



Aviation Investigation Final Report

Location:	Pocatello, Idaho	Accident Number:	WPR14FA091
Date & Time:	January 9, 2014, 15:15 Local	Registration:	N903SR
Aircraft:	CIRRUS DESIGN CORP SR22	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (partial)	Injuries:	2 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, at 17,000 ft mean sea level, the engine suddenly started vibrating severely and partially lost power. He declared an emergency and an air traffic controller provided vectors for an instrument approach into a nearby airport. The pilot stated that the vibrations increased in severity and available engine power was decreasing. The pilot adjusted the mixture and throttle to no effect; he did not cycle the magnetos because he didn't want to risk losing engine power completely. After descending through the 2,000-ft broken cloud layer on the instrument approach, he determined that the airplane was not going to make it to the runway. At 1,000 ft above ground level, he deployed the Cirrus Airframe Parachute System, which brought the airplane down into an open field. He and his passenger rapidly exited the airplane before it was dragged away by the parachute in a 30-knot wind.

Engine data indicated that, 2 hours 56 minutes into the flight, the engine rpm started to fluctuate. Two minutes later, the cylinder head temperature (CHT) of the No. 6 cylinder increased and peaked at 331 degrees F; 7 minutes later, it had decreased to 248 degrees F. At this point, the CHT for the No. 3 cylinder increased to 315 degrees F. About 3 hours 13 minutes into the flight, the engine exhaust gas temperatures (EGT) of cylinder Nos. 2, 4, 5, and 6 dropped off while the EGTs for cylinder Nos. 1 and 3 increased.

Examination of the left and right magnetos revealed that the right magneto distributor drive gear had 10 teeth fractured off in the same gear sector, and the left magneto had 3 teeth broken in the same sector; all of the fracture surfaces on both gears exhibited crack arrest marks and river patterns consistent with progressive fracture.

Based on the right magneto distributor gear damage, it is likely that the failure of the distributor drive gear teeth allowed the magneto distributor to stop rotating in proper firing order and allowed unsequenced repeated firing of the No. 6 cylinder and later the No. 3 cylinder, as reflected by the increase in CHT, which resulted in severe engine vibration and a partial loss of power. The unsequenced firing of the Nos. 6 and 3 cylinders also precipitated erratic power pulses through the engine that

affected the left magneto distributor drive gear, which in turn initiated the left magneto distributor gear teeth failure.

The pilot operating handbook lists the steps the pilot should take in the event of an engine partial power loss. Step seven of the engine partial power loss emergency procedures calls for the pilot to cycle through the left and right magnetos using the ignition switch. It is likely that, if the pilot had selected the left magneto after the initial indications of partial power loss and vibration, power could have been restored by isolating the right magneto and operating the engine entirely on the left magneto.

Probable Cause and Findings

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

The distributor gear teeth failure of the right magneto that resulted in severe engine vibration and partial loss of engine power, which progressively led to the failure of the left magneto distributor drive gear teeth. Contributing to the airplane's continued operation with the partial loss of engine power was the pilot's failure to execute all steps in the engine partial power loss procedure.

Findings

Aircraft	Magneto/distributor - Malfunction
Personnel issues	Incorrect action performance - Pilot
Personnel issues	Use of checklist - Pilot

Factual Information

History of Flight

Enroute	Loss of engine power (partial) (Defining event)
Approach-IFR final approach	Off-field or emergency landing

On January 9, 2014, at 1515 mountain standard time, a Cirrus Design Corp SR22, N903SR, experienced severe engine vibrations and a partial loss of engine power during cruise flight near Pocatello, Idaho. The pilot executed a forced landing utilizing the Cirrus Airframe Parachute System (CAPS). The private pilot and single passenger received minor injuries, and the airplane was substantially damaged. The airplane was registered to, and operated by, Nylund Imports Incorporated, under the provisions of 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules (IFR) flight plan. The flight originated from Centennial Airport, Denver, Colorado, at 1153, and was destined for Sun Valley, Idaho.

The pilot reported that while passing Pocatello at 17,000 feet mean sea level (msl), the engine suddenly started vibrating severely in conjunction with a partial loss of power. He declared an emergency and Salt Lake Center provided vectors to the final approach course for the Pocatello instrument landing system (ILS) RWY 21 approach. The pilot stated that the vibrations increased in severity and available engine power was decreasing. The pilot adjusted the mixture and throttle to no effect. He did not switch between the two magnetos because he didn't want to risk losing engine power completely. After descending through the 2,000-foot broken cloud layer on the ILS approach, engine instruments indicated that only 20% power was being produced, and he determined that the airplane was not going to make it to the runway. At 1,000 feet above ground level (agl) he shut down the engine and deployed the Cirrus Airframe Parachute System (CAPS), which brought the airplane down into an open field. He and his passenger rapidly egressed before the airplane was dragged away by the parachute in a 30-knot wind.

Pilot Information

Certificate:	Private	Age:	58
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	3-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	January 30, 2012
Occupational Pilot:	No	Last Flight Review or Equivalent:	September 14, 2013
Flight Time:	2159 hours (Total, all aircraft), 2046 hours (Total, this make and model), 2134 hours (Pilot In Command, all aircraft)		

The pilot, age 58, held a private pilot certificate with ratings for airplane single-engine land, multi-engine land, and instrument airplane issued December 28, 2003, and a third-class medical certificate issued January 30, 2012, with the limitation that he must have glasses available for near vision. The pilot reported having 2,159 total flight hours, with 2,046 hours in the accident airplane make and model, and 42 hours with in the previous 90 days.

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	Registration:	N903SR
Model/Series:	SR22	Aircraft Category:	Airplane
Year of Manufacture:	2007	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	2465
Landing Gear Type:	Tricycle	Seats:	4
Date/Type of Last Inspection:	December 15, 2013 Annual	Certified Max Gross Wt.:	3400 lbs
Time Since Last Inspection:	10.1 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	860.4 Hrs at time of accident	Engine Manufacturer:	CONT MOTOR
ELT:	C126 installed, activated, did not aid in locating accident	Engine Model/Series:	IO-550-N
Registered Owner:	On file	Rated Power:	310 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

The four-seat, low-wing, fixed-gear airplane, serial number 2465, was manufactured in 2007. It was powered by a Continental Motors IO-550-N46B, 310-hp engine that had been modified with Tornado Alley turbonormalizing system by Cirrus and equipped with Hartzell model PHC-J3YFIN, 3-bladed composite constant speed propeller. Review of the airplane maintenance records show that an annual inspection was performed on December 13, 2013, at a total airframe and engine time of 850.3 hours. On September 2, 2010, at 496.2 engine hours, both magnetos were overhauled, and reinstalled on the engine.

Engine Failure Procedures

The SR22 Pilot Operating Handbook, Section 3, Emergency Procedures, dictate the following for Engine Partial Power Loss.

"The following procedure provides guidance to isolate and correct some of the conditions contributing to a rough running engine of a partial power loss:

1. Air Conditioner – OFF
2. Fuel Pump – BOOST

Selecting BOOST on may clear the problem if vapor in the injection lines is the problem or if the engine-driven fuel pump has partially failed. The electric fuel pump will not provide sufficient fuel pressure to supply the engine if the engine-driven fuel pump completely fails.

3. Fuel Selector – SWITCH TANKS

Selecting the opposite fuel tank may resolve the problem if fuel starvation or contamination in one tank was the problem.

4. Mixture - CHECK appropriate for flight conditions

5. Power Lever – SWEEP. Sweep the Power Lever through the range as required to obtain smooth operation and required power.

6. Alternate Induction Air – ON

7. Ignition Switch – BOTH, L, then R. Cycling the ignition switch momentarily from BOTH to L and then R may help identify the problem. An obvious power loss in single ignition operation indicates magneto or spark plug trouble. If engine does not smooth out in several minutes, try a richer mixture setting. Return ignition to BOTH positions unless extreme roughness dictates the use of a single magneto.

8. Land as soon as practical."

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KPIH,4452 ft msl	Distance from Accident Site:	2 Nautical Miles
Observation Time:	21:53 Local	Direction from Accident Site:	30°
Lowest Cloud Condition:		Visibility	10 miles
Lowest Ceiling:	Broken / 2500 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	20 knots / 29 knots	Turbulence Type Forecast/Actual:	/
Wind Direction:	250°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.85 inches Hg	Temperature/Dew Point:	1°C / -3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Denver, CO (KAPA)	Type of Flight Plan Filed:	IFR
Destination:	Sun Valley, ID (KSUN)	Type of Clearance:	IFR
Departure Time:	12:00 Local	Type of Airspace:	Class D

Airport Information

Airport:	Pocatello Regional Airport KPIH	Runway Surface Type:	
Airport Elevation:	4452 ft msl	Runway Surface Condition:	
Runway Used:		IFR Approach:	ILS
Runway Length/Width:		VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:	1 Minor	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 Minor	Latitude, Longitude:	42.860023,-112.63063(est)

Tests and Research

Primary Flight Display and Multi-Function Display Data

The Primary Flight Display (PFD) unit includes a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displays aircraft flight data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit has external pitot-static inputs for altitude, airspeed, and vertical speed information. Each PFD contains two flash memory devices mounted on a riser card. The flash memory stores information the PFD unit uses to generate the various PFD displays. Additionally, the PFD has a data logging function which is used by the manufacturer for maintenance and diagnostics.

The Multi-Function Display (MFD) unit is able to display checklists, terrain/map information, approach chart information, and other aircraft/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data.

Based on the data downloaded from the PFD & MFD the following event timeline was established.

Time(approx) Elapsed Time Event

11:44:24 0:00 Engine Start

11:53:06 0:08:42 Take Off

14:38:30 2:54:06 Pressure alt starts to decrease (descent starts)

14:41:18 2:56:54 RPM starts to decrease/fluctuate

14:42:00 2:57:36 Increase fuel flow - pilot manipulates the mixture, then manipulates the throttle indicated by RPM changes

14:42:24 2:58:00 CHT* in No. 6 Cyl starts to trend upward

14:44:12 2:59:42 CHT in No. 6 Cyl Peaks 331° F

14:47:00 3:02:36 CHT No. 6 decreases to ~280°F

14:51:00 3:06:36 CHT No. 6 starts to trend upward ~248°F

14:52:18 3:07:54 CHT No. 3 starts to trend upward ~250°F

14:56:30 3:12:06 CHT No. 3 increases above the average peaking at~315°F

14:58:00 3:13:36 EGT** 2,4,5,6, drop off. EGT 1 & 3 increase.

* CHT- cylinder head temperature

**EGT - exhaust gas temperature

The full data download and NTSB Vehicle Recorders Laboratory report are located in the official docket of this investigation.

Engine Examination

On April 15, 2014, the engine was examined at Continental Motors, Inc, under the supervision of the NTSB investigator-in-charge (IIC) with technical representatives from Continental Motors, Cirrus Aircraft, and Tornado Alley.

The engine was removed from the shipping crate and placed on an engine stand for examination. The turbochargers and associated hardware had been removed and placed in the shipping container for shipping. The engine was visually examined and the crankshaft was rotated to verify engine drive train continuity. During the crankshaft rotation both magneto drives were observed through the pressurization port on the magneto housing. Both distributor gears were not moving in either magneto during the crankshaft rotation. The engine driven magneto metal drive gear interfaces with the light weight nylon composite distributor gear during operation. It was noted that the No. 3 ignition leads were producing a spark after the No. 1 ignition leads, indicating an improper firing order. The magnetos were removed for further examination. Examination of the magneto distributor gears revealed that the nylon composite gear teeth, 10 teeth on the right magneto and 3 teeth on the left magneto, had broken off.

The fractured distributor gear teeth were clocked on an exemplary distributor gear in an exemplary magneto. The magneto drive shaft was rotated in a clockwise direction until the area of the separated teeth aligned with the drive gear. Doing so revealed that the separated gear teeth on the right magneto would have correlated to an area that placed the distributor gear electrode between the #6 and #3 cylinders' distributor block electrodes. Doing so on the left magneto revealed that the separated gear teeth would have correlated to an area that placed the distributor gear electrode between the #1 and #6 cylinders' distributor block electrodes.

New magnetos were placed on the engine and the turbocharger system reinstalled. The engine was then successfully test run to full power in a test cell, and no anomalies were noted.

Magneto Distributor Gear Examination

The left and right nylon magneto distributor drive gears and separated teeth were sent to the NTSB Materials Laboratory for further investigation. The magneto distributor had undergone 860.4 hours at the time of the accident. The last magneto inspection was performed at 496.2 hours on September 2, 2009. The required inspection interval is 500 hours.

Three of the teeth on the left gear had fractured off. The fracture surfaces of all three broken gear teeth exhibited crack arrest marks and radial river patterns that were consistent with progressive failure. All three fracture surfaces exhibited features consistent with crack propagation in the same direction.

Examination of the right gear showed 10 of the teeth had fractured. Similar to the left gear, the fracture surfaces of the right gear exhibited features consistent with progressive cracking. The teeth fractures generally progressed circumferentially away from a central point on the gear, as opposed to all in one direction. In addition, there was a 0.5-inch radial crack present on one of the tooth fracture surfaces. Similar to the left gear, all of the fracture surfaces on the right gear exhibited crack arrest marks and river patterns consistent with a progressive fracture. The fracture surfaces of the right gear were sectioned and gold sputter-coated to facilitate examination in a scanning electron microscope (SEM). The initiation region of the fracture was generally flat and smoother than the rest of the fracture surface. There were no material defects noted at the crack initiation site that might have led to premature failure.

The full NTSB Materials Laboratory report is available in the official docket of this investigation.

Administrative Information

Investigator In Charge (IIC):	McKenny, Van
Additional Participating Persons:	Kent Gibbons; FAA; Salt Lake City, UT Nicole Charnon; Continental Motors; Mobile, AL Brad Miller; Cirrus; Duluth, MN George W Braly; Tornado Alley Turbo; Ada, OK
Original Publish Date:	June 18, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=88658

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