National Transportation Safety Board
Aviation Accident Final Report

Location:	Bryans Corner, OK	**Accident Number:**	CEN13FA080
Date & Time:	11/29/2012, 1858 CST	**Registration:**	N1324G
Aircraft:	CESSNA 208B	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Minor
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Scheduled		

Analysis

The airplane was operating as a night, scheduled cargo flight. The pilot reported that, during departure climb, the engine made a loud bang and that the propeller then spooled down toward feather and stopped. The pilot attempted to restart the engine but was unsuccessful. During the forced landing approach to a two-lane highway, the airplane struck a power line. The airplane then landed hard and subsequently exited the highway on the left side, and the left wing struck a power pole.

A postaccident examination of the engine revealed that one of the compressor turbine blades had fractured near the root due to fatigue cracking. The fractured compressor turbine blade released into the engine path and subsequently impacted adjacent compressor turbine blades and downstream components, which caused the loss of engine power. The source of the fatigue crack could not be determined due to secondary damage sustained to the fracture surface. All other mechanical damage to the engine was consistent with collateral damage sustained subsequent to the release of the compressor turbine blade.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The total loss of engine power as a result of a fractured compressor turbine blade due to fatigue cracking.

Findings

Aircraft	Turbine section - Failure (Cause)
	Turbine section - Fatigue/wear/corrosion (Cause)

Factual Information

HISTORY OF FLIGHT

On November 29, 2012, about 1858 central standard time, a Cessna 208B airplane, N1324G, was substantially damaged during an off-airport landing near Bryans Corner, Oklahoma, following a loss of engine power. The airline transport pilot, who was the sole occupant, sustained minor injuries. The airplane was registered to Aero Leasing Corporation and operated by Martinaire Aviation LLC, under the provisions of 14 Code of Federal Regulations Part 135. Night visual meteorological conditions prevailed for the cargo flight, which departed from Guymon Municipal Airport (GUY), Guymon, Oklahoma and had an intended destination of West Woodward Airport, Woodward, Oklahoma.

While climbing through about 7,000 feet above mean sea level, the pilot reported that a loud bang occurred, followed by the propeller spooling down towards feather and stopping. The pilot attempted an unsuccessful air-start and an unsuccessful electric start. During the forced landing approach to a two lane highway, the airplane hit a power line. The airplane subsequently made a hard landing, exited the highway on the left side, and struck a power pole, which damaged the left wing.

PERSONNEL INFORMATION

The pilot, age 46, held an airline transport pilot certificate with airplane single-engine land, multiengine land, and instrument ratings. On April 2, 2012, the pilot was issued a Class 1 medical certificate, with no restrictions. The pilot reported 5,099 hours of total flight experience, with 47 hours in the last 30 days and 44 hours in the make and model of the accident airplane.

AIRCRAFT INFORMATION

The Cessna 208B, two seat, high wing, fixed landing gear airplane, was manufactured in 1999. It was powered by one Pratt & Whitney PT6A-114A, 675 shaft horsepower engine and equipped with a three bladed constant-speed McCauley propeller. A standard airworthiness certificate was issued for the airplane on November 19, 1999. On November 28, 2012, an airframe logbook entry revealed that the airplane's total time was 7,371.8.

The airplane was maintained on an approved Airworthiness Inspection Program (AAIP). The AAIP 400 hour inspection was performed on the airplane on September 19, 2012, with a total of 7305 hours. During this inspection, a borescope inspection of engine hot section components was performed, with no defects observed. The operator utilized an engine data trending program, which captured engine data through November 28, 2012. No anomalies were observed with the engine data.

WEATHER INFORMATION

The weather observation station at GUY, about 26 miles west of the accident site, reported the following weather conditions at 1853: wind 110 degrees at 4 knots, visibility 10 miles, clear skies, temperature 15 degrees Celsius (C) dew point minus seven degrees C, altimeter setting 29.98 inches of mercury. Moonset time was 1752.

WRECKAGE AND IMPACT INFORMATION

Representatives from the National Transportation Safety Board (NTSB), Federal Aviation

Administration (FAA), Cessna Aircraft Company, Pratt & Whitney Canada (P&WC), and the operator Martinaire were present for the documentation and investigation of the accident site.

Dirt and grass-like organic debris was found in the entire length of the engine air inlet. The reduction gearbox, propeller governor and associated control linkage, exhaust case, combustor case, and compressor housing were undamaged. The inlet plenum was coated with dust and organic material. The accessory gearbox, propeller cambox, power control, and reversing linkage were undamaged.

The airframe exhaust ducts were removed and the compressor and power turbines were examined. Bright re-solidified metal splatter was seen on the inner surface of the engine and airframe exhaust duct. The outer half-span of all the power turbine blades were missing. Some power turbine blades were melted at half-span in a sequential manner and others were fractured at half-span also in a sequential manner.

The compressor turbine (CT) blades were visible due to the missing power turbine guide vanes. The tips of all the blades were rounded off and burned. The trailing edges of all the blades were fractured, consistent with hard body impact. The power turbine nozzle vanes exhibited impact damage and molten metal deposit on the downstream side of the airfoil.

TESTS AND RESEARCH

On January 9-10, 2013, representatives from the NTSB, FAA, Cessna Aircraft Company, P&WC, and the operator Martinaire convened at the Pratt & Whitney Canada Service Investigation Facilities at St. Hubert, Quebec, Canada.

Examination of the engine revealed the CT blade airfoils were fractured from their roots to about ½ span. All of the blades displayed gouges, battering, and burning. The CT blade at position No. 25 was fractured near the root, and the fracture surface displayed smooth features, with melting and heat erosion, from the trailing edge to about ½ chord. The blade was fractured in fatigue initiating from the airfoil trailing edge area, approximately 0.2 inches above the blade platform, extending to approximately mid-chord, followed by fracture in tensile overload.

The initiation site was not determined due to secondary damage to the trailing edge from resultant debris. The fracture surface features were coarsened and solutioned, consistent with exposure to elevated temperatures after the turbine blade failure event. Metallographic examination of the trailing edge revealed no material anomalies. The blade material and airfoil trailing edge thickness were determined to be within drawing requirements. The remainder of the blades were determined to be fractured in overload, with no similar features to the fracture of blade No. 25. Sectioning of a sample blade for microstructure evaluation showed characteristics of exposure to elevated temperatures.

HISTORY OF PT6A-114/114A COMPRESSOR TURBINE BLADE FAILURES

According to Pratt & Whitney Canada (PWC), the PT6A-114/114A engine has accumulated 15 million flying hours and the primary In-Flight-Shut-Down contributor is CT blade distress. According to PWC / Cessna Operator Conference documentation for 2012 and 2013, CT blade distress is caused by:

Operational Issues

• Inadvertent cut-off & relight over-temperature

• Inappropriate use of Emergency Power Lever

• Non-compliance with pilot operating handbook (POH)

– Excessive power use

– Different mission profile

Maintenance Issues

• CT vane ring condition – burning and inadequate borescope inspection

• Sulphidation or chemical attack by environmental operation

• Aircraft gauges inaccuracy

None of the above classic factors, however, could be directly related to the failure mode noted on this engine. Blade No. 25 sustained a fatigue failure which originated at the trailing edge and progressed forward until the sudden overload fracture. During normal operation, CT blades sustain high heat (CT blades glow red-hot at take-off power) and high tensile loads due to high rotational speeds. According to PWC, blades that have been used throughout 2 entire overhaul cycles are near the end of their fatigue life. Rare CT blade fatigue failures have been known to occur on -114 engines. One historical event was attributed to a distorted vane ring which transferred a gas flow disturbance (one-per-rev) to the CT blades, setting up a harmonic blade vibration that eventually led to a fatigue fracture. The maintenance review of the event engine showed that at 6,144 hours a streaking fuel nozzle caused hot section distress requiring repair of the large exit duct (LED) while CT vane ring was reinstalled. Operation with a heat damaged LED can distort the air flow and may have initiated the fatigue crack at that time. Additionally, a small unidentified distortion of the reinstalled CT vane ring may have set up a small one-per-rev condition. Either distortion may have initiated a fatigue crack. Once initiated in the blade material, this fatigue crack would eventually grow, although slower, even if the one-per-rev condition is corrected.

Introduction of SB1669 – New Single Crystal CT Blade P/N 3072791-01

The event engine had P/N 3045741 blades which are made of Inconel IN100 material. They are directionally solidified, which ensures that grain growth of the metal is in the axial direction of the blade. Grain boundaries still exist, however leading to sensitivity, even if minor, to creep and cracks. In 2009, PWC introduced a single crystal blade, made of CMSX-6 material, via service bulletin SB1669. As the name suggests, a single crystal blade eliminates grain boundaries in the part making it more robust in resisting damage and heat. All new blades installed in engines and sold will be of the new P/N.

On November 13, 2013, Transport Canada Civil Aviation issued an airworthiness directive (AD) incorporating the new single crystal CT blades. On October 8, 2014, the FAA issued an AD 2014-17-08, which mandates a continuing repetitive inspection of pre SB1669 blades and the eventual incorporation of the new single crystal blade.

History of Flight

Initial climb	Loss of engine power (total) (Defining event)
Landing	Off-field or emergency landing Hard landing

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	**Age:**	46
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last Medical Exam:**	04/02/2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	11/15/2012
Flight Time:	5099 hours (Total, all aircraft), 44 hours (Total, this make and model), 4934 hours (Pilot In Command, all aircraft), 106 hours (Last 90 days, all aircraft), 47 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	CESSNA	**Registration:**	N1324G
Model/Series:	208B	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Utility	**Serial Number:**	208B0777
Landing Gear Type:	Tricycle	**Seats:**	12
Date/Type of Last Inspection:	09/19/2012, AAIP	**Certified Max Gross Wt.:**	8750 lbs
Time Since Last Inspection:	66 Hours	**Engines:**	1 Turbo Prop
Airframe Total Time:	7371 Hours	**Engine Manufacturer:**	P&W
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	PT6A-114A
Registered Owner:	AERO LEASING	**Rated Power:**	675 hp
Operator:	Martinaire Aviation LLC	**Air Carrier Operating Certificate:**	On-demand Air Taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	KGUY, 3123 ft msl	**Observation Time:**	1853 CST
Distance from Accident Site:	26 Nautical Miles	**Direction from Accident Site:**	280°
Lowest Cloud Condition:	Clear	**Temperature/Dew Point:**	15°C / -7°C
Lowest Ceiling:	None	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	4 knots, 110°	**Visibility (RVR):**	
Altimeter Setting:	29.98 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Guymon, OK (GUY)	**Type of Flight Plan Filed:**	IFR
Destination:	West Woodward, OK (WWR)	**Type of Clearance:**	IFR
Departure Time:	1836 CST	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Minor	**Latitude, Longitude:**	36.616667, -100.970278

Administrative Information

Investigator In Charge (IIC):	Michael J Folkerts	**Adopted Date:**	03/10/2015
Additional Participating Persons:	Gordon Morris; Federal Aviation Administration; Lubbock, TX Ricardo Asensio; Cessna Aircraft Company; Wichita, KS Dave Keenan; Federal Aviation Administration; Washington, DC Harry Reichel; National Transportation Safety Board; Washington, DC Marc Gratton; Pratt and Whitney Canada; Montreal, Mark Hamilton; Transportation Safety Board Canada; Ottawa, Ed Gray; Martinaire Aviation LLC; Addison, TX		
Publish Date:	03/10/2015		
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=85706		

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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