



AVIATION



HIGHWAY



MARINE



RAILROAD



PIPELINE

Aviation Investigation Final Report

Location:	Gainesville, Georgia	Accident Number:	ERA18FA137
Date & Time:	April 28, 2018, 17:15 Local	Registration:	N4363F
Aircraft:	Piper PA28R	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (partial)	Injuries:	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

The commercial pilot receiving instruction and a flight instructor were conducting a local instructional flight when the engine lost partial power and oil obscured the front windscreen. The instructor took control of the airplane and maneuvered toward a highway on which to conduct a forced landing; the airplane struck power lines and a vehicle before veering off the road and down a steep embankment, where it came to rest inverted.

Examination of the engine revealed that the No. 2 cylinder had separated from the cylinder mounting deck. The No. 2 cylinder rocker box cover and a pushrod tube were protruding from the left forward side of the cowling. The No. 2 cylinder connecting rod was protruding through the top of the cowling. The No. 2 cylinder base studs and thru bolts remained in the crankcase and were fractured at their threaded section. Metallurgical examination revealed that each of the fractured surfaces exhibited evidence of crack arrest marks consistent with fatigue cracking and microvoid coalescence features typical of overstress separation. The crankcase web mating surfaces at the Nos. 2, 3 and 4 bearing journals exhibited pitting consistent with fretting, which is typically a result of inadequate preload tension or loss of preload tension to the fasteners that secure the cylinder to the engine. The inadequate or loss of preload resulted in fatigue cracking of the No. 2 cylinder studs and thru-bolts, and the subsequent separation of the cylinder.

According to maintenance records, the engine underwent a major overhaul about 4 years before the accident and had accrued 1,071.11 hours since the last overhaul. At the time of the overhaul, the crankcase was reassembled, and all four cylinders were installed. It could not be determined if the thru-bolts and studs were improperly tightened by maintenance personnel at the time of the overhaul or during an undocumented maintenance action that was performed after the overhaul.

Toxicology testing of the flight instructor revealed an unquantifiable amount of doxylamine, a sedating antihistamine that was well below that considered to cause significant effects. Therefore, it is unlikely that the pilot's use of doxylamine contributed to his inability to successfully perform a forced landing on a highway.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A partial loss of engine power due to inadequate thru-bolt and stud preload tension by undetermined maintenance personnel, which resulted in fretting between the engine crankcase halves, and the subsequent separation of the No. 2 cylinder due to the fatigue failure of the No. 2 cylinder stud/thru bolts.

Findings

Aircraft	Recip engine power section - Incorrect service/maintenance
Aircraft	Recip engine power section - Fatigue/wear/corrosion
Aircraft	Recip engine power section - Failure
Personnel issues	(general) - Maintenance personnel

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Enroute-cruise	Loss of engine power (partial) (Defining event)
Emergency descent	Off-field or emergency landing
Emergency descent	Collision with terr/obj (non-CFIT)
Landing-flare/touchdown	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On April 28, 2018, about 1715 eastern daylight time, a Piper PA-28R-200, N4363F, was substantially damaged when it struck a vehicle during a forced landing to a highway near Gainesville, Georgia. The flight instructor was fatally injured; the commercial pilot and passenger were seriously injured. The two people in the vehicle were not injured. The airplane was registered to and was being operated by the Flight School of Gwinnett as a Title 14 *Code of Federal Regulations* Part 91 instructional flight. Visual meteorological conditions prevailed, and no flight plan was filed for the local flight, which departed Gwinnett County Airport–Briscoe Field (LZU), Lawrenceville, Georgia, about 1615.

According to the commercial pilot, who was seated in the front left seat, the purpose of the flight was to practice maneuvers for a single-engine add-on rating to his commercial certificate. After they departed, they flew to the flight school's practice area, which was over Lake Lanier, before returning to the airport to practice landings and traffic pattern work. While returning to the airport in level flight between 3,500 and 5,000 ft mean sea level (msl), the commercial pilot heard a loud bang from the engine and saw the cowling expand simultaneously. Engine oil then sprayed over the entire windshield and obstructed their view. The engine was producing some power, but the airplane was unable to maintain altitude. The flight instructor, seated in the front right seat, took control of the airplane and made two descending 360° turns over the highway and prepared to land to the west. The flight instructor also made a distress call to air traffic control. The flight instructor opened the cabin door so he could see outside and aligned the airplane with the road. The commercial pilot was looking out the left-side window. When the airplane was about 20 to 30 ft above the ground, the flight instructor began to flare the airplane. The commercial pilot remembered an impact, then the airplane flipped over. He recalled seeing the top of the fuselage caving in before losing consciousness.

The passenger in the rear left seat was a student pilot at the flight school and was observing the flight. He stated that they had been practicing maneuvers when he heard a loud bang and the airplane began to shake. Oil then covered the windshield from right to left. The flight instructor said they were going to make an emergency landing. The flight instructor opened the cabin door so he could make sure the landing area was clear, because he could not see out the windshield. The passenger said that there was a loud crash sound as the airplane touched down. The next thing he knew he was upside down still strapped into his seat via his lap belt. He unbuckled the belt and exited the airplane.

Several people witnessed the accident and reported that the airplane's engine was sputtering, leaking fluid, and trailing smoke.

A witness was driving westbound on the highway when she saw the airplane fly over her car. She said the pilots tried to land the airplane and struck a vehicle; there was then an explosion. The airplane then went down an embankment.

Another witness was a passenger in a car driving westbound on Highway 369 when she saw something out of the corner of her eye. The airplane then struck the car from behind. Her husband, who was driving the car, said the airplane struck their car, then he saw flames in his rearview mirror before the airplane passed the car on the left and went into a ditch.

PERSONNEL INFORMATION

The flight instructor held a commercial pilot certificate with ratings for airplane single-engine land and instrument airplane. He also held a flight instructor certificate with ratings for airplane single-engine, and instrument airplane. His most recent Federal Aviation Administration (FAA) second-class medical certificate was issued on December 18, 2017.

The flight instructor's logbook was not recovered. According to information provided by the flight school, as of November 2017, the flight instructor had about 536 total hours of flight experience. The flight instructor began employment at the flight school in December 2017 and had flown about 135 hours between that time and the accident.

The pilot receiving instruction held a commercial pilot certificate with a rating for airplane multi-engine land and instrument airplane, with private pilot privileges for airplane single-engine land. His most recent FAA third-class medical certificate was issued on April 10, 2018. The commercial pilot reported about 560 total hours of flight experience.

AIRCRAFT INFORMATION

The Piper PA-28R-200 is a four-seat, low-wing, single-engine airplane powered by a four-cylinder Lycoming IO-360 engine.

The airplane's most recent annual inspection was conducted on February 6, 2018, at an airframe total time of about 5,477.87 hours. At the time of the accident, the airplane had accrued about 5,515.01 hours.

The engine's most recent annual inspection was conducted on February 6, 2018 at a total time of 1,033.97 hours and the engine had accrued 1,071.11 hours since major overhaul at the time of the accident. The overhaul was conducted in July 2014, at which time the crankcase was reassembled and all four cylinders were installed. Review of maintenance records did not reveal any cylinder removals or crankcase disassembly since the overhaul.

METEOROLOGICAL INFORMATION

Recorded weather at LZU at 1656 included wind from 250° at 8 knots, 10 miles visibility, few clouds at 8,000 ft, temperature 25°C, dew point 5°C, and a barometric pressure setting of 29.92 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

The airplane collided with a set of power lines before touching down on the road. It then struck a car, veered to the right, went off the road, and down a steep embankment before coming to rest inverted on a northerly heading about 450 ft from the power lines. The main wreckage exhibited no evidence of fire; however, the right wing, which had separated from the airplane and came to rest on the opposite side of the highway, was fire damaged.

Postaccident examination of the airplane revealed that the fuselage, including the top and bottom of the engine cowling, the windshield, and the aft section of the fuselage were coated in oil. The top of the fuselage was crushed down, left, and aft. The left wing separated from the airframe at the wing root, but the control cables remained connected. The outboard section of the left wing was separated and found adjacent to the main wreckage.

The vertical stabilizer, including the rudder, was bent to the left. The left side of the horizontal stabilator was bent up. The elevator trim was neutral.

Flight control continuity was established from all flight control surfaces to the cockpit. The flaps were fully retracted and the landing gear were extended.

All four seats remained attached to their respective mounts. The front left seatbelt/shoulder harness assembly was intact and found unbuckled. The shoulder harness inertia reel was locked and would not retract or extend. Some stretching of the harness was observed. The front right lap belt was buckled and the webbing was cut by emergency personnel. The shoulder harness was retracted and found stowed with the metal clip attached to the headliner. Both rear seats were equipped only with lap belts, and both belts were unbuckled.

The engine and cowling remained attached to the airframe and the two-bladed propeller remained attached to the engine. Both blades exhibited chordwise scoring, curling at the tips, and twisting toward the blade faces.

Examination of the engine revealed that the No. 2 cylinder (S/N: EC10 3504-08) had separated from the cylinder mounting deck. Two fractured sections of the left crankcase, which included part of the No. 2 cylinder bore, were found lying in the engine cowling. The No. 2 cylinder rocker box cover and a pushrod tube was protruding from the left forward side of the cowling. The No. 2 cylinder connecting rod was protruding through the top of the cowling. The No. 2 cylinder base studs and thru bolts remained in the cylinder/crankcase bore and were fractured. The separated portions of the bolts and the cylinder base nuts were not observed with the recovered wreckage.

The Nos. 1, 3, and 4 cylinders were removed and the crankcase was disassembled. The No. 1 cylinder head was impact damaged. No damage was noted to the pistons, valves or cylinder walls of the Nos. 1, 3, or 4 cylinders. The No. 2 piston remained in the No. 2 cylinder. The cylinder skirt and piston skirt were damaged consistent with impact by the No. 2 connecting rod. The No. 2 connecting rod remained attached to the No. 2 piston and was damaged consistent with impact with the cylinder skirt. The No. 2 rod cap was not attached to the rod and no bolts were present in the rod bolt holes. The rod cap was damaged. A portion of one rod bolt remained in the rod cap. The shank portion of the rod bolt that remained was narrowed consistent with stretching of the bolt. The rod bearing shell was distorted consistent with the distortion of the rod cap.

The crankcase web mating surfaces at the Nos. 2, 3, and No. 4 bearing journals exhibited pitting consistent with fretting.

The left section of the crankcase with remaining base studs and thru bolts, the two broken sections of the crankcase with remaining bolts, the No. 2 cylinder with piston and attached lower section of connecting rod, the No. 2 cylinder end-cap with one bolt, the No. 2 cylinder connecting cap bearing, and the No. 2 cylinder pushrod tube were sent to the National Transportation Safety Board's Materials Laboratory for examination. The examination revealed that all the No. 2 cylinder's base studs and thru bolts were fractured at their threaded section. The fractured surfaces exhibited evidence of crack arrest marks consistent with fatigue cracking and microvoid coalescence features typical of overstress separation.

Examination of the fractured bolt from the connecting rod end cap revealed that the shank portion exhibited evidence of a cup-and-cone fracture consistent with overstress separation.

MEDICAL AND PATHOLOGICAL INFORMATION

The Division of Forensic Sciences, Georgia Bureau of Investigation, Atlanta, Georgia, performed the autopsy on the pilot. The autopsy report indicated that the cause of death was, "Blunt force trauma of the head and neck."

Toxicology testing performed at the FAA Forensic Laboratory identified an unquantifiable amount of doxylamine in the pilot's iliac blood and urine. Doxylamine is a sedating antihistamine available in several over-the-counter cold and allergy products and in some over-the-counter sleep aids.

ADDITIONAL INFORMATION

According to the FAA Aviation Maintenance Technician Handbook (FAA-H-8083-30), fretting occurs:

...when two mating surfaces, normally at rest with respect to one another, are subject to slight relative motion. It is characterized by pitting of the surfaces and the generation of considerable quantities of finely divided debris. Since the restricted movements of the two surfaces prevent the debris from escaping very easily, an extremely localized abrasion occurs.

According to the Lycoming Overhaul Manual, section 6, page 6-21, "To assure proper assembly of the crankcase halves and to eliminate the possibility of subsequent loosening of the cylinder base nuts, a definite and specific sequence of tightening all crankcase and cylinder base nuts must be followed." Lycoming also issued Service Instruction No. 1029D for all Lycoming piston engines, titled Tightening Procedures for Crankcase Thru-Studs and Bolts, on August 15, 1986. The Service Instruction stated,

All Avco Lycoming aircraft engines incorporate bolts and long thru studs that extend through the crankcase halves primarily for holding them together. The studs also secure the cylinders to their mounting decks on the crankcase. To ensure uniform loading on the main bearings, it is necessary to tighten these studs and bolts in a sequence beginning at the approximate center of the engine and progressing evenly to both front and rear of the engine...

In a June 2014 issue of EAA Sport Aviation, Mike Busch wrote an article, "Cylinder Work: Be Afraid," that stated that:

...preload is the technical term for the clamping force created by tightening a fastener (typically a threaded bolt or stud) that holds assembled parts together. Having sufficient preload is the key to a strong and reliable bolted joint that will not loosen, break, or shift under the load. In order for a bolted joint to be stable under cyclic repetitive stress, the preload on the fasteners must be greater than the maximum stress that is trying to pull the joint apart. If this condition is met, the joint will not separate, and the fasteners won't "feel" the repetitive stress cycles. But if it isn't, the joint will shift under load and the fasteners will ultimately fail from repetitive stress fatigue.

Flight instructor Information

Certificate:	Commercial; Flight instructor; Private	Age:	28, Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	Lap only
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	Toxicology Performed:	Yes
Medical Certification:	Class 2 Without waivers/limitations	Last FAA Medical Exam:	December 18, 2017
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	April 10, 2018
Flight Time:	(Estimated) 671 hours (Total, all aircraft)		

Pilot Information

Certificate:	Commercial; Private	Age:	30, Male
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:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 3 Without waivers/limitations	Last FAA Medical Exam:	April 10, 2018
Occupational Pilot:	No	Last Flight Review or Equivalent:	May 6, 2015
Flight Time:	560 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Piper	Registration:	N4363F
Model/Series:	PA28R 200	Aircraft Category:	Airplane
Year of Manufacture:	1976	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	28R-7635406
Landing Gear Type:	Retractable - Tricycle	Seats:	4
Date/Type of Last Inspection:	February 6, 2018 Annual	Certified Max Gross Wt.:	
Time Since Last Inspection:	37 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	5515.01 Hrs at time of accident	Engine Manufacturer:	Lycoming
ELT:	C91 installed, not activated	Engine Model/Series:	IO-360-C1C
Registered Owner:		Rated Power:	200 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:	LZU, 1061 ft msl	Distance from Accident Site:	16 Nautical Miles
Observation Time:	16:56 Local	Direction from Accident Site:	360°
Lowest Cloud Condition:	Few / 8000 ft AGL	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	8 knots /	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	250°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	29.92 inches Hg	Temperature/Dew Point:	25°C / 5°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Lawrenceville, GA (LZU)	Type of Flight Plan Filed:	None
Destination:	Lawrenceville, GA (LZU)	Type of Clearance:	VFR flight following
Departure Time:	16:15 Local	Type of Airspace:	Unknown

Wreckage and Impact Information

Crew Injuries:	1 Fatal, 1 Serious	Aircraft Damage:	Substantial
Passenger Injuries:	1 Serious	Aircraft Fire:	On-ground
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Fatal, 2 Serious	Latitude, Longitude:	34.25,-83.972778(est)

Administrative Information

Investigator In Charge (IIC):	Read, Leah
Additional Participating Persons:	John Spears; FAA/FSDO; Atlanta, GA Jonathan Hirsch; The New Piper Aircraft Company; Wichita, KS James M Childers; Textron Lycoming; Atlanta, GA
Original Publish Date:	December 16, 2019
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=97127

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](#).