



Aviation Investigation Final Report

Location:	Laramie, Wyoming	Accident Number:	WPR19LA088
Date & Time:	February 10, 2019, 16:00 Local	Registration:	N549CJ
Aircraft:	Lancair IV	Aircraft Damage:	Substantial
Defining Event:	Aircraft structural failure	Injuries:	2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, during cruise flight at 15,500 feet mean sea level in the pressurized airplane, he heard a loud “bang” as the windshield fractured. The pilot diverted to a nearby airport, where he landed the airplane uneventfully.

An examination of the windshield pieces revealed that the fracture origin area displayed features consistent with a preexisting crack that developed due to environmental stress cracking (ESC). ESC is a fracture mechanism in polymer materials that occurs when a susceptible polymer material is exposed to a combination of tensile stress and exposure to a substance that degrades the integrity of the material. The ESC was likely a result of contact with a degrading substance, the origin of which could not be determined.

Although a stress analysis of the windshield structure was not completed, the location of the fracture origin was likely an area of high stress on the windshield due to the curvature at that location. Sustained high stress in acrylic can promote crack development, particularly when the acrylic is also exposed to certain chemical agents. The overall appearance of the windshield edge showed limited visual evidence of adhesive on the surface, suggesting a relatively low bond strength between the windshield at the frame. Evidence of voids in the epoxy at the interior bond surface were observed; if portions of the windshield became disbonded, this could have affected the stress state of the windshield and contributed to increased stress at the fracture origin area.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

An environmental stress cracking failure of the acrylic windshield, which resulted in a rapid decompression during cruise flight.

Findings

Aircraft

(general) - Failure

Factual Information

History of Flight

Enroute-climb to cruise	Aircraft structural failure (Defining event)
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On February 10, 2019, about 1600 mountain standard time, a Lancair IV-P airplane, N549CJ, sustained substantial damage when it was involved in an accident near Laramie, Wyoming. The pilot and passenger were not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* (CFR) Part 91 personal flight.

The pilot reported that, following departure, he configured the airplane to climb to 15,500 feet mean sea level (msl). The airplane reached that altitude and was cruising about 235 kts when the pilot heard a loud “bang,” as the windscreen suddenly blew out of the airframe. The pilot reduced the airplane’s speed and lowered the landing gear in an effort to stabilize the airplane. He diverted to Laramie and made an uneventful landing.

The windshield was manufactured from cast acrylic and the frame was from a carbon fiber reinforced polymer (CFRP) with layers of carbon-fiber fabric and epoxy. According to the window installation instructions, the exterior surface of the windshield is bonded in position with Hysol paste epoxy structural adhesive.

Recovered portions of the windshield pieces were sent to the National Transportation Safety Board (NTSB) for examination. (see Figure 1.) The outer edge of the windshield displayed a white appearance consistent with a roughening process used during the windshield installation process before bonding to the windshield frame.

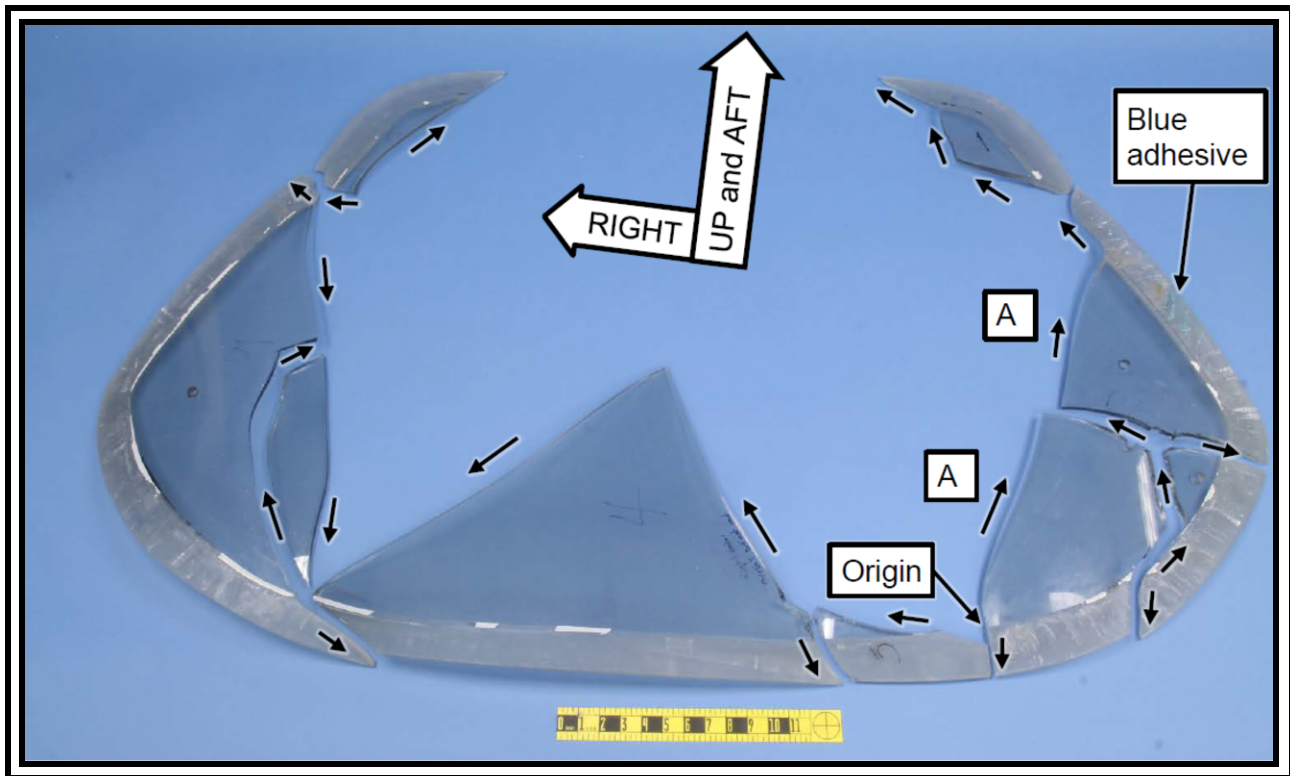


Figure 1: Overall view of the submitted windshield pieces. Unlabeled arrows indicate fracture propagation directions.

Most of the windshield fractures exhibited fracture planes that varied across the thickness with curving hackles turning toward the interior or exterior surface, features consistent with fracture under a combination of tension and bending loads. One fracture (shown as “A”) displayed smooth, mirror-like fracture features along most of the fracture surface in a flat plane perpendicular to the interior and exterior surfaces consistent with fracture under primarily tension loads. A portion of that fracture surface had curving rib marks and with a somewhat hazy surface, consistent with preexisting progressive crack growth. The features were consistent with the crack’s origin positioned at the forward left side of the windshield above the edge of the frame. The surface adjacent to the fracture appeared disturbed consistent with a surface scratch.

The origin area fracture displayed features consistent with a preexisting crack that developed due to environmental stress cracking (ESC). ESC is a fracture mechanism in polymer materials that occurs when a susceptible polymer material is exposed to a combination of tensile stress and exposure to a substance that degrades the integrity of the material. At high magnification, the crack surface had fracture features that were significantly different than features observed in laboratory-created impact fracture surfaces.

The examination further revealed liquid oozing from secondary cracks. The liquid was identified as a plasticizer, a chemical that could cause ESC in acrylic. The source of the plasticizer was unknown, but potential sources include flexible polymers such as vinyl tape potentially used in the construction of the windshield or possible contact with a vinyl material if that material had been used in the airplane

interior. Plasticizers can exude from the adjacent material due to changes in temperature or humidity, mechanical stress, or weathering.

The windshield edge showed limited visual evidence of adhesive on the bond surface, with evidence of voids in the epoxy at the interior bond surface.

Pilot Information

Certificate:	Commercial	Age:	62, Male
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	3-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	January 28, 2019
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:	2700 hours (Total, all aircraft), 400 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Lancair	Registration:	N549CJ
Model/Series:	IV P	Aircraft Category:	Airplane
Year of Manufacture:	2014	Amateur Built:	Yes
Airworthiness Certificate:	Experimental (Special)	Serial Number:	218
Landing Gear Type:	Retractable - Tricycle	Seats:	4
Date/Type of Last Inspection:	March 1, 2018 Condition	Certified Max Gross Wt.:	3550 lbs
Time Since Last Inspection:	91 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	307 Hrs at time of accident	Engine Manufacturer:	Continental
ELT:	Installed, not activated	Engine Model/Series:	TSIO-550-E
Registered Owner:	On file	Rated Power:	350 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KLAR,7272 ft msl	Distance from Accident Site:	4 Nautical Miles
Observation Time:	22:53 Local	Direction from Accident Site:	298°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	24 knots / 34 knots	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	150°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	29.63 inches Hg	Temperature/Dew Point:	-2°C / -11°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Casper, WY (CPR)	Type of Flight Plan Filed:	None
Destination:	Denver, CO (FTG)	Type of Clearance:	None
Departure Time:	15:30 Local	Type of Airspace:	Class E

Airport Information

Airport:	Laramie Regional LAR	Runway Surface Type:	
Airport Elevation:	7283 ft msl	Runway Surface Condition:	Dry
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 None	Aircraft Damage:	Substantial
Passenger Injuries:	1 None	Aircraft Fire:	None
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	2 None	Latitude, Longitude:	41.287498,-105.60749(est)

Administrative Information

Investigator In Charge (IIC):	Keliher, Zoe
Additional Participating Persons:	Bruce Hanson; Federal Aviation Administration; Laramie, WY
Original Publish Date:	April 21, 2022
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99026

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).