Aviation Investigation Final Report

Location:	Dade City, Florida	**Accident Number:**	ERA13FA217
Date & Time:	April 27, 2013, 18:00 Local	**Registration:**	N5944J
Aircraft:	Cessna 172N	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	3 Minor
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

During the accident flight, the exhaust gas temperature on the No. 3 cylinder began as the coldest and then transitioned to the hottest. Subsequently, the cylinder head temperature on the No. 3 cylinder also transitioned to the hottest. According to the pilot, the engine then began to run roughly, and he adjusted the throttle and mixture positions to gain control of the malfunctioning engine. During emergency communications with air traffic control, the engine lost all power, and the pilot conducted an emergency landing to a field.

Examination of the engine revealed that the No. 3 cylinder exhaust valve rocker arm stud had backed out of the cylinder, which prevented the exhaust valve from opening properly. Specifically, the loose rocker arm stud prevented the pushrod from depressing the exhaust valve far enough in to release exhaust from the cylinder, which damaged the intake valve pushrod and caused a complete loss of engine power. The No. 3 cylinder had been replaced about 14 months before the accident and had accumulated 480.9 hours since installation. It is likely that the rocker arm and nut assembly became loose over time; the initial torque value could not be determined.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The in-flight loosening of the No. 3 cylinder exhaust valve rocker arm stud, which resulted in a complete loss of engine power.

Findings

Aircraft	Recip eng cyl section - Malfunction

Factual Information

History of Flight

Enroute-climb to cruise	Loss of engine power (partial) (Defining event)
Emergency descent	Loss of engine power (total)
Emergency descent	Off-field or emergency landing
Landing-landing roll	Collision with terr/obj (non-CFIT)

On April 27, 2013, about 1800 eastern daylight time, a Cessna 172N, N5944J, was substantially damaged during a forced landing to a field following a total loss of engine power about seven miles north of Zephyrhills, Florida. The flight instructor, student pilot, and private pilot passenger received minor injuries. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the instructional flight that was conducted under the provisions of Title 14 Code of Federal Regulations Part 91. The flight departed Hernando County Airport (BKV), Brooksville, Florida at 1746.

According to the pilot, about 19 minutes after departure from BKV, the airplane was climbing through 4,500 feet mean seal level (msl) for 5,000 feet msl. Suddenly, the engine started to "rumble" and run rough. The pilot stated that he reduced engine power, applied carburetor heat, and "played" with the mixture because the number three engine cylinder was not indicating any exhaust gas temperature or cylinder head temperature. The pilot added that he informed Tampa Air Traffic Control (ATC) that he had a rough running engine and that he needed to land as soon as possible. ATC offered the pilot an alternate airfield for landing but the pilot stated that the more engine adjustments that he made, the worse the engine responded.

The pilot stated that engine power decreased to near zero, he tuned code 7700 on the airplane transponder, notified ATC of his location, selected a landing site, and ran the emergency checklist from memory. The pilot stated that after the engine quit and during the forced landing sequence, he left the fuel selector on the "BOTH" tank position and extended the flaps to 40 degrees. As he made the approach to the field, he realized that a tailwind was disrupting his intended landing spot and that a ditch came into view that he had not previously recognized. The pilot flared the airplane for touchdown in the field, pulled the control yoke all the way aft and braced for impact. The airplane impacted the ditch and flipped end over end before coming to rest.

The high-wing, tricycle gear equipped airplane, serial number 17273846 was manufactured in 1980 and was powered by a Lycoming O-320-H2AD 150-hp engine, serial number L-7539-76. The engine had accrued 2,815 total flight hours at the time of the accident. A review of the airplane and engine maintenance records revealed that the last annual inspection was completed on March 14, 2013 with an airframe total time of 2,747.9 hours and an engine total time of 2,621 hours. The No. 3 engine cylinder was replaced on December 7, 2011 at a recorded time of 2,207.5 hours.

Examination of the airplane revealed that the fuselage was buckled, the main landing gear boxes were crushed, and the overhead section of the cabin was detached from the door frames. The propeller spinner was crushed. The engine was equipped with a 2-blade McCauley propeller. One blade was bent aft

approximately 10 degrees beginning about 10 inches outboard of the blade root. The other blade exhibited a gouge four inches outboard of the blade root. The right fuel tank contained twenty gallons and the left tank contained fifteen gallons of a blue fluid that was similar in color and smell to 100LL aviation fuel.

Crankshaft continuity was observed by removing the top spark plugs and turning the attached propeller by hand. The rocker covers were removed and valve action was observed through several engine rotations confirming drivetrain continuity. Thumb compression was confirmed on Cylinder Nos 1, 3, and 4. Cylinder No. 2 was filled with compressed air and was noted as escaping past the piston rings. The spark plug leads were removed and spark was observed on each lead when the engine was rotated. The carburetor was removed, found full of a blue fluid similar to 100LL aviation fuel, and free of contaminates. The oil filter was removed and no contaminants were noted.

Further examination of the engine revealed that the No. 3 cylinder intake push rod was bent and the exhaust push rod was unremarkable. The No. 3 cylinder exhaust rocker arm was observed to have about one-half of an inch of free play as compared to the other cylinder exhaust rocker arms. The No. 3 cylinder was removed and the piston was observed to have normal wear. No foreign objects were noted in the cylinder intake and exhaust ports. The push rod tappets operated normally as the propeller was turned. The crankshaft intake and exhaust lobes were unremarkable and operated normally when the propeller was turned. Examination of the intake and exhaust rocker arms noted that the fulcrum of the exhaust rocker arm displayed wear on the top and bottom surfaces and that the assembly was dislodged from the fulcrum mounting rail. The mounting rail also displayed wear on the top and bottom surfaces. The rocker arm and fulcrum are attached to the cylinder via a metal stud that runs into the cylinder head. The intake rocker arm measured 1 1/4 of an inch from the mounting rail to the side of the rocker arm. The exhaust rocker arm was measured to 1 3/8 of an inch from the mounting rail to the side of the rocker arm. The exhaust rocker arm adjusting nut was rotated and the mounting stud rotated with the nut. The stud and nut were removed and were unremarkable.

According to the engine manufacturer, if the exhaust rocker arm stud were to back out, the push rod will still receive commands from the crankshaft lobes. However, due to the increased free play with the exhaust side fulcrum, the push rod will not be able to sufficiently push the rocker arm far enough down for the exhaust valve to release cylinder pressure. Therefore, the intake push rod will not be able to depress the intake valve with the cylinder head pressure and the intake push rod will bend as a result.

The airplane was equipped with a JP Instrument EDM 800 engine monitor and was downloaded and examined by the NTSB Vehicle Recorder Laboratory in Washington, D. C.

Figure 4 of the report shows a plot of the flight immediately prior to the accident flight, which occurred earlier on the same day. Exhaust Gas Temperature (EGT) 3 was generally operating colder than the EGTs associated with the other cylinders. Cylinder Head Temperature (CHT) 3 generally operated hotter than other the CHT associated with the other cylinders.

Figure 5 of the report shows a plot for the accident flight EGT-3 began as the coldest EGT, and transitioned to the hottest EGT between about 1745:50 and 1757:16 EDT, when CHT-3 also became the hottest CHT. At about 1757:16 EDT, EGT-3 increased momentarily, and then began to decrease rapidly. Coincident with the EGT-3 change at about 1757:16 EDT, all the CHTs began to decrease. A detailed report of the data is contained in the public docket associated with this accident.

Lycoming Service Bulletin (SB) 412B, with an effective date of March 10, 1978, mandated replacement of the intake and exhaust valve rocker arm retaining studs. The SB applied to all O-320-H engines with serial numbers L-101-76 through L-2182-76 inclusive. Lycoming SB 412B did not apply to the accident engine. According to the engine maintenance logs, the No. 3 cylinder was replaced with a serviceable cylinder 14 months prior to the accident flight. According to paragraph 5 of SB 412B, the No. 3 cylinder was also exempt from the SB due to the letter "L" stamped onto the milled rail between the 2 retaining studs. At the time of the accident, the No. 3 cylinder accumulated 480.9 total hours since installation on the accident engine.

Flight instructor Information

Certificate:	Commercial; Flight instructor	**Age:**	27,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	March 19, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 15, 2012
Flight Time:	397 hours (Total, all aircraft), 351 hours (Total, this make and model), 295 hours (Pilot In Command, all aircraft), 34 hours (Last 90 days, all aircraft), 31 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Student pilot Information

Certificate:	Private	**Age:**	59,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	July 5, 2011
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	April 21, 2013
Flight Time:	300 hours (Total, all aircraft), 57 hours (Last 90 days, all aircraft), 37 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N5944J
Model/Series:	172N	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	17273846
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	March 14, 2013 Annual	**Certified Max Gross Wt.:**	2300 lbs
Time Since Last Inspection:	50 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	2748 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed, activated, aided in locating accident	**Engine Model/Series:**	O-320-H2AD
Registered Owner:	On file	**Rated Power:**	160 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	ZPH,90 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	17:55 Local	**Direction from Accident Site:**	150°
Lowest Cloud Condition:	Scattered / 5000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	90°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.12 inches Hg	**Temperature/Dew Point:**	26°C / 15°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Hernando County, FL (BKV)	**Type of Flight Plan Filed:**	IFR
Destination:	Fort Pierce, FL (FPR)	**Type of Clearance:**	IFR
Departure Time:	17:46 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	2 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Minor	**Latitude, Longitude:**	28.360397,-82.190292(est)

Administrative Information

Investigator In Charge (IIC):	Murray, Patrick
Additional Participating Persons:	Bob Donahue; FAA/FSDO; Tampa, FL
Original Publish Date:	December 11, 2013
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=86746