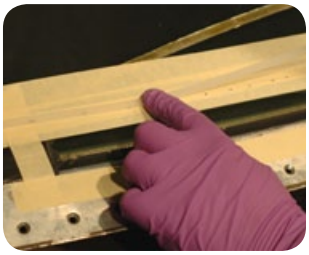
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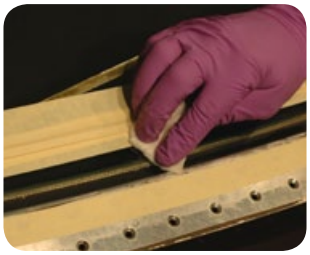
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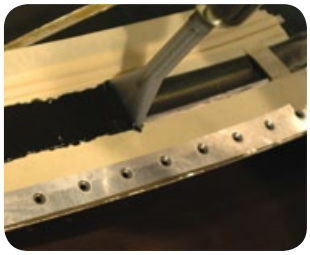
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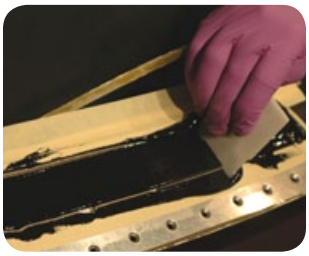
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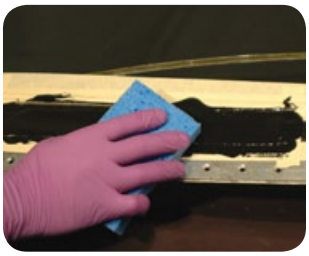
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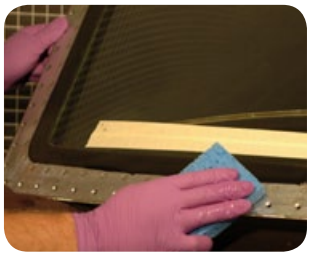
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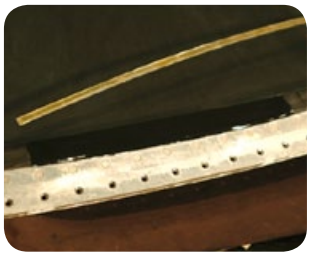
Step 12

Step 1.
Apply masking tape around the damaged area of the hump seal. Carefully remove only the damaged area of the seal with a razor blade, following the ACMM.

Step 2.
Clean the repair area using the cleaning compound to remove any dirt or oils.

Step 3.
Wipe the cleaned area with a task wiper to remove any cleaning compound residue.

Step 4.
Make sure the surface is water break free, or hydrophilic, by squirting water to verify the water does not adhere and sheets across the surface, demonstrating there are no contaminants. This assures a good bonding surface for the new sealant.

Step 5.
Apply additional masking tape to the area around the removed sealant. Use the forming tool as a guide to mark a line on the tape for applying the butt guide.

Step 6.
Apply the butt guide along the marks. The guide will be used to form a uniform shape for the finished seal.

Step 7.
Use gauze to apply PR-1861 adhesion promoter to the clean glass and metal surfaces. Allow for a cure time of 30 minutes.

Step 8.
Apply PR-1425CF windshield sealant (compatible with PR-1425 sealant).

Step 9.
Use the forming tool to form the seal.

Step 10.
Wipe the surface with a wet sponge to smooth the sealant.

Step 11.
Remove the tape and smooth the sealant again with a wet sponge.

Step 12.
Allow the sealant to cure according to the recommendations on the *Semkit*® package of PR-1425CF sealant. The finished repair shows the new seal merging with the original seal.

For the PPG Aerospace transparencies sales office or application support center nearest you, please visit our website at www.ppgaerospace.com.

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Issue Date: 1/12
Supersedes: New

Visual Inspection Guide for aging aircraft windshields

Aerospace Transparencies

This booklet is intended for use as a general information guide only. It does not replace or supersede the allowable defect limits provided by the OEM in either the AMM, CMM or ACMM.

This booklet was produced by PPG
Product Support, 1719 US Highway 72 East,
Huntsville, Alabama 35811 USA.

Table of contents

Glass and plastic*

Recommended cleaning materials and agents:

Note: Equivalent or approved substitutes may be used for items listed.

- 50/50 solution of water and isopropyl alcohol
- Mild liquid soap formulated for dishwashing
- Chamois, sponge or soft cotton cloth
- Nylon scrub pad for glass surfaces only
  (Do not use nylon scrub pad on acrylic or polycarbonate)

Cleaning procedure:

1. Remove watches and rings before performing any cleaning operation to prevent accidental scratching of glass or plastic surface.
2. Remove all excess amounts of dirt and other foreign debris from window surface with clean water. The preferred initial application of water is by spraying or flooding the surface with water in order to wash away any abrasive debris such as grit, sand or dirt. If spraying or flooding is impractical, such as on the inner glass surface, use a clean sponge or soft cotton cloth saturated with water or isopropyl alcohol. Never wipe dry glass or plastic surface with a dry cloth or paper towel.
3. Wash outer surface of windshield gently using a 50/50 solution of water and isopropyl alcohol containing 2-5% concentration of a mild liquid soap.
4. Do not use powdered detergents, abrasive cleaners, or a cleaner with any strong acidic or caustic solutions.
5. Rinse thoroughly with clean water, and dry with a chamois, sponge or cloth.

*CLARITY® *Transparency Cleaning System by PPG is now available for plastic transparencies. It can increase the service life of coated plastics if used regularly. More information is available at www.ppgaerospace.com under "Products: Transparencies." Contact your PPG aerospace representative to purchase.*

PPG windshield serial number code

For parts manufactured at PPG's Huntsville aerospace transparencies facility:

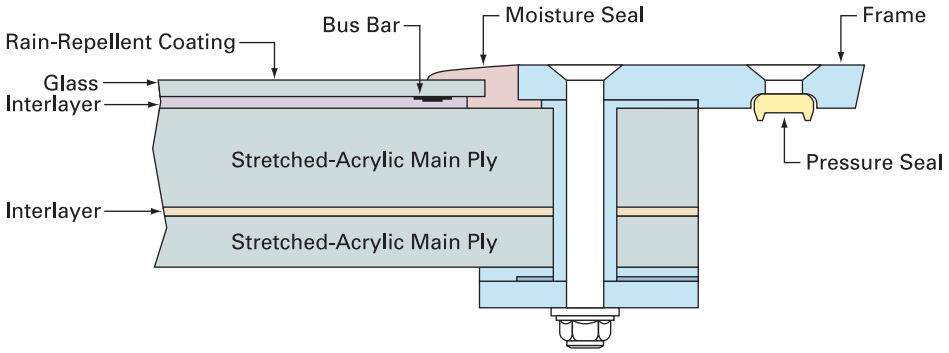
08244H8431

08	244	H	or	R	8431
Year of manufacture 2008 (99 = 1999) (06 = 2006)	Julian date (Day of year)	Manufacturing location (Huntsville, Alabama)		Rebuild	Sequential unit number

For parts manufactured at PPG's Sylmar aerospace transparencies facility:

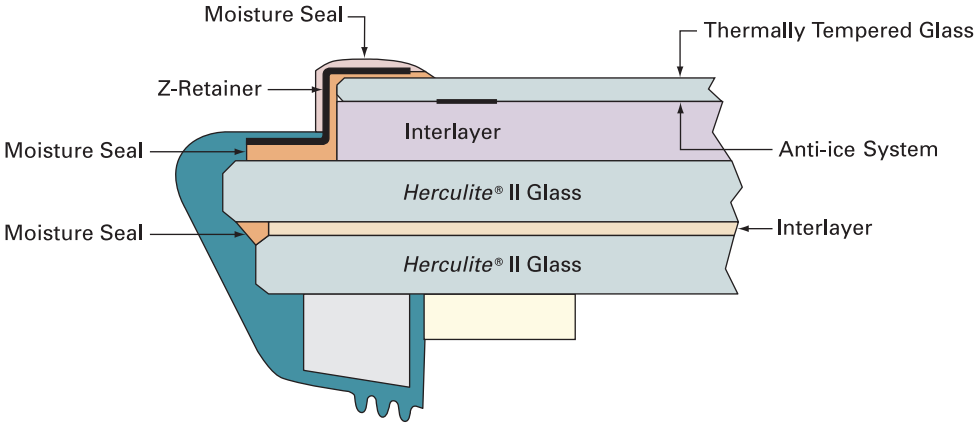
(178500)	8431	05/08
(178500)	8431	05/08
Part number	Sequential unit number	Month/Year of manufacture 05/08 = May 2008

Windshield cross section examples



Structurally loaded composite

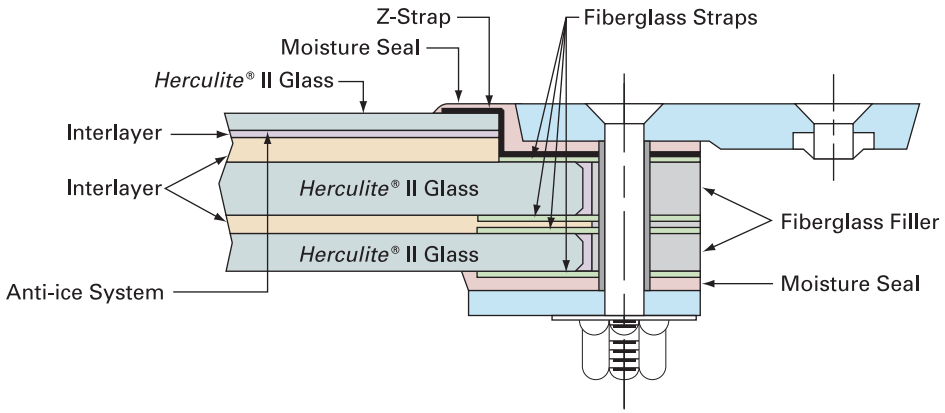
- Global Express



Plug-loaded glass

- A320

Windshield cross section example

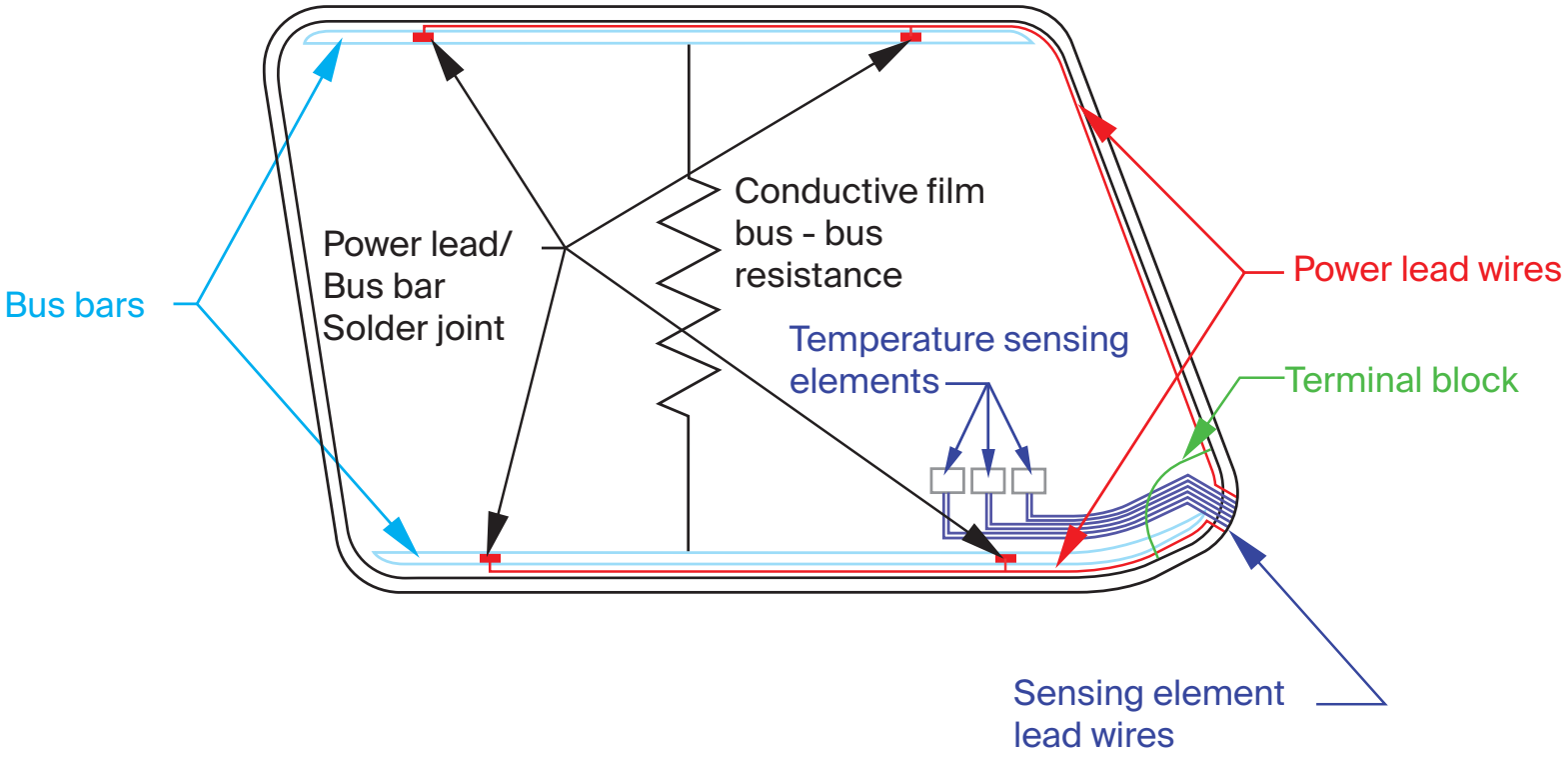


Structurally loaded glass

- CRJ

See more windshield cross sections on our Technical Data sheets posted online at www.ppgaerospace.com. Under “Products,” click on “Transparencies,” and then select “Commercial Aviation,” “Regional Aviation” or “General Aviation.” Click on the program link for access to the Technical Data sheet.

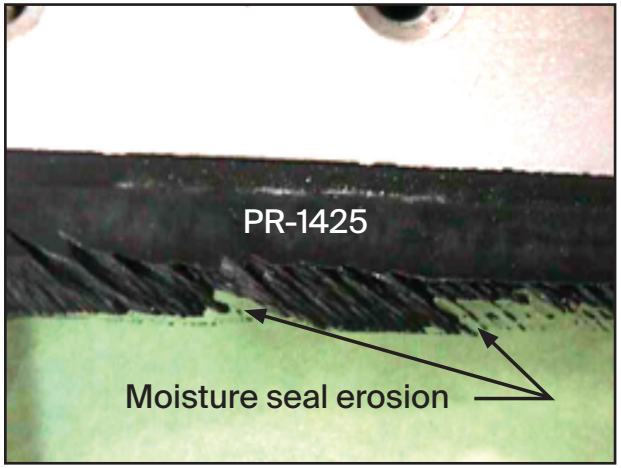
Heating system components

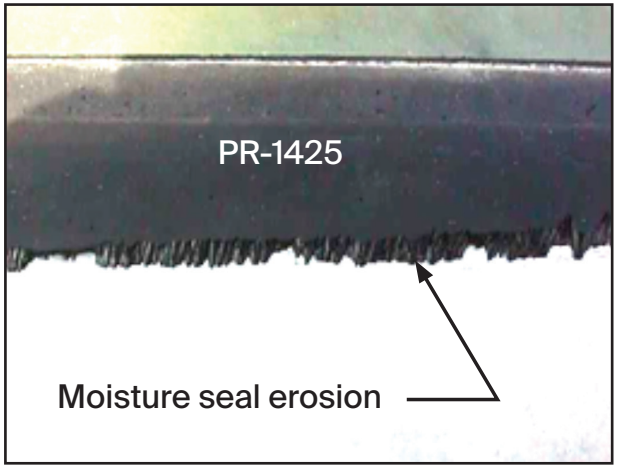


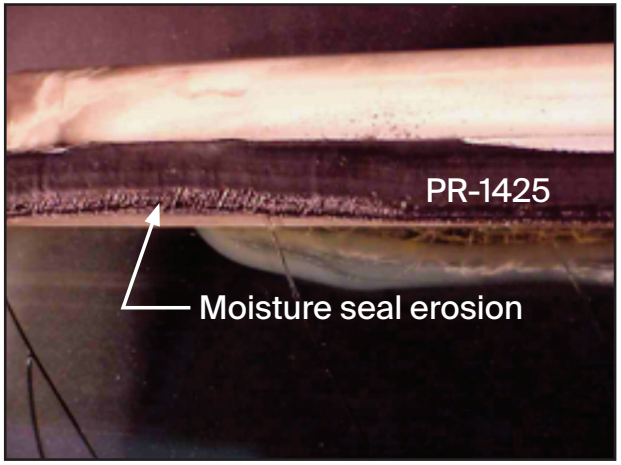
Typical aging-windshield failure sequence

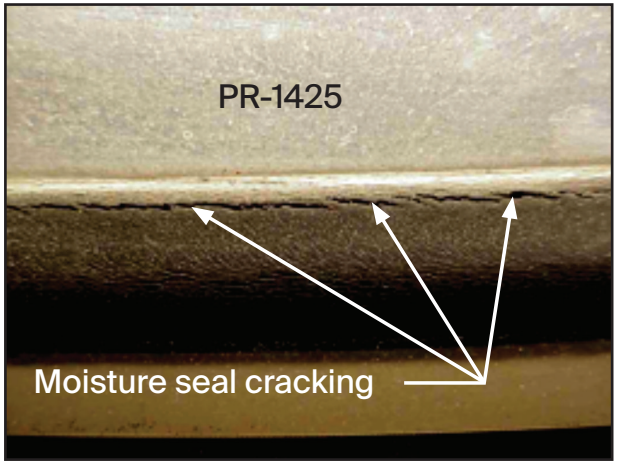
1. Moisture seal degradation caused by wind erosion, rain erosion, cracking or debonding of sealant
2. Moisture ingress into laminate and UV exposure
3. Interlayer degradation (discoloration and cracking)
4. Delamination (separation of interlayer from glass/plastic)
5. Bus bar degradation (discoloration and cracking)
6. Deterioration at the junction of the bus bar and conductive heating film
7. Electrical arcing caused by discontinuity at the junction of the bus bar and conductive heating film
8. Glass ply fracture resulting from surface damage caused by electrical arcing and localized overheating condition

Moisture seal degradation





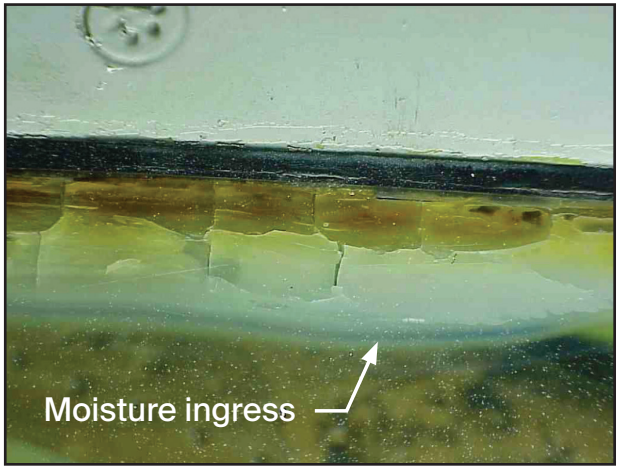


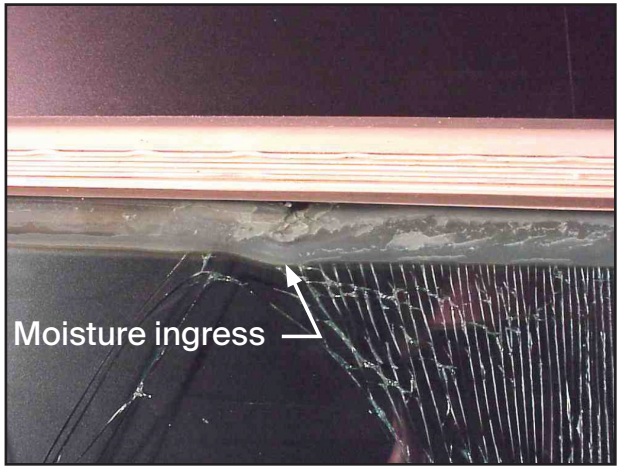


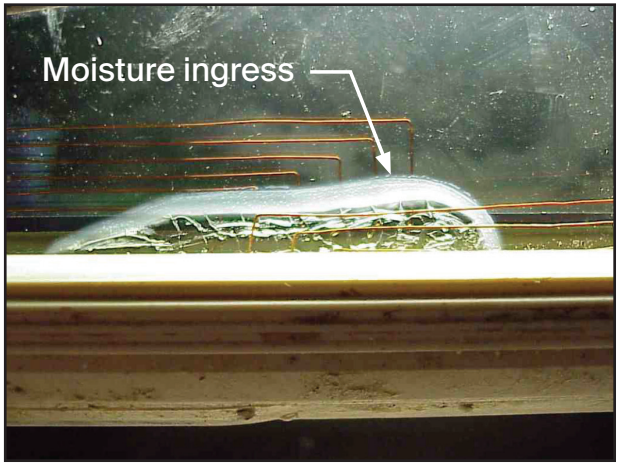
Moisture seal degradation

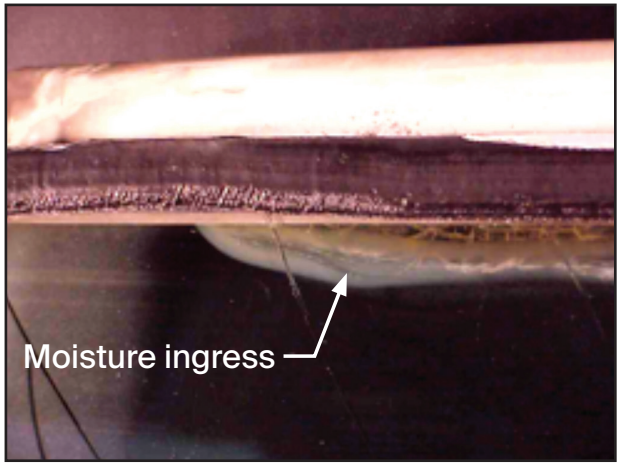
- The windshield's outboard moisture seal, also referred to as a "hump" seal because of its shape, is the primary barrier to prevent moisture from entering the laminate. If moisture gets inside the laminate, while not a structural issue, delamination and degradation of the electrical heating system can occur, reducing windshield service life.
- Regularly inspect the windshield's outer moisture seal for evidence of sealant erosion, cracking or separation from glass, plastic or metal. A typical inspection interval is every four months or 1,000 flight hours. Refer to appropriate AMM/CMM for specific inspection requirements.
- Give particular attention to areas where the seal appears worn. If the sealant has eroded more than 25% of its original width or if the sealant has cracked or debonded, the moisture seal should be repaired at the next opportunity.
- Information about PPG Hump Seal Repair Kits is posted online at www.ppgaerospace.com. Under "Products," click on "Transparencies" and then "Transparency Repair Services."

Moisture ingress





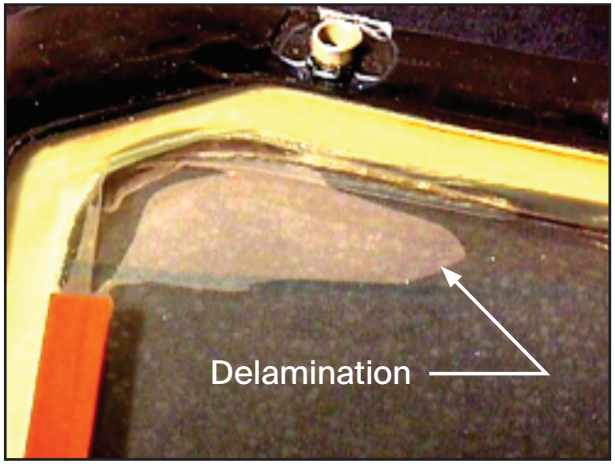


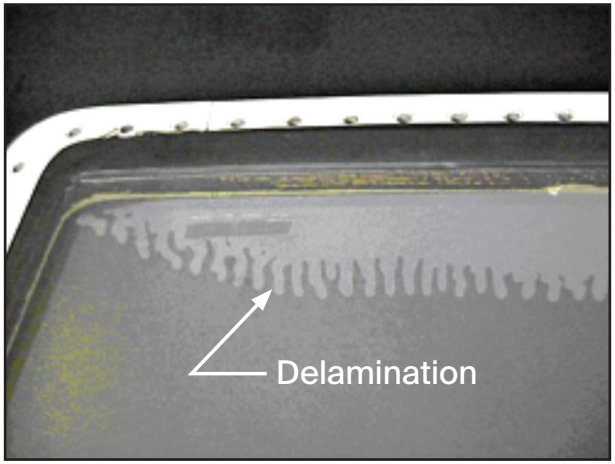


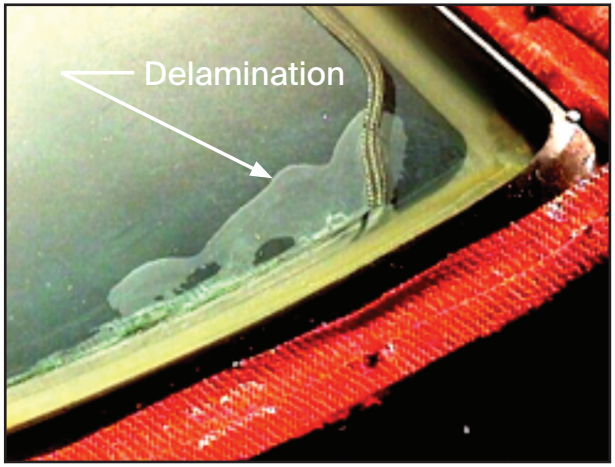
Moisture ingress

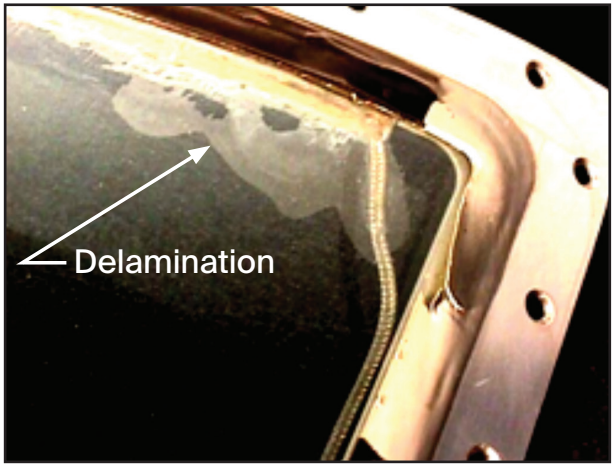
- Moisture ingress can occur from wind erosion, rain erosion, cracking or separation of the outboard moisture seal, or from damage to the windshield vertical edge seal or edge attachment.
- The first sign of moisture ingress is a change in the appearance of the interlayer from optically clear to hazy, cloudy or translucent. Interlayer may also begin to delaminate or separate from the glass or plastic substrate without discoloration.
- Long-term effects of moisture ingress include interlayer degradation (crackling and discoloration), interlayer delamination (separation from glass or plastic substrate) and bus bar degradation (discoloration and cracking), which can lead to electrical arcing at the junction of the bus bar and conductive heating film and subsequent glass fracture.

Delamination







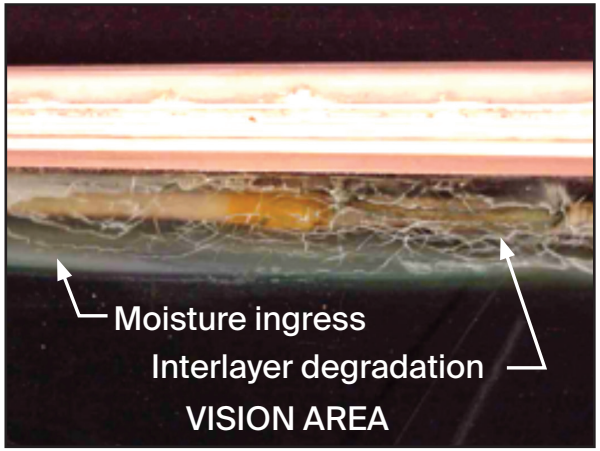


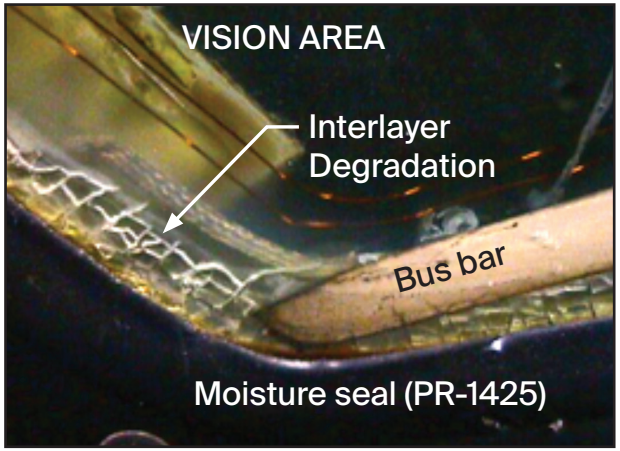
Delamination

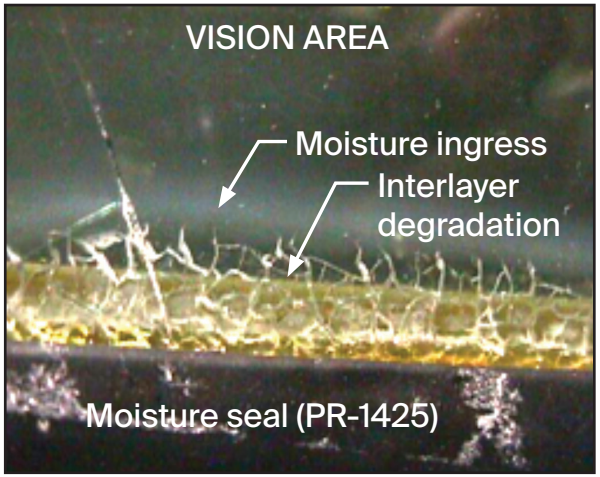
- Delamination is defined as the reduced adhesion of the interlayer to the glass or plastic or separation of the interlayer from any of the glass or plastic surfaces within the windshield laminate.
- Delamination within the specified limits is not considered a structural issue, but can be an optical issue.
- Delamination can appear to be visibly clear or cloudy depending on the type of interlayer and exposure conditions. It normally appears around the window periphery.
- Typical allowable limits for delamination are 2 inches (51 mm) from the edge of the vision area, with 4 inches (102 mm) allowed in corners. Localized areas of delamination may exceed these limits if visibility is not affected. Consult your maintenance manual for aircraft specific limits.
- Delamination is typically related to time in service such that older transparencies are more likely to experience the condition.

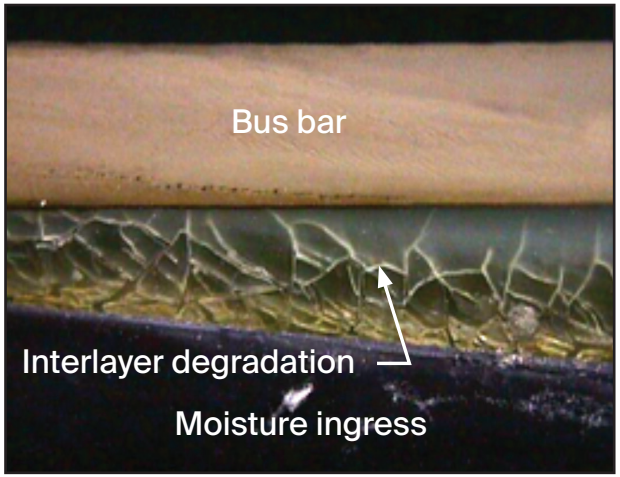
CAUTION: PPG does not recommend or approve “re-laminating” or injecting liquid polymer to remove or repair areas of delamination. These procedures do not address the reason for the original delamination and typically do not significantly extend service life.

Interlayer degradation





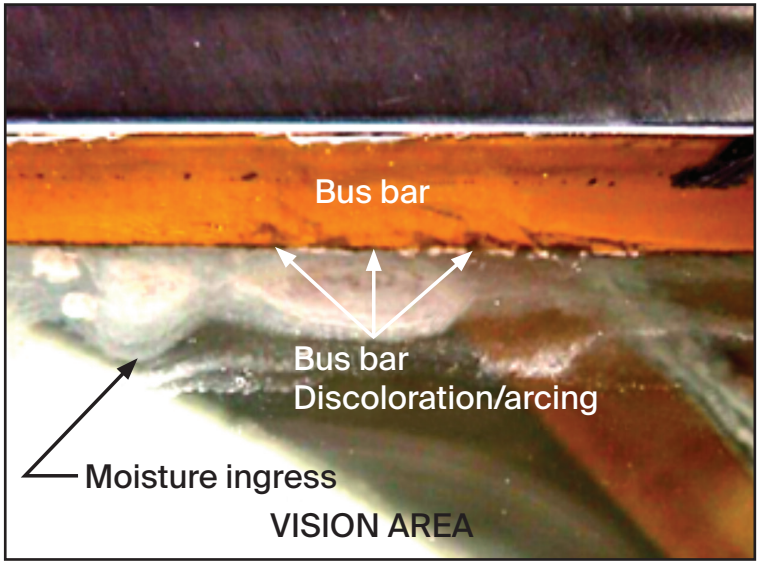


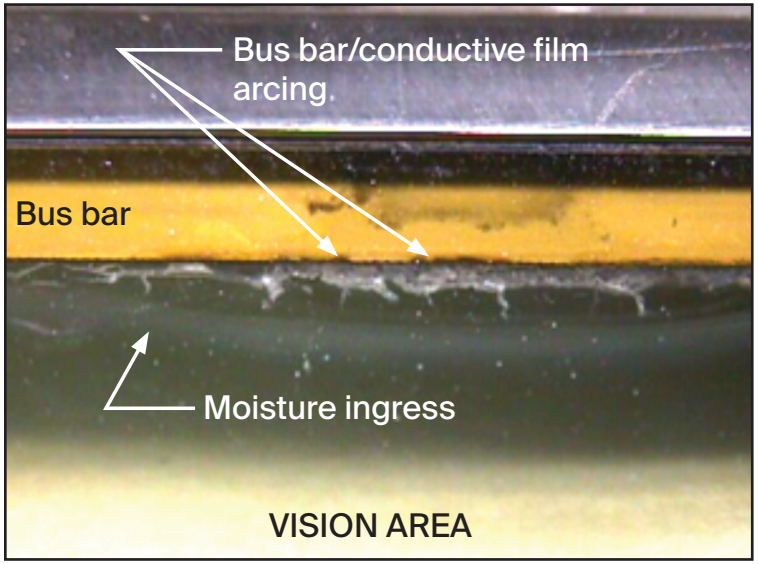


Interlayer degradation

- Two types of interlayers are used in PPG's aircraft windshields: (1) Polyurethane (urethane) and (2) Polyvinyl Butyral (PVB or vinyl). The interlayer sections between the glass or acrylic plies can be all PVB, all urethane, or a combination of the two.
- Interlayer degradation can occur because of outboard moisture seal failure, allowing moisture to enter the laminate and interact with the interlayer, while being exposed to UV under normal operating conditions. Degradation of either interlayer is not considered a structural issue.
- Interlayer degradation occurs around the windshield periphery, becoming visible at the inner edge of the vision area, or daylight opening. The interlayer can change from optically clear to hazy and cloudy. Continued exposure to moisture can cause the interlayer to change color to a yellow/amber tint with small cracks resembling "mud-cracking" or "dry lakebed." Do not confuse this degradation with glass fracturing.
- Interlayer degradation results in a weakened or failed bond with the glass or plastic substrate and is considered to be delaminated where present. Limits for interlayer degradation are the same as delamination.
- Improved urethane interlayer has been UV stabilized so that the interlayer will not degrade, turn hazy, cloudy, or crack with moisture ingress. Programs with UV stabilized interlayer include but are not limited to 787, A320 (p/ns NP165331, NP165332, NP165333), C919, C-series.

Bus bar discoloration



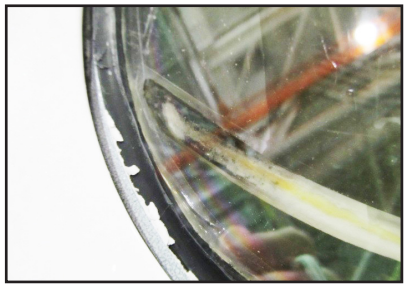


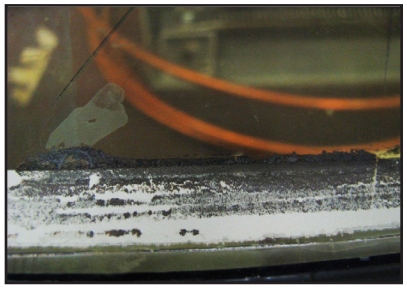
Bus bar discoloration:
Caused by moisture ingress resulting in bus bar/conductive heating film arcing and localized “hot spots.”

Bus bar discoloration

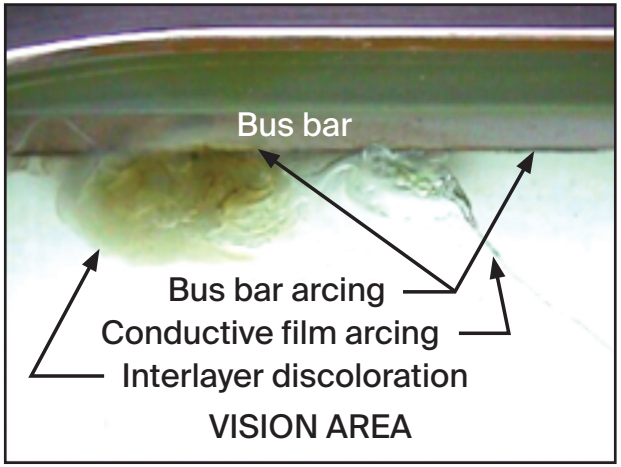
Bus bar discoloration can be caused by the following:

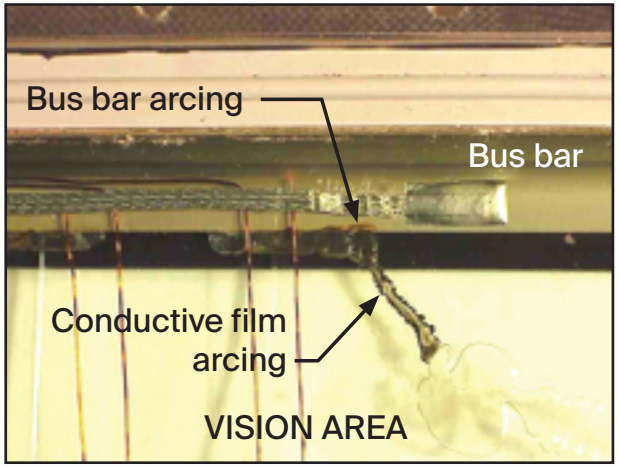
- **Moisture ingress** – This can result in oxidation, corrosion, degradation, debonding and cracking of the bus bar material. Discoloration alone is not a reason to remove the window, unless it occurs along the edge of the bus bar at the connection to the heated area (an indication of arcing).
- **Bus bar/conductive film arcing** – Moisture ingress can result in degradation of the electrical system and lead to electrical arcing. This can cause discoloration (amber, brown or black) along the inner edge of the bus bar as a result of the overheating condition. If the heating film bus-to-bus resistance is outside the allowable limits defined in the AMM or applicable CMM/ACMM, the window should be removed.
- On programs with UV stabilized interlayer, the bus bars will degrade the same as all other windshields. Special attention should be given to inspecting the bus bars since the interlayer will not break down and show moisture ingress. Discoloration along the edge of the bus bar at the connection to the heated area is an indication of a potential failure and the part should be scheduled for removal.

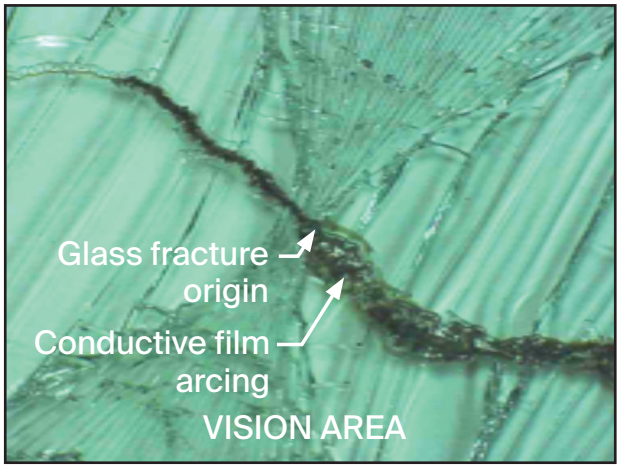


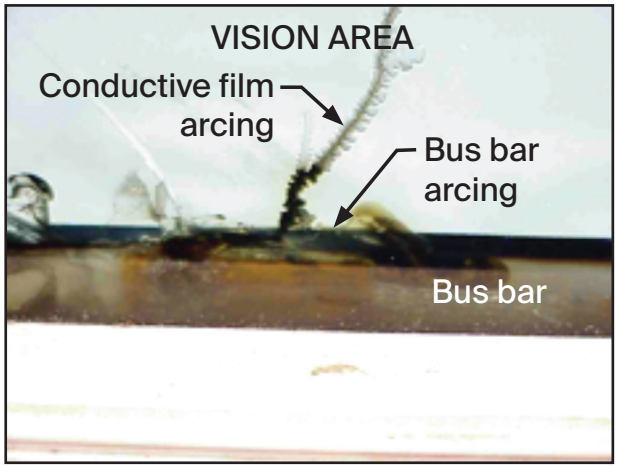


Heating system failure







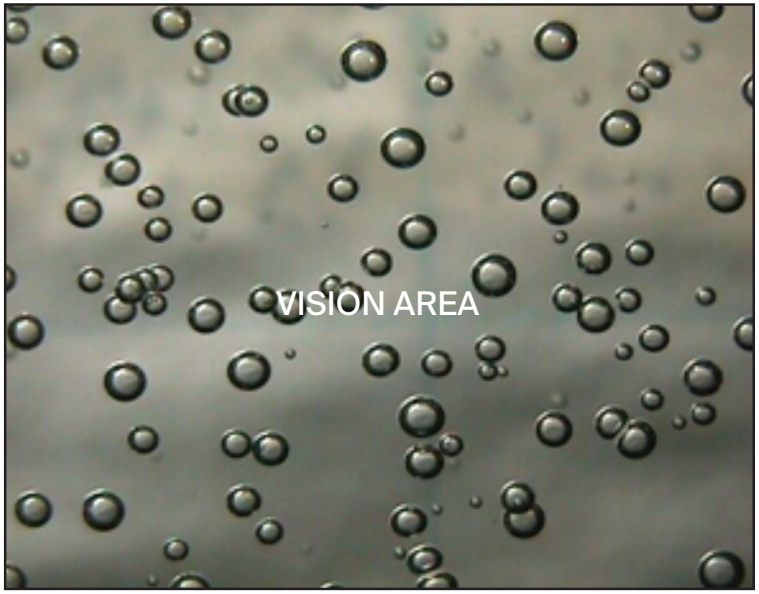


Heating system failure

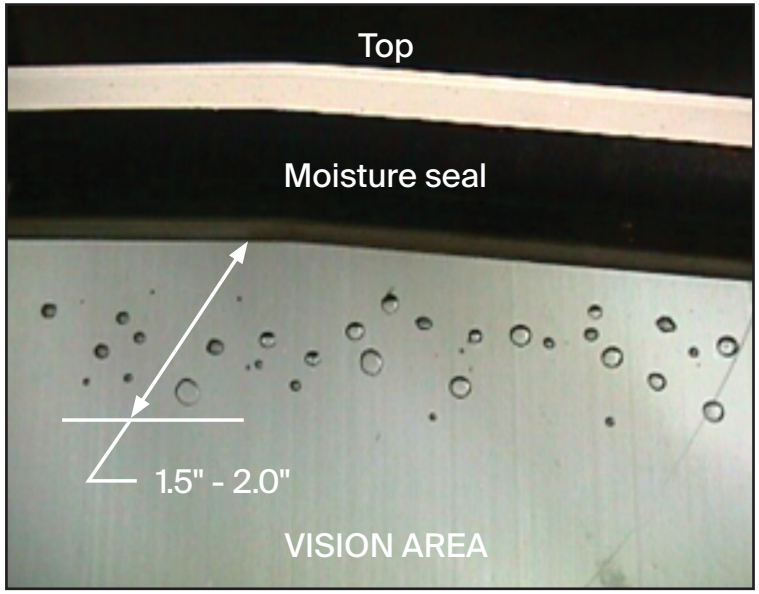
The electrically conductive heating system of an aging aircraft window may not function properly as a result of a variety of failure modes:

- Arcing – Arcing is an electrical discharge across a discontinuity in a wire, bus bar or electrical conductor. Structural integrity of the windshield is not affected, but the heating system may become inoperative as a result of an arcing condition. Electrical arcing may occur along the inner edge of the bus bar at the bus bar/conductive film interface. Arcing may progress across the heating film into the vision area. Continued application of the operating voltage to the windshield will likely result in fracture of the outer nonstructural glass ply as a result of an overheat condition. Arcing of the electrically conductive film, lead wires or terminal connections is cause for windshield replacement.
- Heating system failure – If an arcing condition exists or the windshield does not heat properly, deactivate the windshield circuit breaker and consult the AMM or applicable CMM/ACMM. The bus-to-bus resistance of the conductive heating film must be within the design tolerance range. Remove the windshield if the resistance of the heating film is outside this range.
- Sensing element and controller failure – If bus-to-bus resistance of the windshield heating film is within design specification, check resistance of the controlling temperature-sensing element, aircraft controller or both for an out-of-tolerance or fault condition.

Interlayer bubbling



Overheat condition



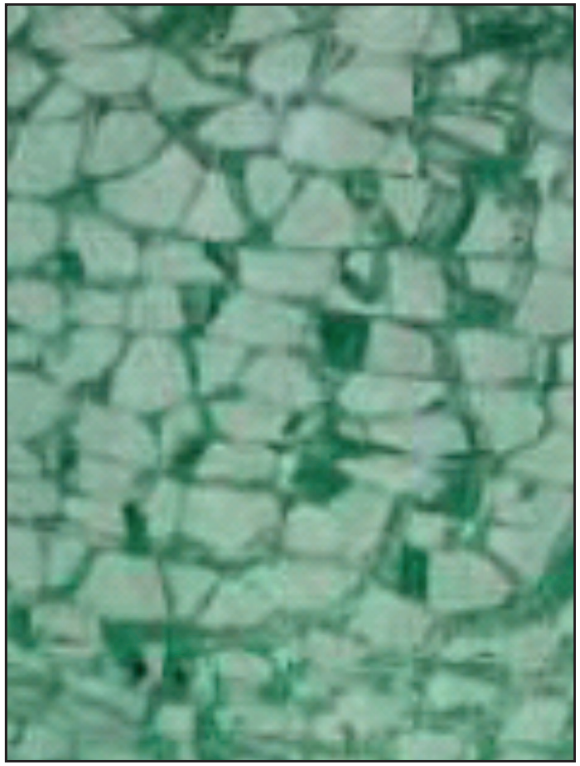
Overtorque condition

Interlayer bubbling

- Bubbles may form within the window interlayer as a result of an overheating condition or from edge “pinch” caused by overclamping or overtorquing fasteners during windshield installation.
- Bubbles in the interlayer are not considered a structural issue.
- Bubbling of the interlayer may indicate a problem with the electrical heating system of the windshield or the aircraft controller.
- To determine if there is a problem with the windshield heating system:
  - Check the bus-to-bus resistance of the heating element.
  - Check the resistance of the controlling temperature-sensing element.
- If either of these checks indicates an out-of-tolerance condition, consult the AMM for recommendations.
- For instructions on how to check the windshield heat control system, refer to the applicable AMM.

Glass fracture

Typical fracture pattern
fragment size of
chemically strengthened glass

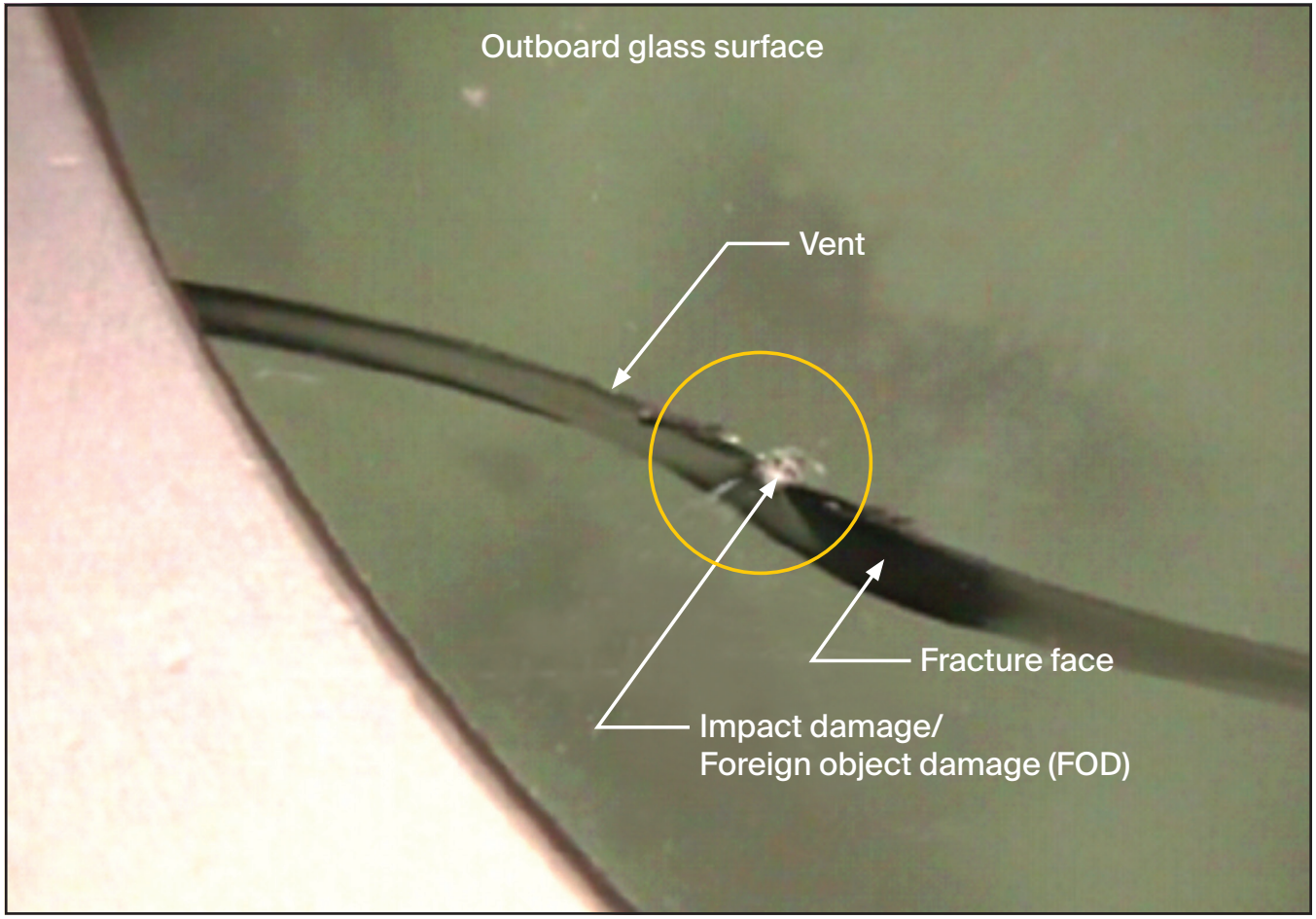


Typical fracture pattern
fragment size of
thermally tempered glass

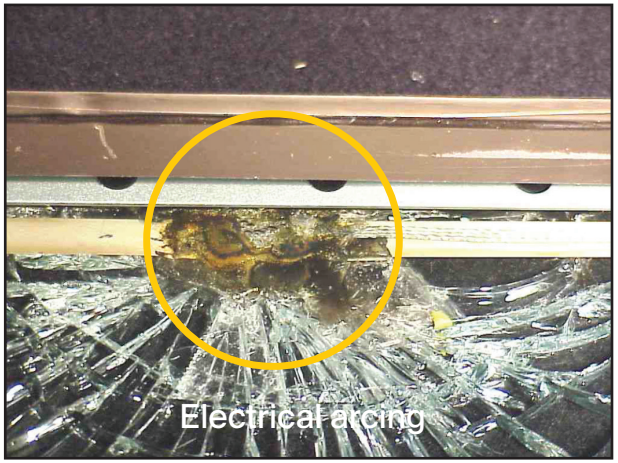
Glass fracture

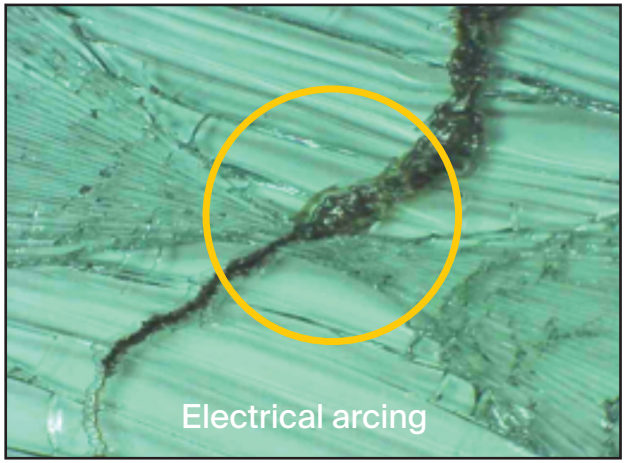
- Glass fracture can occur on any of the glass plies within the laminate.
- The outboard glass ply is typically the nonstructural glass component in the aircraft window cross section. The aircraft can be flown with restrictions if the outboard glass ply is fractured. See the AMM or flight manual for details on restrictions.
- The center and inner glass plies in the window cross section are considered structural glass plies. If either of these glass plies fractures, the windshield must be replaced. In some cases, the aircraft may be flown/ferried with structural glass plies fractured only as a nonrevenue (no passengers) flight in order to return the aircraft to a maintenance facility. See the AMM or flight manual for details on restrictions.
- Glass fracture can result from impingement, impact, foreign object damage (FOD), glass ply edge damage, surface scratches, electrical arcing or peel adhesion chip.
- Heated glass plies may fracture as a result of the overheat condition caused by electrical arcing at the bus bar/conductive film interface. The extreme heat generated by the electrical arcing causes damage to the glass that propagates from mechanical and thermal stresses encountered in service. The damage propagates until the center tension area of the thermally tempered or chemically strengthened glass is penetrated, causing spontaneous fracture.

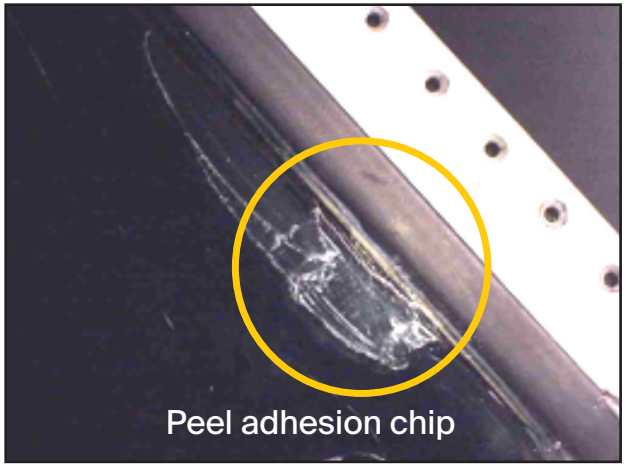
Impingement, foreign object damage (FOD)



Electrical arcing, peel adhesion chip







Structural glass ply visual inspection

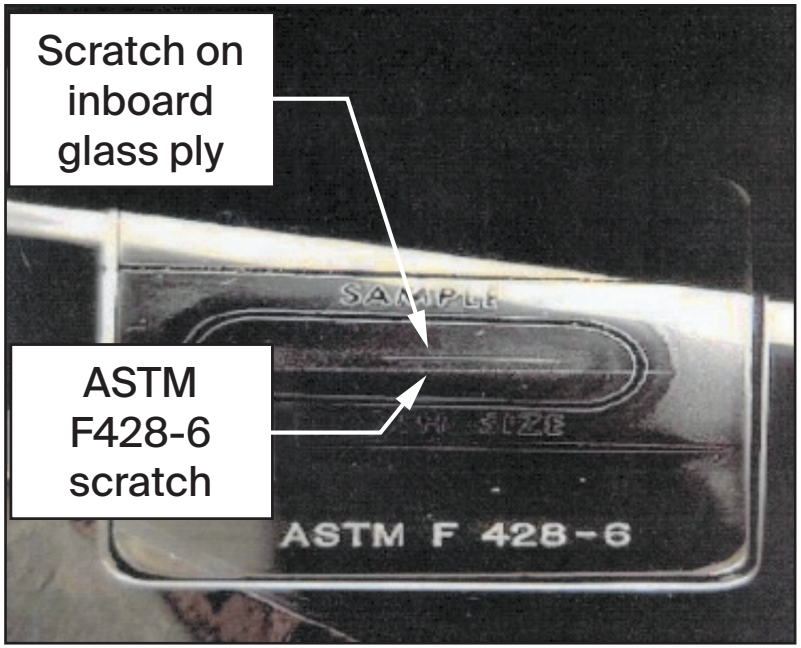
Inspect scratches using the ASTM F428-6 Aerospace Scratch Standard for Glass. Scratch intensity is best viewed in reflected light against a dark background.

A scratch is acceptable if the visible scratch intensity is equal to or less than the F428-6 scratch standard.

Window removal not required

A scratch is unacceptable if the visible scratch intensity is greater than the F428-6 scratch standard.

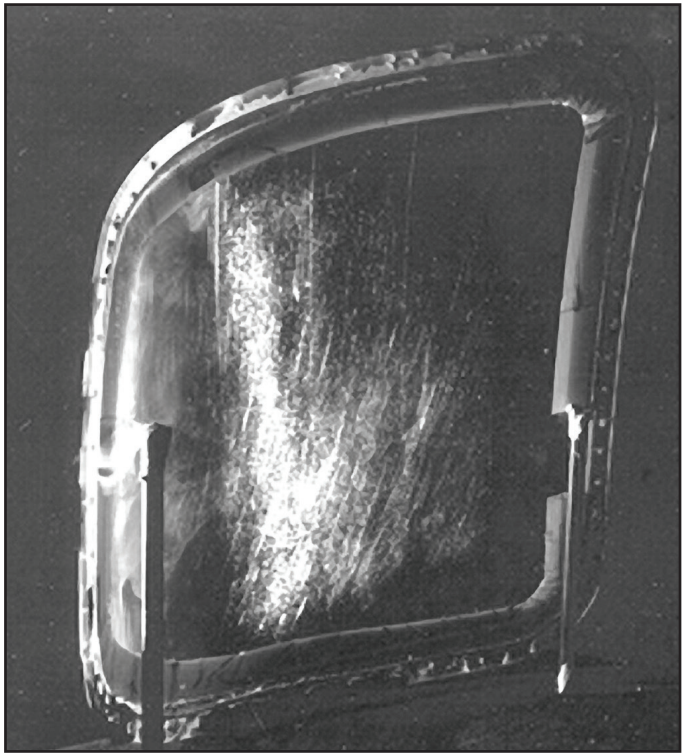
Window removal required



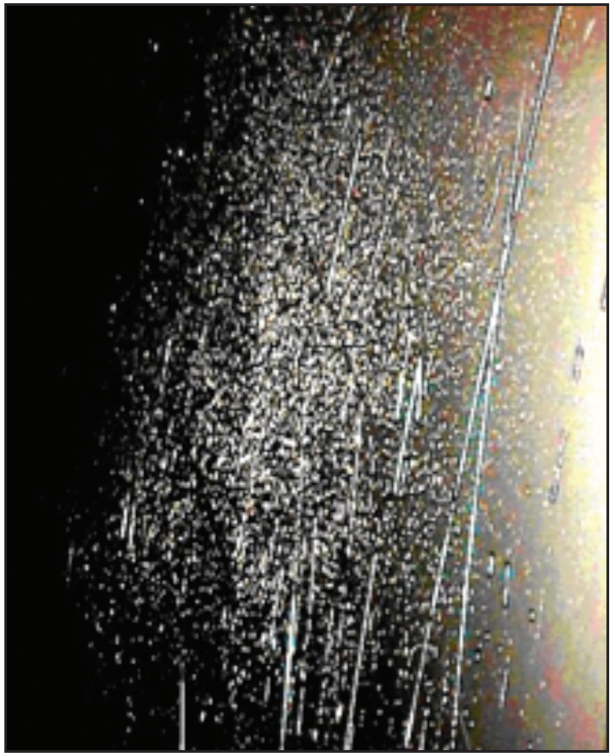
Glass surface scratch

- Scratches may occur on the outer surface of the nonstructural outboard glass ply. Scratches on the outer glass surface are structurally acceptable. The windshield may remain in service as long as visibility through the windshield is not impaired.
- Scratches on the inboard surface of the inner structural glass ply shall be compared to the ASTM F428-6 Aerospace Scratch Standard for Glass. Note: Aerospace Scratch Standards illustrate scratch severity as reflected light intensity. The greater the intensity, the more severe the scratch. This is a visual evaluation and does not indicate the actual depth of the scratch.
  - Any scratch on the inboard surface of the inner structural glass ply with an appearance intensity equal to or less than the ASTM F428-6 standard or having a depth equal to or less than 0.002 inch (0.05 mm) shall be allowed no matter what the
    accumulated length as long as the pilot's visibility is not impaired.
  - Any scratch on the inboard surface of the inner structural glass ply appearing to have an intensity greater than the ASTM F428-6 Aerospace Scratch Standard or a depth greater than 0.002 inch (0.05 mm) requires replacement of the window.

Acrylic and polycarbonate crazing

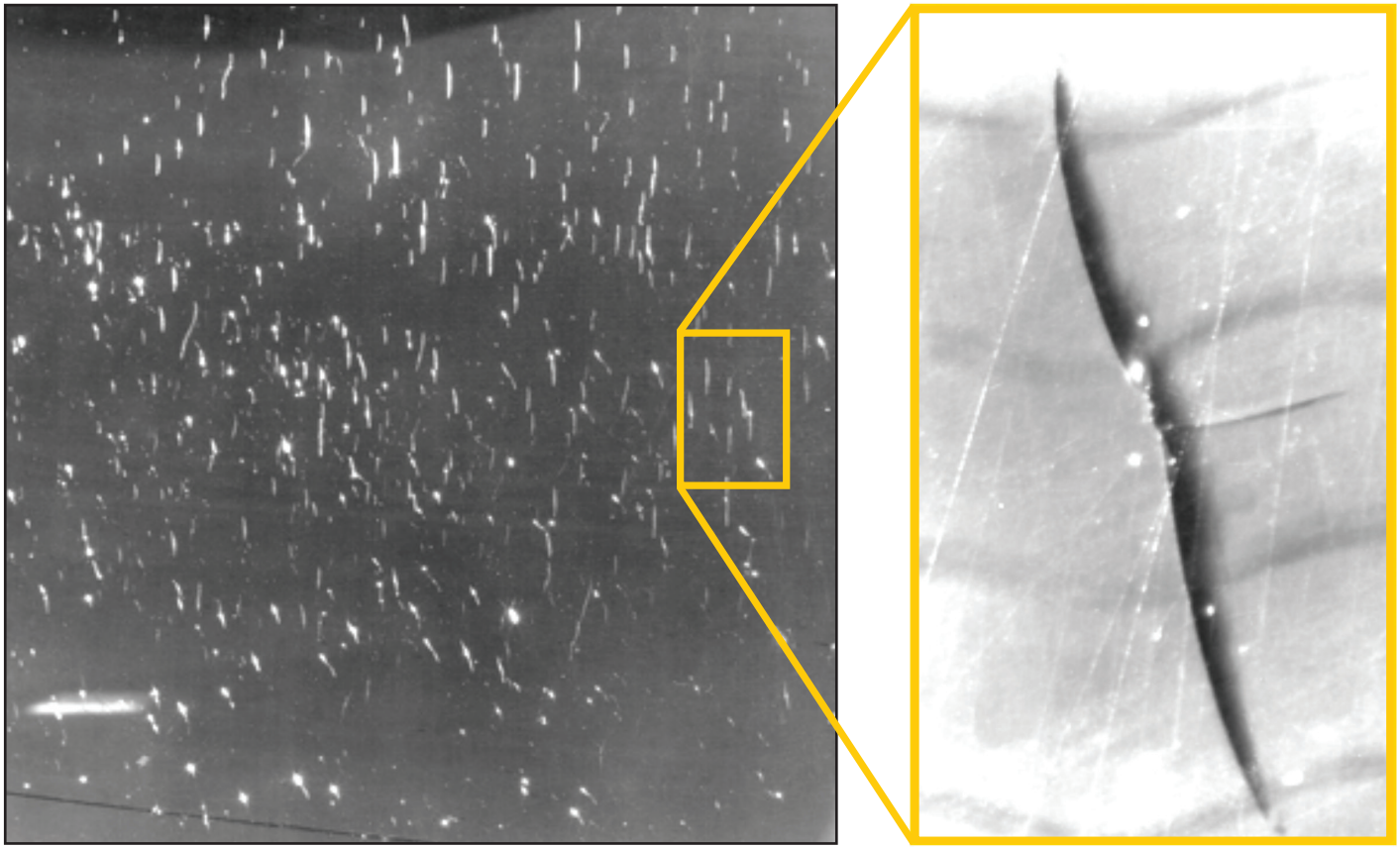


Overall view
With reflected light



Close-up view
With reflected light

Acrylic and polycarbonate crazing



Surface crazing

Magnified view

Surface scratches and crazing

- Acrylic and polycarbonate surface scratches and crazing can occur from improper cleaning procedures, impingement (foreign object damage) or chemical attack.
- Crazing refers to the microscopic surface cracks that occur as a result of localized stresses which are relieved by the physical separation of the acrylic or polycarbonate surface.
- The effect of scratches and crazing is an increase in light scattering, resulting in objectionable glare under certain lighting conditions (i.e., reflected light).

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For the PPG application support center nearest you, please visit our website.

For urgent or time-sensitive matters, please contact your sales or technical representative by telephone or email.

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