Aviation Investigation Final Report

Location:	Windsor Locks, Connecticut	**Incident Number:**	ENG15IA024
Date & Time:	June 5, 2015, 12:15 Local	**Registration:**	N363PH
Aircraft:	BOMBARDIER INC DHC 8	**Aircraft Damage:**	Minor
Defining Event:	Fire/smoke (non-impact)	**Injuries:**	37 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The airplane suffered an in-flight fire at the right windshield terminal block while on approach to the destination airport. The flight crew donned oxygen masks, declared an emergency, landed without incident, and performed an emergency evacuation.

Examination of the windshield revealed that it had been installed on the airplane since manufacture more than 17 years prior to the incident, which far exceeded the average life of 8.2 years reported by the windshield manufacturer. The windshield exhibited typical signs of aging with ample evidence of moisture ingression into the laminate around the edges of the windshield. The aging discrepancies noted were within the published limits and did not contribute to the failure. The fire damage was concentrated in an area between the upper edge of the terminal block and the lower edge of the windshield gasket where the power wire was routed. The power wire was melted through in this area but remained soldered to the bottom of the terminal block indicating an arcing failure of the power wire. The damage and melting precluded determining if there was any pre-existing damage to the power wire prior to the incident. The arcing of the power wire produced enough localized heating to melt the glass and cause the fracture of the inner glass pane.

Examination of the maintenance records showed that the operator was in compliance with all recommended inspections from the airplane manufacturer, and the most recent inspection occurred more than 2 years and 3,500 flight hours prior to the incident with no discrepancies. The windshield manufacturer recommends inspection of the windshields at intervals significantly less than the airplane manufacturer.

The crew reported at least two attempts to extinguish the fire, but the fire continued, eventually extinguishing itself. The windshield heat selector switch was found in the normal position which would continue to provide power to the windshield heating system. Switching the windshield heat selector to off would have cut power to the circuit eliminating the arcing and fire. There is no training or guidance provided to the crew for windshield arcing, smoke, fire, or overheat events.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The arcing failure of the windshield heat power wire on the right windshield due to unknown reasons. Contributing to the severity of the fire was the lack of training or guidance provided to the crew for selecting the windshield heat to off that would cut power to the circuit.

Findings

Aircraft	Windows/windshields & doors - Failure
Personnel issues	Total instruct/training recvd - Flight crew

Factual Information

History of Flight

Approach-IFR initial approach	Fire/smoke (non-impact) (Defining event)

On June 5, 2015, about 1215 Eastern daylight time (EDT), a Bombardier DHC-8-202 airplane, N363PH, had an in-flight cockpit fire during approach to Bradley International Airport (BDL), Windsor Locks, Connecticut. The flight crew donned oxygen masks, declared an emergency, and landed without incident. There were no injuries to the passengers or crew. The airplane sustained minor damage. The aircraft was registered to Wells Fargo Bank Northwest NA Trustee and operated by Champlain Enterprises, Inc. (doing business as CommutAir - United Express, flight 4776) under the provisions of 14 *Code of Federal Regulations* Part 121 as a scheduled passenger flight. Visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan. The flight originated from Newark Liberty International Airport (EWR), Newark, New Jersey, at 1134 EDT.

In written statements the crew reported that the flight was normal from departure at EWR to the initial approach into BDL. The first officer was the pilot flying and the captain was the pilot monitoring for the flight. The airplane was cleared to the initial approach fix, PENNA, and about 15-20 miles from PENNA, the first officer heard a 'pop' and noticed arcing at the right windshield terminal block. A fire ensued and the captain declared an emergency with approach control and the crew donned their oxygen masks. Aircraft control was transferred to the captain while the first officer attempted to extinguish the fire. The captain called the flight attendant with instructions to plan for an emergency evacuation once the airplane was off the runway and the propellers were stopped. The crew performed a successful emergency landing and cleared the runway at the first available taxiway. An emergency evacuation of the airplane was performed on the taxiway with no reported injuries. Airport fire personnel responded and confirmed there was no continued fire. The crew did not recall seeing any caution or warning lights during the event and no circuit breakers were popped.

A representative from the Federal Aviation Administration (FAA) examined the airplane after the incident and noted that the windshield heat switch was in the NORM position.

Pilot Information

Certificate:	Airline transport; Commercial; Flight instructor; Private	**Age:**	28,Female
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	October 22, 2014
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	January 29, 2015
Flight Time:	2860 hours (Total, all aircraft), 2000 hours (Total, this make and model), 1379 hours (Pilot In Command, all aircraft), 145 hours (Last 90 days, all aircraft), 80 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Commercial; Flight instructor; Private	**Age:**	46,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	January 26, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	February 26, 2015
Flight Time:	2995 hours (Total, all aircraft), 1100 hours (Total, this make and model), 1850 hours (Pilot In Command, all aircraft), 177 hours (Last 90 days, all aircraft), 70 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

The captain, age 28, held Airline Transport Pilot, Commercial and Flight Instructor certificates with single-engine land, multiengine land, and instrument airplane ratings. She held instructor ratings for airplane single-engine and instrument airplane and a type rating in the DHC-8 airplane. Her most recent FAA first-class airman medical certificate was issued on October 22, 2014, without limitations. Her most recent FAA proficiency check was dated January 29, 2015, and was performed in a Bombardier DHC-8 airplane. Her reported flight time after the incident was a total flight time of 2,860 hours, with 2,000 hours in the incident airplane make and model.

The first officer, age 46, held Airline Transport Pilot, Commercial and Flight Instructor certificates with single-engine land, multiengine land, and instrument airplane ratings. He held an instructor rating for airplane single-engine and type ratings in the DHC-8 and B-737 airplanes. His most recent FAA first-class airman medical certificate was issued on January 26, 2015, without limitations. His most recent

FAA proficiency check was dated February 26, 2015, and was performed in a Bombardier DHC-8 airplane. His reported flight time after the incident was a total flight time of 2,995 hours, with 1,100 hours in the incident airplane make and model.

Aircraft and Owner/Operator Information

Aircraft Make:	BOMBARDIER INC	**Registration:**	N363PH
Model/Series:	DHC 8 202	**Aircraft Category:**	Airplane
Year of Manufacture:	1998	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	520
Landing Gear Type:	Retractable - Tricycle	**Seats:**	41
Date/Type of Last Inspection:	June 3, 2015 Continuous airworthiness	**Certified Max Gross Wt.:**	36301 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo prop
Airframe Total Time:	31984 Hrs at time of accident	**Engine Manufacturer:**	P&W CANADA
ELT:	C126 installed, not activated	**Engine Model/Series:**	PW123D
Registered Owner:	WELLS FARGO BANK NORTHWEST NA TRUSTEE	**Rated Power:**	2150 Horsepower
Operator:	CHAMPLAIN ENTERPRISES INC	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	CommutAir - United Express	**Operator Designator Code:**	JJBA

The incident aircraft, a Bombardier DHC-8-202 airplane, serial number 520, was manufactured in 1998 and had accumulated 31,984.1 flight hours and 42,579 cycles. The right windshield was installed during manufacture and had accumulated the same time and cycles.

The Bombardier DHC-8-200 windshield is a laminated glass configuration. The windshield is manufactured of the following materials, from the outboard surface to the inboard surface; a 0.115-0.134 inch thick Herculite® thermally tempered glass layer, a PPG Nesatron® conductive heating film layer for anti-ice capability, a urethane interlayer, a vinyl interlayer, a 0.187-0.203 inch thick Herculite® II chemically tempered glass layer, a vinyl interlayer, and a 0.219-0.265 inch thick Herculite® II chemically tempered glass layer. The windshield is a plug design that utilizes aluminum retainers to secure the windshield in the fuselage opening. A polysulfide moisture seal around the window perimeter protects the interlayer materials from moisture ingression.

The anti-ice function for the two main windshields is controlled by the HEAT switch located on the WINDSHIELD panel on the left overhead console in the cockpit. The rotary switch has three positions; OFF, WARM UP, and NORM. The WARM UP position starts the system and applies partial power to preheat the windshield and prevent thermal shock. The NORM position applies full power to the windshields to maintain them at 108ºF ±4ºF. Sensors in the windshield monitor the temperature and the system will turn off power to the windshields if a temperature of 122ºF ±4ºF is reached. In the event of an overheat condition on one of the windshields or a malfunction in the controller or sensors, an amber caution light (L WSHLD HOT or R WSHLD HOT) will illuminate on the caution/warning panel. The

caution light will extinguish if the HEAT switch is placed in the WARM UP position.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KBDL,179 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	11:51 Local	**Direction from Accident Site:**	168°
Lowest Cloud Condition:	Few / 4500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 25000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots / None	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.06 inches Hg	**Temperature/Dew Point:**	21°C / 9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	NEWARK, NJ (EWR)	**Type of Flight Plan Filed:**	IFR
Destination:	Windsor Locks, CT (BDL)	**Type of Clearance:**	IFR
Departure Time:	11:34 Local	**Type of Airspace:**	Class C

The nearest official reporting station was an Automated Surface Observing System at BDL. About 24 minutes before the incident, at 1151 EDT, an Aviation Routine Weather Report (METAR) reported: Wind, variable at 3 knots; visibility, 10 statute miles; sky condition, few clouds at 4,500 feet and 11,000 feet, scattered clouds at 14,000 feet, and broken clouds at 25,000 feet; temperature, 21 degrees C; dew point, 9 degrees C; altimeter, 30.07 inches Hg.

Airport Information

Airport:	BRADLEY INTL BDL	**Runway Surface Type:**	Asphalt
Airport Elevation:	173 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	06	**IFR Approach:**	Visual
Runway Length/Width:	9510 ft / 200 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Minor
Passenger Injuries:	34 None	**Aircraft Fire:**	In-flight
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	37 None	**Latitude, Longitude:**	41.939167,-72.683334

The right windshield sustained burning and charring damage in the area of the terminal block and the inner glass ply was fractured. There was also some burning and charring damage to the interior airplane trim components adjacent to the forward, upper edge of the windshield. The power and sensor wires to the windshield were cut and the windshield was removed from the airplane. The damaged windshield was shipped to PPG Aerospace in Huntsville, Alabama, for a tear down examination under the supervision of the NTSB.

Communications

There were no reported communication problems with the approach or tower air traffic controllers.

Fire

The airplane experienced an in-flight cockpit fire at the right windshield terminal block location near the upper, forward corner of the windshield. The crew reported that a 'pop' was heard and they noticed arcing at the terminal block location. Almost immediately, a "torch like fire occurred at the terminals making a loud hissing sound." The first officer discharged the fire extinguisher on the terminal block after donning his oxygen mask and transferring control to the captain. The fire ceased momentarily but the arcing continued, re-igniting the fire. The first officer discharged the extinguisher a second time momentarily extinguishing the fire. The fire flared back up and continued for an unknown amount of time before extinguishing itself while still producing smoke.

Tests and Research

The damaged right main windshield (P/N NP157901-12, S/N 97316H9791) was examined under direction of the NTSB. Representatives from PPG Aerospace, CommutAir, and the Air Line Pilots Association were present for the exam. The windshield serial number indicated that the windshield was a new unit and was completed on the 316th day of 1997. The windshield was last inspected 3,582.8 flight hours prior to the event.

The windshield exhibited a few sparse fractures of the inner glass pane in the upper, aft quadrant. There was cloudiness and cracking of the interlayer material (evidence of moisture ingression) around the entire periphery of the windshield about 1 inch wide. There was evidence of repair to the moisture seal along the entire upper and aft edges and the repaired areas exhibited evidence of erosion along the upper and aft edges. The lower bus bar was discolored along its length with some areas darker in appearance. The upper bus bar was slightly discolored along its lower edge.

The terminal block remained securely attached to the inboard surface of the inner glass pane, but there was burning, charring, and sooting concentrated at the aft end of the block. The screws at the power and sensor connections remained installed with a lock washer between the terminal and screw head. The screw connections were disassembled and no signs of cross threading were noted at any of the locations. The end of the L1 power braid wire remained soldered to the bottom of the terminal lug but the wire was melted through adjacent to the upper edge of the terminal block. The bottom of the terminal block around the L1 location and the area above the terminal block where the L1 braid wire normally sits showed extensive burning and charring. An area of damaged and melted glass about 1 inch in diameter was located in the same area. The inner glass pane fractures all originated at the area of damaged glass.

The CommutAir maintenance program outlines two separate inspections of the cockpit windshields and one inspection of the terminal block. A general visual inspection of the windshields from the inside should be performed at every other C-check (10,000 flight hours). The most recent inspection of the windshield from the inside was performed on April 4, 2011, at an aircraft total time of 24,776.5 flight hours and 33,636 cycles, with no findings. A general visual inspection of the windshields from the outside should be performed at every C-check (5,000 flight hours). The most recent inspection of the windshields from the outside was performed on April 9, 2013, at an aircraft total time of 28,401.3 flight hours and 38,245 cycles, with no findings. A detailed inspection of the windshield heater terminal blocks should be performed every 12,000 hours. The most recent inspection of the terminal blocks was performed on April 9, 2013, at an aircraft total time of 28,401.3 flight hours and 38,245 cycles, with no findings. The moisture seal was noted to be eroded and repaired during the C-check on April 9, 2013. Between scheduled inspections the windshields would only be examined in the event of write up in the aircraft logbook according to the operator.

The average life of the DHC-8-200 windshields manufactured by PPG is about 8.2 years based on fleet data provided to PPG. CommutAir does not track the life of the windshields in their fleet since they are replaced on condition.

The relevant pages from the DHC-8-200 Emergency and Abnormal Checklist were provided by the operator. The emergency AIRCRAFT FIRE or SMOKE checklist provides instructions to the crew to diagnose the source of the fire but does not specifically mention the windshield heating system or terminal blocks. There are no instructions in the checklist to turn off the windshield heat in the event of smoke or fire at the terminal block. If an electrical fire is suspected the crew is instructed to configure the airplane to run on only essential power which does not include windshield heat. There is no specific training provided for the crew for windshield arcing, smoke, fire, or overheat events.

Additional Information

A search of Bombardier provided information, the FAA Service Difficulty Reports (SDR) database, the Transport Canada (TC) SDR database, and the Transportation Safety Board of Canada (TSB) database from 2000 to the present yielded 77 events involving arcing, smoke, fire, or overheating at the

windshield terminal block locations similar to this incident. A search of the NTSB database found no other investigations focused on a DHC-8 windshield. Information on 17 additional windshields was provided by PPG for which no SDR data existed.

In 2003 Bombardier revised the aircraft maintenance manual (AMM) to provide information on the correct screw and washer part numbers for attaching the power and sensor wires to the windshield terminal blocks and in 2005 revised the AMM to include the proper installation torque values for the terminal block screws. In 2012 Transport Canada issued civil aviation safety alert CASA 2012-01 recommending detailed inspection of the windshield terminal blocks for security, overheating, and wire routing and re-torqueing of the attaching hardware. Over the years Bombardier has published several in-service activities report (ISAR) articles on windshield arcing, smoke, fire, or overheat events.

Administrative Information

Investigator In Charge (IIC):	Crookshanks, Clinton
Additional Participating Persons:	
Original Publish Date:	January 12, 2016
Last Revision Date:	July 8, 2024
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=91314