



National Transportation Safety Board Aviation Accident Final Report

Location:	Verdigris, OK	Accident Number:	CEN15LA180
Date & Time:	03/24/2015, 1507 CDT	Registration:	N106BZ
Aircraft:	CESSNA 208B	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (partial)	Injuries:	1 Minor, 1 None
Flight Conducted Under:	Part 91: General Aviation - Flight Test		

Analysis

The pilot reported that, during the postmaintenance test flight, the turboprop engine lost power. The airplane was unable to maintain altitude, and the pilot conducted a forced landing, during which the airplane was substantially damaged.

The engine had about 9 total flight hours at the time of the accident. A teardown of the fuel pump revealed that the high-pressure drive gear teeth exhibited wear and that material was missing from them, whereas the driven gear exhibited little to no visible wear. A metallurgical examination of the gears revealed that the damaged drive gear was made of a material similar to 300-series stainless steel instead of the harder specified M50 steel, whereas the driven gear was made of a material similar to the specified M50 steel. Subsequent to these findings, the airplane manufacturer determined that the gear manufacturer allowed three set-up gears made from 300-series stainless steel to become part of the production inventory during the manufacturing process. One of those gears was installed in the fuel pump on the accident airplane, and the location of the two other gears could not be determined. Based on the evidence, it is likely that the nonconforming gear installed in the fuel pump failed because it was manufactured from a softer material than specified, which resulted in a loss of fuel flow to the engine and the subsequent loss of engine power.

The manufacturer subsequently inspected its stock of gears and issued notices to customers that had engines with fuel pumps installed with the same part number gear set as the one installed on the accident airplane. The manufacturer also issued a service information letter and service bulletins regarding the fuel pump gear set for engines used in civilian and military applications. As of the date of this report, the two remaining gears have not been located.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The fuel pump gear manufacturer's allowance of set-up gears made from a nonconforming

material to be put in the production inventory system, the installation of a nonconforming gear in the accident airplane's production fuel pump, and the gear's failure, which resulted in a loss of fuel flow to the engine and the subsequent loss of engine power.

Findings

Aircraft	Fuel pump - Fatigue/wear/corrosion (Cause) Fuel - Not specified (Cause)
Organizational issues	Parts/tools tracking - Manufacturer (Cause)

Factual Information

On March 24, 2015, about 1507 central daylight time, a Cessna 208B, N106BZ, collided with terrain and trees during an off airport forced landing in Verdigris, Oklahoma. The forced landing was a result of a loss of engine power during an en route climb. The airline transport rated pilot received minor injuries and the passenger/mechanic was not injured. The airplane was substantially damaged. The aircraft was owned and operated by a private individual under the provisions of 14 Code of Federal Regulations Part 91 as post maintenance test flight. Visual meteorological conditions prevailed for the flight and no flight plan was filed. The flight originated from the Tulsa International Airport (TUL), Tulsa, Oklahoma, at 1500.

The pilot stated they were on a post maintenance test flight when the accident occurred. He stated they first noticed the exhaust gas temperature (EGT) was 640 degrees and the engine torque was low, about 65%, but steady. As they continued to climb, the pilot noticed the EGT and engine torque began to decrease.

The pilot determined that he could not make it back to TUL so he decided to land at a nearby private airstrip. However he was unable to maintain sufficient altitude to reach the airstrip, so he chose a field for the forced landing. Shortly after touching down, the airplane impacted trees, completely severing the left wing from the fuselage and partially severing the right wing from the fuselage.

The airplane was equipped with a Honeywell TPE331-12JR engine, serial number P123178. Maintenance records show the new engine was installed on March 10, 2015, in accordance with STC SA10841SC. The engine had been flown about 9 hours since the engine installation.

The initial on-scene inspection of the airplane was conducted under the supervision of a Federal Aviation Administration Inspector. During this inspection, the fuel pressure line from the bottom of the fuel filter housing was removed. No fuel was visible in either the fuel line or the filter bowl. The main fuel line was disconnected from the engine driven low pressure pump. There was no fuel in the pump inlet and very little fuel drained from the line. The fuel line was removed at the firewall fuel filter and a little fuel was drained from the line, but not enough to have filled the line; however, there was a strong odor of fuel near the firewall. About 4 gallons of fuel were drained from the fuel reservoir tank when the airplane was recovered from the field. In addition, about 40 gallons of fuel were drained from the left wing fuel tank and 20 gallons of fuel were drained from the right wing fuel tank.

The aircraft was recovered and examined at the facilities of Air Salvage of Dallas. An examination of the airframe and flight controls did not reveal any failure or malfunction which would have resulted in the pilot's inability to control the airplane. The right wing, vertical stabilizer, rudder, elevator, and horizontal stabilizer had been removed from the airplane during the retrieval process. The flap jackscrew indicated the flaps were extended between 10 and 15 degrees. The Hobbs hour meter that was installed at the time of the engine installation indicated 9.6 hours.

The left and right wing fuel valves were in the ON position. Continuity of the fuel system was verified from the reservoir tank to the fuel line going to the engine. There were no pre-impact anomalies found with the aircraft fuel system which would have prevented fuel from the aircraft fuel tanks from getting to the engine. An external examination of the engine did not reveal any evidence of an uncontained failure or fire damage. The engine did show evidence of

dirt and vegetation ingestion. The engine was then shipped to Honeywell for an operational check/teardown.

On May 12, 2015, the engine was examined at Honeywell Aerospace. An overall visual examination of the engine did not reveal any preimpact anomalies that would have prevented normal operation. The propeller shaft was rotated which resulted in corresponding rotation of the first-stage compressor impeller, third stage turbine rotor, and gearbox oil scavenge pump gerotor indicating continuity throughout the engine. A boroscope examination of the engine did not reveal any anomalies.

The air flow path of the engine was pressure washed and the engine was staged in a test cell. Without changing any of the original fuel and engine control components, all initial engine start attempts were unsuccessful. The fuel pump and fuel control unit (FCU) were changed out with surrogate engineering components. None of these changes resulted in a successful engine start. It was noted that the compressor discharge pressure was less than 2 psi while dry motoring the engine which is consistent with the amount of earthen debris found in the engine core, at the entrance to the second-stage compressor impeller, at the exit from the second-stage compressor vanes, and at the entrance to the combustor.

The fuel pump, part number 897390-8, series 3, serial number P1604, was disassembled. There was wear and material missing from the gear teeth of the high pressure drive gear. The driven gear exhibited little to no visible wear. A metallurgical examination of the gears revealed the damaged drive gear was made of a material similar to 300 series stainless steel instead of the specified M50 steel which is a harder material. The driven gear was made of a material similar to the specified M50 steel. The gear housing exhibited wear consistent with the interface of material from the worn drive gear against the walls of the housing during operation of the pump.

As a result of the metallurgical findings, Honeywell initiated an internal investigation with their supply vendor, Shimadzu, who manufactured the gear sets for the fuel pump. It was determined that the manufacturer used three set-up gears made from 300 series stainless steel during the manufacturing process. One of those gears was installed in the fuel pump on the accident airplane and the two remaining gears were not accounted for. Honeywell inspected their stock of gears and issued Notices of Escape to their customers who had engines that had fuel pumps installed with the same part number gear sets as the accident airplane. Honeywell also issued a Service Information Letter and Service Bulletins TPE331-72-A2255, TPE331-72-A2256 (military use), and TPE331-72-A2254 (military use) regarding the fuel pump gear set.

As of the date of this report, the two remaining gears have not been located.

The FCU, part number 897801-3 (Honeywell) 8070-471 (Woodward), serial number 19357690, was examined at Woodward on June 9, 2015. The stub shaft (drive spline) could not be turned by hand. The shaft was loosened with a wrench and was subsequently able to be turned. No external damage was noted on the shaft. A new inlet screen was placed in the FCU as the original one was removed at Honeywell and was found to contain metal contamination. The FCU was placed on a test bench with a clean membrane filter installed. The FCU was tested and most of the test points were out of limits on the Accel and Power Lever schedules. The filter was removed from the discharge flow line and it contained a significant amount of metallic debris. The debris was not magnetic. The FCU was then disassembled. Both the overspeed and underspeed governor assemblies were rough when rotated and small metal

particles were found on the ballheads, valve plungers, and valve sleeves. The bypass valve was disassembled and metal debris was found on the bypass plunger. Scoring was observed on the overspeed governor pilot valve. Metal shavings found throughout the FCU in particular on the fly weight bearings and on the bypass valve are consistent with metal from the fuel pump drive gear.

History of Flight

Enroute-climb to cruise	Loss of engine power (partial) (Defining event)
Landing-flare/touchdown	Collision with terr/obj (non-CFIT)

Pilot Information

Certificate:	Airline Transport; Foreign	Age:	39
Airplane Rating(s):	Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With Waivers/Limitations	Last FAA Medical Exam:	05/12/2014
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	02/08/2015
Flight Time:	6500 hours (Total, all aircraft), 970 hours (Total, this make and model), 5500 hours (Pilot In Command, all aircraft), 22 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	CESSNA	Registration:	N106BZ
Model/Series:	208B	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	208B0106
Landing Gear Type:	Retractable - Tricycle	Seats:	2
Date/Type of Last Inspection:	03/11/2015, Annual	Certified Max Gross Wt.:	7449 lbs
Time Since Last Inspection:	9 Hours	Engines:	2 Turbo Prop
Airframe Total Time:	11443 Hours as of last inspection	Engine Manufacturer:	Honeywell
ELT:	C126 installed, activated	Engine Model/Series:	TPE331-12JR
Registered Owner:	Bank of Utah Trustee	Rated Power:	900 hp
Operator:	On file	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	TUL, 650 ft msl	Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:		Visibility	10 Miles
Lowest Ceiling:	Broken / 6000 ft agl	Visibility (RVR):	
Wind Speed/Gusts:	11 knots / 21 knots	Turbulence Type Forecast/Actual:	/ None
Wind Direction:	220°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.74 inches Hg	Temperature/Dew Point:	28° C / 13° C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Tulsa, OK (TUL)	Type of Flight Plan Filed:	None
Destination:	Tulsa, OK (TUL)	Type of Clearance:	VFR
Departure Time:	1500 CDT	Type of Airspace:	Class E

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:	1 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Minor, 1 None	Latitude, Longitude:	36.267500, -95.630833 (est)

Administrative Information

Investigator In Charge (IIC):	Pamela S Sullivan	Report Date:	10/19/2015
Additional Participating Persons:	Dan Donnelly; FAA; Oklahoma City, OK Marlin Kruse; Honeywell; Phoenix, AZ Andrew Hall; Textron Aviation; Wichita, KS Bobby Bishop; Texas Turbine; Denison, TX Steve Krugler; Woodward; Rockford, IL		
Publish Date:	10/19/2015		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=90927		

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.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available [here](#).