



# Aviation Investigation Final Report

---

<b>Location:</b>	Verdigris, Oklahoma	<b>Accident Number:</b>	CEN15LA180
<b>Date &amp; Time:</b>	March 24, 2015, 15:07 Local	<b>Registration:</b>	N106BZ
<b>Aircraft:</b>	Cessna 208B	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Loss of engine power (partial)	<b>Injuries:</b>	1 Minor, 1 None
<b>Flight Conducted Under:</b>	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

<b>Aircraft</b>	Fuel pump - Fatigue/wear/corrosion
<b>Organizational issues</b>	Parts/tools tracking - Manufacturer
<b>Aircraft</b>	Fuel - Not specified

## Factual Information

### History of Flight

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

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.

## Pilot Information

<b>Certificate:</b>	Airline transport; Foreign	<b>Age:</b>	39
<b>Airplane Rating(s):</b>	Single-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	5-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 2 With waivers/limitations	<b>Last FAA Medical Exam:</b>	May 12, 2014
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	February 8, 2015
<b>Flight Time:</b>	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

<b>Aircraft Make:</b>	Cessna	<b>Registration:</b>	N106BZ
<b>Model/Series:</b>	208B	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	1988	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	208B0106
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	2
<b>Date/Type of Last Inspection:</b>	March 11, 2015 Annual	<b>Certified Max Gross Wt.:</b>	7449 lbs
<b>Time Since Last Inspection:</b>	9 Hrs	<b>Engines:</b>	1 Turbo prop
<b>Airframe Total Time:</b>	11443 Hrs as of last inspection	<b>Engine Manufacturer:</b>	Honeywell
<b>ELT:</b>	C126 installed, activated	<b>Engine Model/Series:</b>	TPE331-12JR
<b>Registered Owner:</b>	On file	<b>Rated Power:</b>	900 Horsepower
<b>Operator:</b>	On file	<b>Operating Certificate(s) Held:</b>	None

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	TUL,650 ft msl	<b>Distance from Accident Site:</b>	
<b>Observation Time:</b>		<b>Direction from Accident Site:</b>	
<b>Lowest Cloud Condition:</b>		<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	Broken / 6000 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	11 knots / 21 knots	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	220°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	29.73 inches Hg	<b>Temperature/Dew Point:</b>	28°C / 13°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Tulsa, OK (TUL )	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	Tulsa, OK (TUL )	<b>Type of Clearance:</b>	VFR
<b>Departure Time:</b>	15:00 Local	<b>Type of Airspace:</b>	Class E

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 Minor	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>	1 None	<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	1 Minor, 1 None	<b>Latitude, Longitude:</b>	36.267501,-95.630836(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Sullivan, Pamela
<b>Additional Participating Persons:</b>	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
<b>Original Publish Date:</b>	October 19, 2015
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB did not travel to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=90927">https://data.nts.gov/Docket?ProjectID=90927</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).