



National Transportation Safety Board Aviation Accident Final Report

Location:	Wailea, HI	Accident Number:	WPR14FA024
Date & Time:	10/21/2013, 1845 HST	Registration:	N861MA
Aircraft:	CESSNA 208	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (total)	Injuries:	10 None
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Scheduled		

Analysis

According to the flight crew, as the airplane passed through about 8,000 ft mean sea level during climb over open ocean water, they heard a loud bang and a grinding sound, which was followed by a loss of engine power. Sparks were observed coming out of the engine's right exhaust. The flight crew initiated a turn back towards the departure airport, which was about 13 miles north of their position. The crew accomplished the emergency checklists and elected to perform an emergency landing on a highway. During the landing roll, the airplane struck two highway traffic signs, which resulted in substantial damage to the right wing.

A postaccident examination of the airplane's engine revealed that all of the compressor turbine (CT) blades had separated near the blade platforms, and the remaining stubs were gouged and battered. The fracture surface of one of the blades displayed smooth features characteristic of fatigue fracture; all other blade fracture surfaces displayed coarse features characteristic of overload fracture. The fatigue-fractured blade's microstructure in the fracture area was normal, and the blade material and hardness met engineering drawing requirements. The CT hub displayed a frosted appearance over the entire front and aft surfaces, and glass beads and bead fragments were observed between the fir-tree joints of the blade platforms and the CT disc, consistent with the disc assembly having been cleaned by aggressive glass media blasting in the assembled condition. The engine manufacturer specifies that all media blast cleaning be performed with the CT disc and blades disassembled. The glass bead contamination of the fir-tree joints caused the CT blades to be unevenly restrained, and it altered the blades' designed vibration frequency, making them susceptible to the aerodynamic vibrations from the combustor gas flow. Therefore, the fatigue fracture of the blade was most likely due to the glass bead contamination.

The CT disc assembly had been removed from the engine for repair about two months before the accident, and this was likely when the glass bead media cleaning occurred and the beads became embedded in the exposed fir tree joints. When the CT disc assembly is installed in the engine, the fir tree joints are protected from exposure; therefore, the glass bead contamination could not have occurred when the engine was installed on the airplane.

Probable Cause and Findings

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

Improper maintenance that resulted in contamination of the engine's compressor turbine disc and blade assembly by glass bead remnants, which resulted in a blade failure.

Findings

Aircraft	Turbine section - Damaged/degraded (Cause)
Personnel issues	Repair - Maintenance personnel (Cause)

Factual Information

This report was modified on October 27, 2015. Please see the docket for this accident to view the original report.

On October 21, 2013, about 1845 Hawaii standard time, a Cessna 208B, N861MA, sustained substantial damage during an emergency landing, about 13 miles south of the Kahului Airport (OGG), Kahului, Hawaii. The airplane was registered to Mokulele Flight Service Inc., and operated by Mokulele Airlines as flight number 1770, under the provisions of Title 14 Code of Federal Regulations Part 135. The airline transport pilot, commercial pilot, and eight passengers were not injured. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The scheduled domestic flight originated about 1830, from OGG with a planned destination of Waimea-Kohala Airport (MUE), Kamuela, Hawaii.

According to the flight crew, during climb out, as the airplane passed through about 8,000 feet mean sea level, while over the ocean, a loud bang and grinding was heard followed by a loss of engine power. Sparks were observed coming out of the right side engine exhaust. The loss of engine power occurred about 5 miles southeast of the Harpo Intersection on the Beach Three Departure. No engine restart was attempted and the flight crew turned the airplane and proceeded back towards the island of Maui, about 9 miles north of their position. The flight crew accomplished emergency checklists and elected to perform an emergency landing on the Piilani highway (state route 31). During the landing roll out, the airplane struck two highway traffic signs which resulted in substantial damage to the right wing.

The airplane was recovered to a secure storage facility prior to the engine being shipped to the manufacturer for further examination.

PERSONNEL INFORMATION

The captain, age 29, held an Airline Transport Pilot certificate with an airplane multi engine land, single-engine land, and instrument ratings. The pilot also had an instructor rating in airplane multiengine and single engine. The pilot was issued a second-class airman medical certificate on September 26, 2013, with no limitations stated. The pilot reported that he had accumulated 3,062 total flight hours and 281 hours within the preceding 90 days, 81 hours within the preceding 30 days, and 3 flight hours within the previous 24 hours. The total time logged in the accident make/model airplane was 411 hours.

The first officer, age 24, held a commercial pilot certificate with an airplane multi engine land, single-engine land, and instrument ratings. The pilot also had an instructor rating in airplane single engine. The pilot was issued a first-class airman medical certificate on February 4, 2013, with the limitation that he must wear corrective lenses stated. The pilot reported that he had accumulated 1,040 total flight hours and 115 hours within the preceding 90 days, 70 hours within the preceding 30 days, and 2 flight hours within the previous 24 hours. The total time logged in the accident make/model airplane was 890 hours.

According to the training records, the captain was current in his flight training. The captain's most recent proficiency/qualification check for the Cessna 208B airplane was satisfactory completed on June 10, 2013. The first officer was current in his flight training. The first officer's most recent proficiency/qualification check for the Cessna 208B airplane was satisfactory completed on August 13, 2013.

AIRCRAFT INFORMATION

The accident airplane was a 2000 Cessna model 208B airplane, serial number (S/N) 208B0825. The high wing, eleven seat, fixed landing gear airplane, had a maximum takeoff weight of 8,750 pounds. It was powered by a Pratt and Whitney PT-6A-114A engine, serial number PCE-PC-1213, rated at 675 horsepower. The airplane was also equipped with a McCauley model 3GFR34C703B, controllable pitch propeller. The approved inspection program (AAIP) showed an inspection was completed on October 10, 2013, at an airframe total time of 11,828 hours.

Maintenance service records established that the engine had accumulated 9,343.2 hours since new (TSN) and 19,316 cycles since new (CSN). The engine had accumulated 5,249.1 hours and 10,997 cycles since the last overhaul. The engine had accumulated 138 hours since the last hot section inspection.

At 9,162 total hours and 18,954 total cycles, 5,068 hours since overhaul and 10,997 total cycles, a hot section inspection was performed. Concurrent engine repairs included replacement of the 3rd stage compressor disc, compressor impeller, and the power turbine disc with overhauled units, due to cycle limitations. The power turbine blades were overhauled and reinstalled. The reduction gearbox 1st stage gears and bushings were visually inspected. This work was completed by Southwest Airmotive, Eloy Arizona on August 8, 2013. Previously, on August 2, 2013, the engine was functionally tested by Timkin Overhaul Services, Mesa, Arizona.

METEOROLOGICAL INFORMATION

A review of recorded data from OGG automated weather observation station, located about 9 miles north of the accident site, revealed at 1854 conditions were wind from 020 degrees at 5 knots, visibility 10 statute miles, clear sky, temperature 26 degree Celsius, dew point 18 degrees Celsius, and an altimeter setting of 29.95 inches of mercury.

COMMUNICATIONS

According to air traffic control summaries obtained from the FAA, about 1840 the pilot reported that he lost power to his engine and turned back towards OGG, and was cleared to land on runway 02. The pilot then stated he could not make the runway and would try to make it to the old airport south of OGG. Subsequently, the pilot advised them that they could not make the airport and would execute a 360 degree turn to land northbound on the Piilani highway. Shortly thereafter, the pilot advised them that the airplane was safe on the ground and they were evacuating.

FLIGHT RECORDERS

The airplane was not equipped; nor was it required to be equipped, with a cockpit voice recorder (CVR), or flight data recorder (FDR).

WRECKAGE AND IMPACT INFORMATION

Examination of the accident site by an Federal Aviation Administration (FAA) Inspector revealed that the airplane landed on a highway about 9 miles south of OGG. The airplane landed north bound and came to rest upright. Two highway signs were damaged and appeared to be struck by the airplane. The airplane's wings and engine remained attached to the fuselage. Substantial damage on the airplane's right wing was observed. The leading edge of the outer portion of the right wing was bent upwards and damage was observed on the top portion of the wing. Additional damage was observed at the top portion of the fuselage near the area where the right wing attaches, with multiple wrinkles.

The engine was examined prior to shipment to the manufacturer's facility. This initial inspection of the engine revealed that several 1st stage rotor blades had tears in the trailing edge in the compressor inlet area. Damage was also observed on the power turbine blades. The compressor was reported to be seized and the power turbine did not rotate.

TESTS AND RESEARCH

On December 3rd and 4th 2013, an examination of the PT6A-114A engine, serial number PCE-PC1213, was accomplished at the Pratt & Whitney facilities in St Hubert, Quebec. (See the Powerplant Group Chairman's Examination Report in the public docket for detailed information). The examination revealed no external indication of any engine distress, however when the engine was examined through the exhaust duct, the power turbine blades were observed to have sustained damage, with only about 20 percent to 60 percent of their spans remaining.

With the engine disassembled, the compressor turbine hub was observed to display a frosted appearance over the entire front and aft surfaces, consistent with glass media blasting. Additionally, glass-like beads and bead fragments were observed between the "fir-tree" joint of the blade platforms and the compressor turbine (CT) disc, consistent with the disc assembly having been cleaned by glass media blasting in the assembled condition. The manufacturer's PT6A-114A Overhaul Manual specifies that all media blast cleaning be performed with the disc and blades disassembled and cleaned before assembly.

A dimensional and chemical analysis of a sample of the glass-like beads was accomplished by the manufacturer's materials laboratory. The beads were revealed to be approximately 195 to 160 μm in size and were composed predominantly of silica with small quantities of sodium, calcium, magnesium and sulfur, which were consistent with the chemical components of glass.

A detailed examination of the CT blades revealed that all 58 blades were present but fractured. All the airfoil sections of the blades were fractured near the blade platform and the remaining stubs were gouged and battered. The fracture surface of blade number 57 however, had unique features which contrasted with all the other blade's fracture surfaces. The Pratt & Whitney Laboratory analysis of blade number 57 determined that the fracture was a result of a fatigue

crack. The analysis also determined that blade number 57's material and hardness met manufacturer drawing requirements and was not affected by overheating.

The rotational speed of the CT disc assembly is approximately 40,000 revolutions per minute (RPM) and the temperature of the blades is approximately 750° degrees C. The radial loads from the blades are transferred into the disc rim through the "fir-tree" connection, a highly specialized joint, so-called because of its resemblance to the branches of a "fir tree." Its multiple lobes serve to gradually distribute the high tensile blade loads deep into the disc rim. The contact surfaces in the "fir-tree" must be of a very high precision and extremely smooth, so that the loads are evenly transferred along the entire length. When the CT assembly spins up to speed, the tensile loads of the blades cause the "fir-tree" surfaces to become highly loaded and if any hard contaminants are present in the slots, then the loads will not be evenly distributed and cause the blade to be unevenly restrained. Additionally, since the blade is not seated correctly, its designed natural vibration frequency will be altered.

The postaccident examination of the engine revealed evidence of a glass bead contamination in the compressor turbine portion of the engine between the "fir tree" joint of the blade platforms and the CT disc.

A review of the log books revealed that the last repair work on CT disc assembly had been performed on August 8, 2013 by Southwest Airmotive Corporation. The CT disc assembly was removed from the engine during this repair.

History of Flight

Prior to flight	Aircraft servicing event
Enroute-climb to cruise	Loss of engine power (total) (Defining event)
Landing	Off-field or emergency landing

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	Age:	30
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	3-point
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine	Toxicology Performed:	No
Medical Certification:	Class 2 Without Waivers/Limitations	Last Medical Exam:	09/26/2013
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	05/07/2013
Flight Time:	3062 hours (Total, all aircraft), 411 hours (Total, this make and model), 1950 hours (Pilot In Command, all aircraft), 281 hours (Last 90 days, all aircraft), 81 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Flight Instructor; Commercial	Age:	24
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	3-point
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Single-engine	Toxicology Performed:	No
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	02/04/2013
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	08/12/2013
Flight Time:	(Estimated) 1040 hours (Total, all aircraft), 690 hours (Total, this make and model), 470 hours (Pilot In Command, all aircraft), 115 hours (Last 90 days, all aircraft), 70 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	CESSNA	Registration:	N861MA
Model/Series:	208 B	Aircraft Category:	Airplane
Year of Manufacture:	2000	Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	208B0825
Landing Gear Type:	Tricycle	Seats:	11
Date/Type of Last Inspection:	10/20/2013, AAIP	Certified Max Gross Wt.:	7449 lbs
Time Since Last Inspection:		Engines:	1 Turbo Prop
Airframe Total Time:	11828 Hours	Engine Manufacturer:	P&W
ELT:	Installed, not activated	Engine Model/Series:	PT6A SER
Registered Owner:	MOKULELE FLIGHT SERVICE INC	Rated Power:	675 hp
Operator:	MOKULELE FLIGHT SERVICE INC	Air Carrier Operating Certificate:	Commuter Air Carrier (135); On-demand Air Taxi (135)
Operator Does Business As:		Operator Designator Code:	MK9A

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Dusk
Observation Facility, Elevation:	OGG, 45 ft msl	Observation Time:	1854 HST
Distance from Accident Site:	13 Nautical Miles	Direction from Accident Site:	360°
Lowest Cloud Condition:	Scattered	Temperature/Dew Point:	26° C / 18° C
Lowest Ceiling:	None	Visibility	10 Miles
Wind Speed/Gusts, Direction:	5 knots, 20°	Visibility (RVR):	
Altimeter Setting:	29.96 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Kahului, HI (OGG)	Type of Flight Plan Filed:	IFR
Destination:	Waimea-Kohala, HI (MUE)	Type of Clearance:	IFR
Departure Time:	1830 HST	Type of Airspace:	Class G

Airport Information

Airport:	Kahului (OGG)	Runway Surface Type:	Asphalt
Airport Elevation:	54 ft	Runway Surface Condition:	Dry
Runway Used:	N/A	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced Landing

Wreckage and Impact Information

Crew Injuries:	2 None	Aircraft Damage:	Substantial
Passenger Injuries:	8 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	10 None	Latitude, Longitude:	21.100000, -156.716667 (est)

Administrative Information

Investigator In Charge (IIC):	Albert P Nixon	Adopted Date:	10/28/2015
Additional Participating Persons:	Herman Rios; FAA; Honolulu, HI Edward Santa-Elena; FAA; Honolulu, HI Henry Soderlund; Cessna; Wichita, KS Dan Stevens; Mokulele Airlines; Kailua-Kona, HI		
Publish Date:	11/07/2016		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=88252		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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