



**PPG Aerospace**  
Transparencies

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**Subject:** Manufacturing effects on Pilatus PC-12 Main Windshields

**Scope:**

This document will address the effect of resin flow during the manufacturing process of Pilatus PC-12 main windshields to address the concerns of Customers purchasing Pilatus PC-12 aircraft. It is PPG's goal to assure the purchasers of the aircraft that there is no issue with the window and this effect will not affect the fit, form, or function of this window. It is merely a phenomenon that can occur during the manufacturing process and is inherent in the design of this particular window to achieve the strength, weight, and electrical characteristics required by Pilatus. The service life of this window is excellent and is in no way affected by the resin flow shown in the window photos.

**Customer Concern Defined:**

Customers have expressed concern that an observed "mark or line" in the window extending from the edge inside the routing of the wiring (see photo below) may be delamination, a scratch, or a crack. The area may have a translucent appearance but typically will appear along the wiring in the window. The "3" photos below are an example of different manifestations of this manufacturing effect.

**Photo #1**



**Photo #2**



**Photo #3**



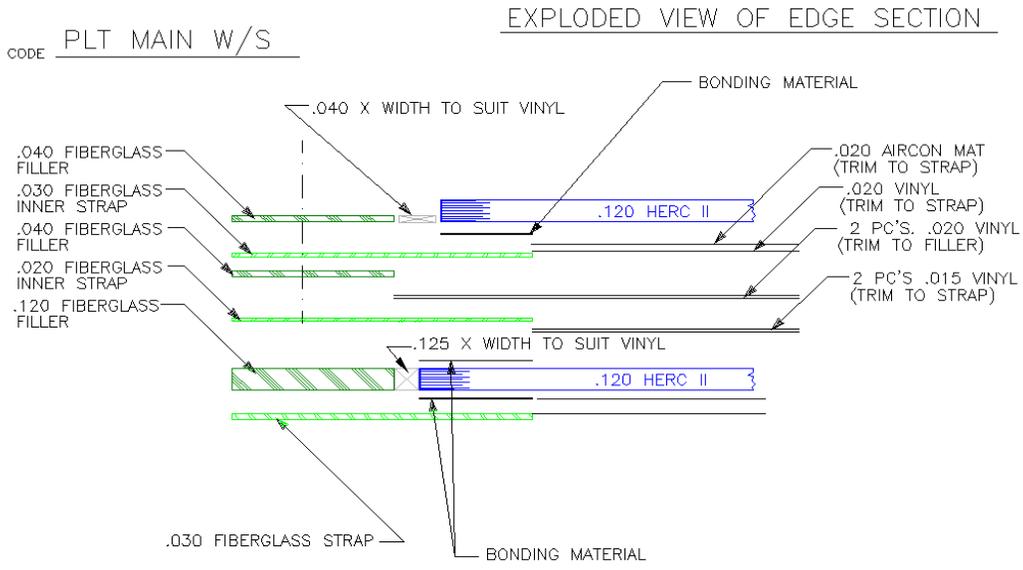
**PPG Explanation:**

This observation is NOT "delamination, a scratch or a crack". To achieve the weight to strength ratio required for this window the design incorporates a fiberglass edge strap that frames the actual glass and is the mounting surface for the windshield. The mounting bolts extend through the fiberglass edge strap increasing the strength of the windshield for pressurization and bird strike integrity. The Pilatus windshield incorporates an anti-icing system called an Aircon mat that has 4 separate heating zones. The 4 heating zones require 4 separate "braid" wires to supply the current and 3 separate "sensing elements" that operate as a "thermostat" to power the window "on & off". Only 1 sensing element is utilized at a time with the other 2 being redundant "spares", increasing the service life of the window for the Customer. This reduces expensive window replacement in the event the "sensing element" fails when one of the 2 backups can be wired up and flight operations continued. A "cross section" of the window is provided below to illustrate the basic window design (Photo #4).

The straight line marks observed along the side of the window or the translucent marks at the top corner around the braid and sensing element wires occurs when the window is being laminated. This window is a "2 ply" design meaning there are 2 pieces of glass laminated together with a vinyl heating mat in-between the glass. The fiberglass is bonded to the surfaces of the glass plies in a proprietary process that gives PPG windshields their unique durability. The Fiberglass is made up of glass fiber strands encased in an epoxy "resin" for strength. During the lamination process the window is heated under pressure, where the fiberglass resin reaches a "liquid" state and flows to bond to the surface of the glass before finally curing to a hardened state. As the fiberglass flows it will flow to the area of least resistance. Any area where wires have been routed into the glass is a path for the resin to flow. In the case where there is a straight line such as Photos #1 & #2, the vinyl between the windows has to be cut to route the braid wires through. A close inspection of the "mark" will show it lines up with a "dark" line on the braid wire. The dark line across the braid wire is where the braid wire was bent at a 90 degree angle to route up through the vinyl. This is where the vinyl is cut. When the window is in the oven the fiberglass resin will melt before the vinyl does and flow into the cut in the vinyl. Once the vinyl melts the resin is encapsulated in the vinyl. This can actually be viewed using a 10X loupe to examine the mark. The resin flow that occurs at the top where the braid wires & sensing wires are routed into the glass occurs much the same way except that in this case the wires act as "wicks" during the oven operation. The wires absorb heat and the resin will flow along the wire and spread from the wire. The actual entry point of the wire from the fiberglass edge into the vinyl is a difficult area to totally eliminate any resin flow. The process is further complicated by the amount of resin present in the fiberglass, the temperature & humidity during production, and the operator who builds the unit by hand. PPG controls the manufacturing process very closely and some windows are produced that with perfect conditions no resin flow is visible. However, this is a rare event and if required to produce all windows with no resin flow visible at all would increase the cost of each windshield enormously.

Delamination typically occurs in windows that have been in service for quite some time. This condition occurs due to moisture ingress along the edge of the windows and can be observed anywhere along the edge of the window not just where the wiring is routed. A scratch is readily identifiable with a loupe and can be evaluated using the ASTM F-428 scratch criteria. A crack will be self declaring and never run for such a short distance. Once the glass ply cracks due to the tempering process it will run across the unit to the edge. That is the nature of how glass breaks.

**Photo #4 Cross Section of PC-12 Main Windshield**



NOTE :  
FIBERGLASS STRAP PENETRATION ON GLASS = .60 ALL SURFACES EXCEPT TAB PROJECTIONS.

**Summary:**

PPG welcomes the opportunity to set the record straight and educate potential PC-12 Customers about PPG windows. PPG is the #1 producer of cockpit windows in the world for good reason. Our windows are excellent windows that meet the requirements of our Customers to the design specifications. Specifications are always compromises between competing design needs. The PC-12 main windows have a 1 inch border down both sides and across the top with a 3 inch border along the bottom edge of the window that is an "optics free" zone. This zone is there for the very reason that to produce outstanding optics in the "Critical" pilot zone with sufficient strength at the edge any producer of windshields has to have that lee way. The area immediately around the wires and bus bars is optics free as well. If there are any further questions please feel free to contact PPG Aerospace Transparencies at anytime.

Sincerely,

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