



National Transportation Safety Board Aviation Accident Final Report

Location:	DENVER, CO	Accident Number:	FTW98FA364
Date & Time:	08/19/1998, 1715 MDT	Registration:	N251GL
Aircraft:	Beech 1900D	Aircraft Damage:	Substantial
Defining Event:		Injuries:	1 Minor, 14 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

Shortly after the airplane took off, the crew heard a loud noise and felt a slight vibration from the left propeller. They returned and landed. It was discovered that the propeller erosion shield had debonded and a portion had penetrated the passenger cabin just aft of the airstair door, knocked ajar Seat 1A Passenger Service Unit, ricocheted off the ceiling, and penetrated the inner window pane at Seat 2C. Laboratory examination of the propeller blade revealed an area 'consistent with adhesive disbonding (debond) on about 80% of the total bond area...' Three hundred hours before the accident, the blade had been overhauled and repaired. The repaired area contained numerous voids, air bubbles, dirt and debris. Evidence of chaffing (rubbing) was found at several locations in the debonded area, indicative of movement between the debonded erosion shield and the propeller blade body. Samples of the erosion shield adhesive were tested and found to have been mixed in improper proportions, reducing bond strength.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Debonding of the propeller erosion shield due to an improper overhaul and repair by other maintenance personnel.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION

Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

1. (C) PROPELLER SYSTEM/ACCESSORIES, LEADING EDGE CAP - DEBONDED
2. (C) MAINTENANCE, MAJOR REPAIR - IMPROPER - OTHER MAINTENANCE PERSONNEL
3. FUSELAGE, CABIN - PENETRATED
4. PRECAUTIONARY LANDING - PERFORMED - PILOT IN COMMAND

Factual Information

HISTORY OF FLIGHT

On August 19, 1998, at 1715 mountain daylight time, a Beech 1900D, N251ZV, owned by Mesa Airlines, Inc., of Farmington, New Mexico, and operated by Great Lakes Aviation, Ltd., of Spencer, Iowa, as United Express flight 1605, was substantially damaged when the erosion shield separated from one of the left propeller blades and punctured the pressure vessel during initial climb at Denver, Colorado. There were no injuries to the airline transport-rated captain, commercial certificated first officer, and 12 passengers, but one passenger sustained a minor injury. Visual meteorological conditions prevailed, and an IFR flight plan had been filed for the scheduled domestic passenger flight operating under Title 14 CFR Part 135.

The airplane taxied from its gate at 1710, and took off from runway 17R at 1714. The following was contained in the captain's discrepancy report: "Reaching 500 feet agl [above ground level] after takeoff, heard loud 'bang.' Slight vibration from left prop. Returned for landing. Discovered hole in fuselage from prop leading edge strip." The airplane returned to Denver and landed on runway 17L at 1719 and arrived at its gate at 1725.

Postaccident examination revealed the entire erosion shield was missing. There were three holes punctured in the fuselage. The first hole was about 12 inches aft of the airstair door and just above the cabin window. The second hole was slightly higher than the first. The third hole was at the top of the fuselage. A portion of the erosion shield entered the cabin and knocked out the overhead passenger service unit at seat 1A. Two small dents were found in the ceiling. The inner window pane at seat 2C was punctured and a piece of the erosion shield was found lodged between the inner and outer panes. Another piece was found between the ceiling and the pressure vessel. The passenger seated in row 2C sustained a small cut on his forehead when he was grazed by a piece of the shrapnel. He refused medical treatment.

AIRCRAFT INFORMATION

N251ZV (s.n. UE-251), a Beech 1900D, was manufactured by the Raytheon Aircraft Corporation in 1996. It was equipped with two Pratt and Whitney PT6A-67D engines, driving two Hartzell HC-E4A-31 composite propellers. The propeller blades are made of Kevlar, fiberglass, foam and epoxy. A metallic erosion shield is bonded to the leading edge of the propeller blades, and de-icing boots are bonded to the inboard end of the erosion shield and propeller blade body.

According to the aircraft maintenance records, the four propeller blades were last overhauled and repaired by Aircraft Propeller Service, Inc., in July 1998.

TESTS AND RESEARCH

The four composite blades from the left propeller were removed from the airplane and sent to NTSB's Materials Laboratory in Washington, D.C., where, on August 27, 1998, they were examined. According to the Materials Laboratory's Factual Report (No. 99-23, attached), the surface of the damaged blade (s.n. 811) was smooth and shiny, "consistent with adhesive disbonding (debond) on about 80% of the total bond area...The remaining outboard separation area had a much rougher powdery white appearance typical on cohesive separation within the bonding material."

The report further stated that the propeller blade (s.n. 811) had been repaired by injecting

adhesive into the joint. This repair reportedly occurred approximately 300 hours before. The repaired area was readily apparent during the examination because it contained numerous voids, air bubbles, dirt and debris. Evidence of chaffing (rubbing) was found at several locations in the debonded area, indicative of movement between the debonded erosion shield and the propeller blade body.

The other three blades (1802, 808, and 806) appeared to be undamaged when visually inspected, but tap tests indicated approximately 80 to 90% debonding of the erosion shield under the deice boots on blades 1802 and 808. Blade 806 had "spotty" debonding. When the deice boots were removed, the erosion shields on blades 808 and 806 were found to be cracked.

Samples of the erosion shield adhesive were removed and forwarded to the manufacturer for analysis. Using differential scanning calorimetry (DSC), the samples were found to be "fully cured," and contained no "environmental contaminants" such as water or solvents. Further tests of the adhesive, Hysol EA 9330, showed that the cured mixture contained approximately 120 to 140% (by weight) of the recommended amount of part B of the epoxy. A mixing ratio of 100:33 of part A (hardening components) to part B (catalyzers) is recommended by the data sheet.

In a report prepared for Hartzell Propellers by the University of Dayton Research Institute, it was found that decreased bond strength would result if Hysol EA 9330 was improperly mixed (such as a 20 to 40% excess of part B). Oil and dirt contamination detected on the blade surfaces would also reduce bonding strength of the joint. However, it could not be determined if the contamination was introduced before or after the erosion shield debonded. Finally, the report noted that exposure to high temperatures could cause a separation.

ADDITIONAL INFORMATION

The airplane was released to Great Lakes Aviation for repairs on August 20, 1998. After being examined at NTSB's laboratory, the composite blades from the left propeller were sent to Hartzell Propellers. Hartzell Propellers then sent four new replacement propeller blades to Great Lakes Aviation on September 1, 1998.

In addition to the Federal Aviation Administration, parties to the investigation included the Raytheon Aircraft Corporation, Great Lakes Aviation, Hartzell Propellers, and Aircraft Propeller Service, Inc.

Pilot Information

Certificate:	Airline Transport	Age:	27, Male
Airplane Rating(s):	Multi-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last Medical Exam:	04/07/1998
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	1700 hours (Total, all aircraft), 700 hours (Total, this make and model), 840 hours (Pilot In Command, all aircraft), 200 hours (Last 90 days, all aircraft), 40 hours (Last 30 days, all aircraft), 8 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Beech	Registration:	N251GL
Model/Series:	1900D 1900D	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	UE-251
Landing Gear Type:	Retractable - Tricycle	Seats:	19
Date/Type of Last Inspection:	08/15/1998, Continuous Airworthiness	Certified Max Gross Wt.:	16950 lbs
Time Since Last Inspection:	34 Hours	Engines:	2 Turbo Prop
Airframe Total Time:	4142 Hours	Engine Manufacturer:	P&W
ELT:	Installed, not activated	Engine Model/Series:	PT6A-67D
Registered Owner:	MESA AIRLINES, INC.	Rated Power:	1279 hp
Operator:	GREAT LAKES AVIATION, LTD.	Air Carrier Operating Certificate:	Flag carrier (121)
Operator Does Business As:	UNITED EXPRESS	Operator Designator Code:	GLBA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	DEN, 5431 ft msl	Observation Time:	1653 MDT
Distance from Accident Site:	0 Nautical Miles	Direction from Accident Site:	0°
Lowest Cloud Condition:	Scattered / 18000 ft agl	Temperature/Dew Point:	27° C / 8° C
Lowest Ceiling:	None / 0 ft agl	Visibility	10 Miles
Wind Speed/Gusts, Direction:	9 knots, 140°	Visibility (RVR):	0 ft
Altimeter Setting:	30 inches Hg	Visibility (RVV):	0 Miles
Precipitation and Obscuration:			
Departure Point:	(DEN)	Type of Flight Plan Filed:	IFR
Destination:	ROCK SPRINGS, WY (RKS)	Type of Clearance:	IFR
Departure Time:	1715 MDT	Type of Airspace:	Class B

Airport Information

Airport:	DENVER INTERNATIONAL (DEN)	Runway Surface Type:	Concrete
Airport Elevation:	5431 ft	Runway Surface Condition:	Dry
Runway Used:	17R	IFR Approach:	None
Runway Length/Width:	12000 ft / 150 ft	VFR Approach/Landing:	Full Stop; Precautionary Landing

Wreckage and Impact Information

Crew Injuries:	2 None	Aircraft Damage:	Substantial
Passenger Injuries:	1 Minor, 12 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Minor, 14 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC):	ARNOLD W SCOTT	Adopted Date:	02/11/2000
Additional Participating Persons:	RANDY L HAYNES; DENVER, CO		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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