Mrs. Connie Little
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PPG Aerospace Transparencies ***Failure Analysis Report***

The information herein is based on the best available data and practices known to PPG at the present time, but PPG does not warrant the performance, results, accuracy or comprehensiveness of such information.

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June 17, 2019

TO: Daniel Boggs
Air Safety Investigator, National Transportation Safety Board

RE: Evaluation of a Left Hand Window for Pilatus; Part Number NP172121-5; S/N 01120H6846; CA136394

Introduction and Background

The subject window was received from Banyan Air Service for investigation of an inboard ply fracture. The window was received by PPG Huntsville in April 2019. Correspondence indicated that the windshield cracked in flight going through 20,000 feet and the aircraft depressurized. PPG Aerospace completed manufacture of the window in April 2001.

Summary of Key Findings

- Electrical readings of the windshield were recorded as followed:
  - K – L – 3.1 Ω (within limits)
  - K – M – open
  - K- J – open
  - Sensing elements were all found to be within limits (314 Ω, 315.2 Ω, and 313.5 Ω respectively)
  - Anti-static coating – open
- The inboard glass ply failed with the fracture origin location along the aft bottom edge (see Figure C). Arcing visible at bus bar location with black discoloration.
- Heavy delamination/moisture ingress was visible along bottom/aft edges. Missing glass from inboard ply along the bottom/aft edges made determining the failure origin impossible, but likely became disbanded from windshield after breakage due to delamination issue.
- Moisture seal removed around entire periphery of window to reveal that ~80% of fiberglass straps had been removed during maintenance practices. Combination of missing straps and heavy delamination caused the outboard ply to become detached from the edge attachment.
- No reading for anti-static coating were able to be determined. Likely the grounding wires were cut during moisture seal repair/removal of fiberglass straps during maintenance. This could have potentially caused a static build-up on the window, aiding in the arcing event.

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Conclusion

Evaluation of the fracture pattern indicated that the inboard glass ply failed along the bottom aft edge of the window. According to correspondence received, the inboard glass ply failed first, leading to the depressurization of the aircraft (when the outboard ply separated from the edge attachment allowing for an air gap). Due to the majority of the edge of the inner glass ply being missing from the bottom and aft edges of the window, the exact failure origin was unable to be determined. However, Wallner lines were able to be detected in the remaining glass pieces, confirming the fracture origin location. While the arcing event took place in the heating system which is closest to the outboard ply, the moisture ingress/delamination provided an access path for the arc to travel to the inner glass ply, causing it to break. The combination of delamination between the two glass plies and missing fiberglass straps along the outboard surface of the outboard ply cause the outboard ply to become detached from the edge attachment, thus causing depressurization of the aircraft.

Reported by:

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Detailed Failure Analysis

Figure A: Outboard overall view of the window as received.

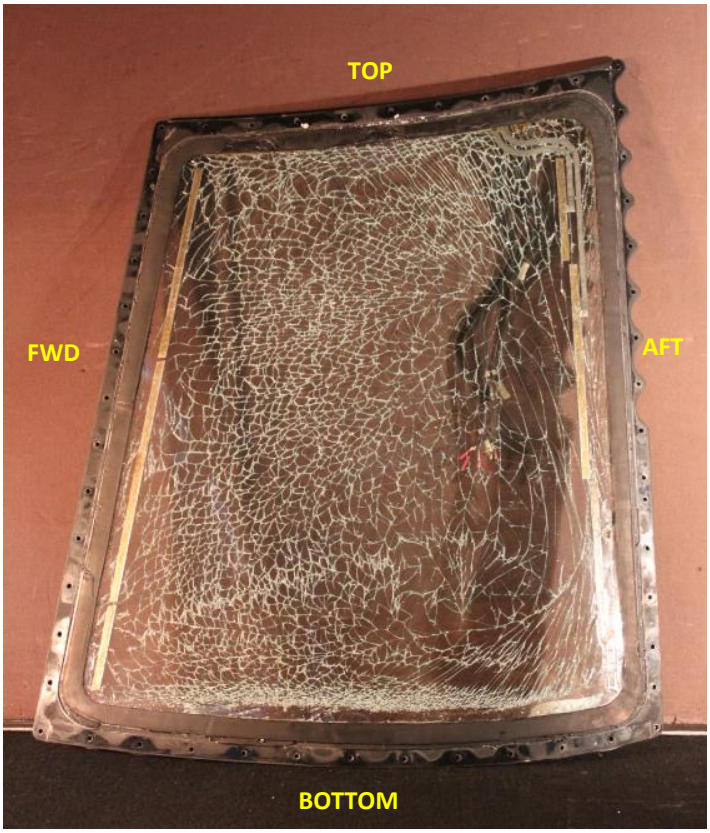

Figure A: Inboard Overall View

Figure B: Trademark label including the part number and serial number for window.

Figure B: Trademark Label

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Figure C: Inboard view of the window at fracture origin location. Inner glass ply was missing along bottom/aft edges around fracture origin, so exact failure origin location was unable to be determined. Delamination present.

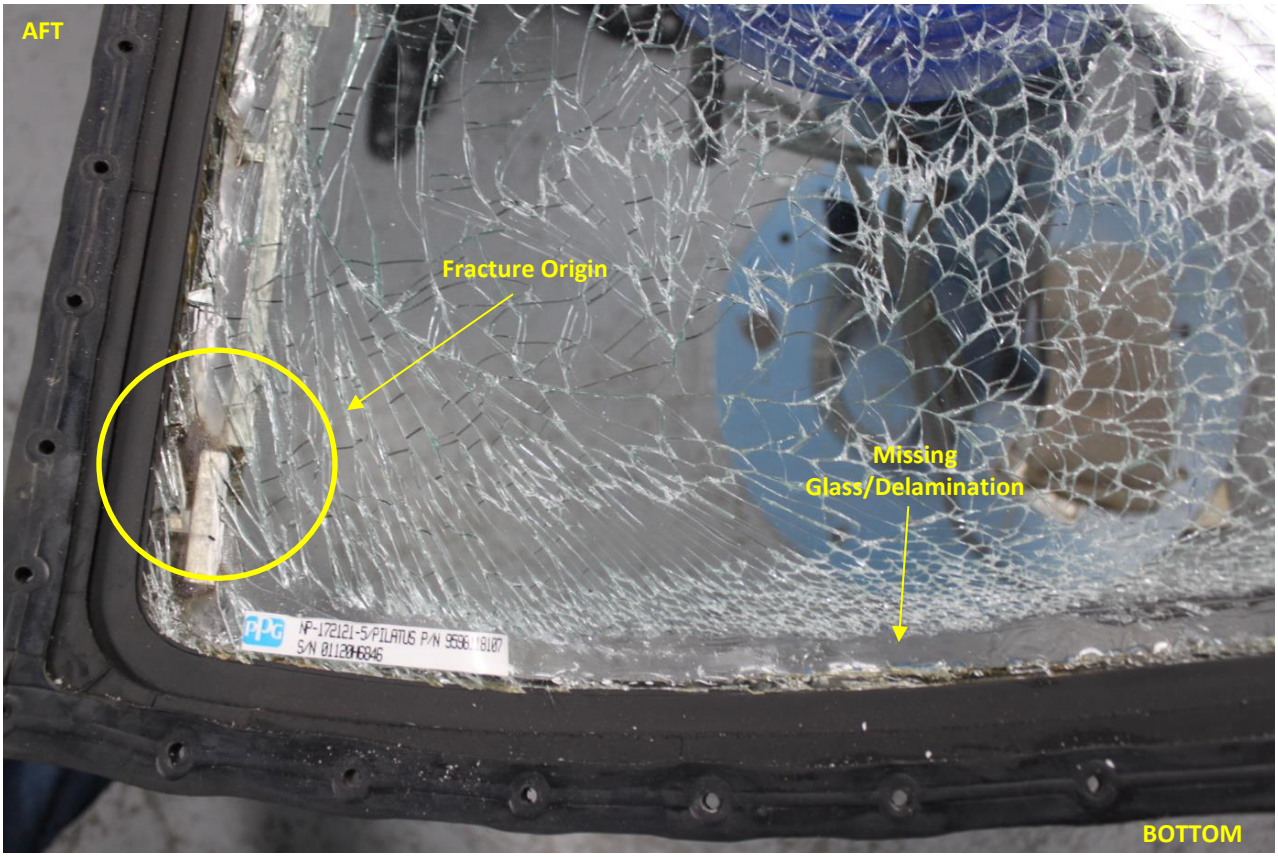

Figure C: Fracture Location

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Figure D: Close-up view of delamination present along edge of windshield.

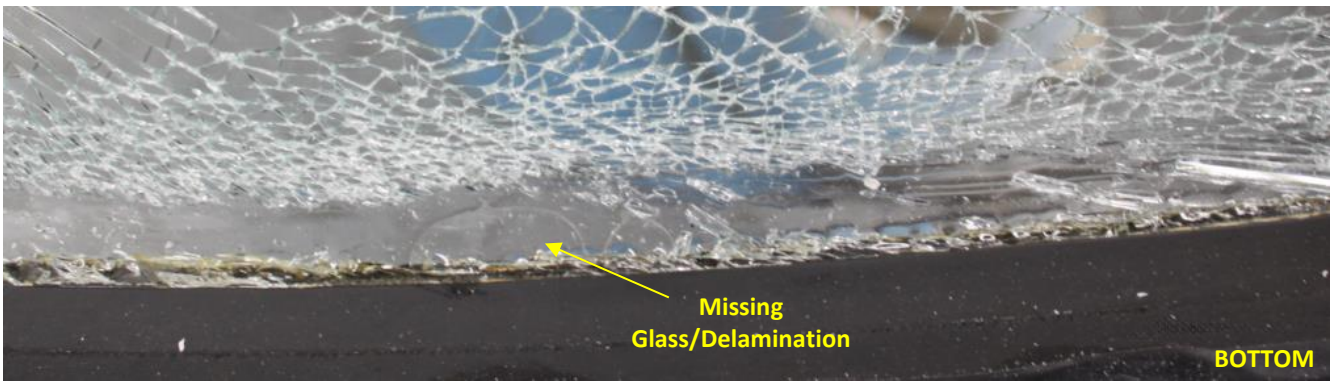

Figure D: Close-up View of Delamination

Figure E: Close-up view of aft-bottom edge of windshield where outboard ply was separated from edge attachment.

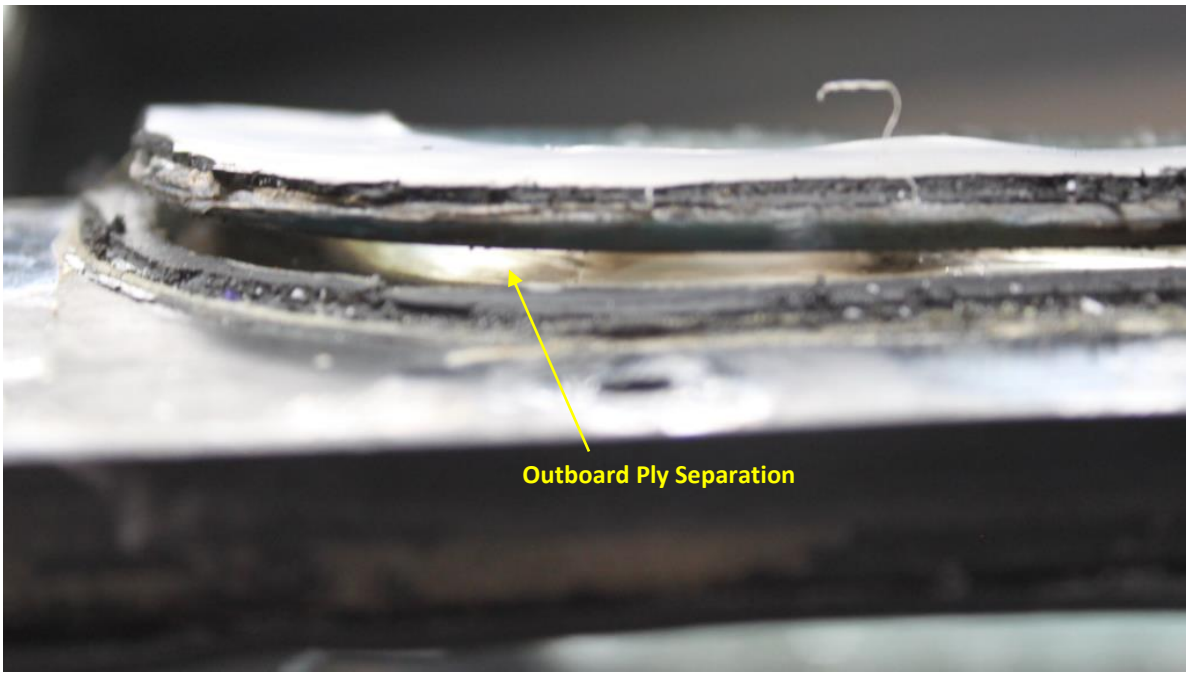

Figure E: Close-up View of Detached Outboard Ply

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Figure F: Outboard view of windshield at fracture origin. No fiberglass straps present.

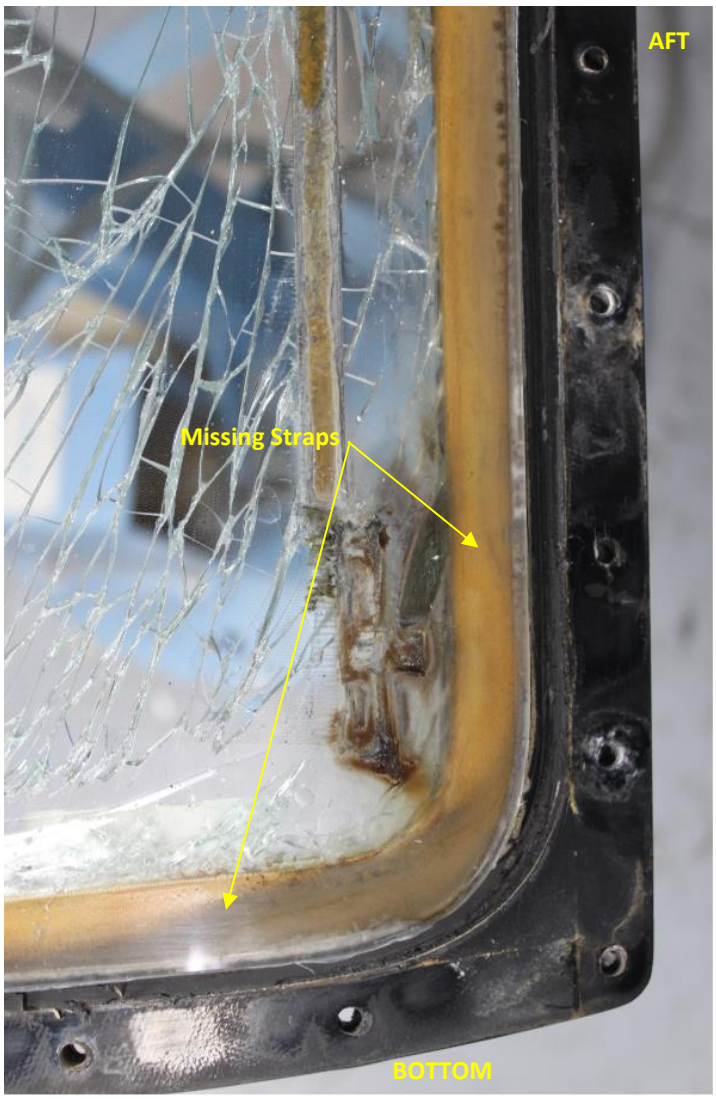

Figure F: Outboard View – No Fiberglass Straps

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Figure G: Outboard view of windshield to highlight where remaining fiberglass straps remain. ~80% of straps had been removed. Green lines below highlight the areas of remaining strap – all other areas have the strap removed.

Figure G: Outboard Overall View – Remaining Strap Locations