Aviation Investigation Final Report

Location:	Harpswell, Maine	**Accident Number:**	ERA17LA307
Date & Time:	September 1, 2017, 17:10 Local	**Registration:**	N4615X
Aircraft:	Cessna U206	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Minor
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The pilot reported that, while en route to his destination, he heard a “loud bang,” followed by a complete loss of engine power. After determining that the airplane was not within gliding distance of the nearest airport, the pilot performed an off-airport landing, during which the airplane impacted a small drainage ditch, nosed over, and came to rest inverted, resulting in substantial damage.

Disassembly of the engine revealed mechanical damage in multiple locations inside the crankcase. The No. 1 main bearings had shifted slightly out of the support and displayed deformation. The No. 2 main bearings displayed bearing shift signatures. One was missing, and the other had extruded out of the bearing support. Multiple pieces of the missing bearing were found in the oil sump. The No. 3 main bearings were intact and had moved in a clockwise direction when viewed from the back of the engine, had shifted slightly out of the support, and the oil passage holes were partially blocked. The crankshaft was fractured at the crankshaft cheek between the No. 2 main journal and the No. 2 connecting rod journal. The No. 2 connecting rod journal and connecting rod bearings displayed incipient signatures of lubrication distress.

Review of the engine maintenance records revealed that, about 500 flight hours before the accident, all the cylinders had been replaced with overhauled cylinders and new pistons had been installed along with reconditioned lifters and seals.

If a bearing shifts for any reason after removal of one or more cylinders, or during replacement of one or more cylinders, the oil holes in the bearing can become misaligned with the oil passages in the crankcase, partially cutting off the oil supply to the bearing. If the engine is then put back into service, the reduced oil supply to the bearing can cause increased heat and friction that can result in the bearing shifting more, further reducing its oil supply. Eventually, the bearing can shift enough to cause the oil supply to be cut off completely, resulting in a catastrophic failure. This is usually referred to as a "spun bearing."

To prevent a spun bearing, the manufacturer specified a multiple-step torquing process for proper cylinder installation. The process required that the through bolt nuts be torqued on both sides of the engine, even if only one cylinder was being installed. The manufacturer warned that "failure to torque through bolt nuts on both sides of the engine can result in a loss of main bearing crush with main bearing shift and subsequent engine failure." Given the observed damage, it is likely that maintenance personnel did not apply sufficient torque to the cylinder flange nuts and through bolts during installation of the cylinders, which resulted in shifting of the Nos. 1, 2, and 3 main bearings, a loss of lubrication, and failure of the crankshaft.

Probable Cause and Findings

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

A total loss of engine power due to maintenance personnel's failure to apply proper torque to the cylinder flange nuts and through bolts, which resulted in shifting of the Nos. 1, 2, and 3 main bearings, loss of lubrication, and failure of the crankshaft.

Findings

Personnel issues	Replacement - Maintenance personnel
Aircraft	Recip eng cyl section - Incorrect service/maintenance
Aircraft	Recip engine power section - Damaged/degraded

Factual Information

History of Flight

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

On September 1, 2017, about 1711 eastern daylight time, a Cessna U206G airplane, N4615X, was substantially damaged when it was involved in an accident near Harpswell, Maine. The pilot was not injured. The airplane was operated by Waters Aero-Marine, doing business as Penobscot Island Air as a Title 14 *Code of Federal Regulations* Part 91 positioning flight.

The airplane was operating on a company visual flight rules (VFR) flight plan when it departed Knox County Regional Airport (RKD), Rockland, Maine, about 1645, destined for Portland International Jetport (PWM), Portland, Maine. According to the pilot, while in cruise flight at 2,500 ft about 6 nautical miles from the departure end of runway 19L at Brunswick Executive Airport (BXM), Brunswick, Maine, he heard a "loud bang," followed by a complete loss of engine power. He immediately transmitted a distress call to air traffic control and advised that he was going to attempt to land at BXM. He then performed the emergency procedures for securing the engine and continued with the emergency landing.

Upon realizing that the airplane was not within gliding distance of BXM, the pilot transmitted his intention to make an off-airport landing. The airplane bounced, traveled about 150 ft, and touched down again. The nose landing gear then dropped into a small drainage ditch and the airplane nosed over and came to rest inverted, resulting in substantial damage to both wings, the aft and forward fuselage, and the nose gear assembly.

The engine remained intact; however, the crankshaft would not rotate. Three cracks were visible on the crankcase; two above the No. 1 cylinder, and one between the Nos. 1 and 3 cylinders, which extended from the No. 1 cylinder saddle toward the spine on the top right half of the crankcase. Metallic debris was evident in the oil filler neck and port in the crankcase. The externally visible portion of the crankshaft was intact and appeared undamaged. All of the rear accessories remained attached.

Both the left and right magnetos remained attached to their mounting locations. Both magnetos produced spark at all of their terminal leads when placed on a test bench. Examination of the engine revealed that the fuel manifold was intact and the fuel injection lines were undamaged. The exhaust system displayed normal operating signatures and there were no signs of induction system leaks.

The oil sump was intact and undamaged. The oil sump contained multiple metallic pieces and particles consistent with bearing material. The oil pick-up tube and screen were undamaged, and there were

metallic particles in the screen. The oil pump was intact and undamaged. The oil pump was disassembled, and the oil pump housing displayed scoring consistent with hard particle passage. The oil filter remained secure and undamaged. The oil filter housing was cut open and the filter pleats contained a significant amount of metallic material. The oil cooler was secured to its installation point and displayed minor impact damage. When examined internally it contained small flakes of metal.

All the valves were intact and undamaged and displayed normal operating and combustion signatures. All the rocker arms also remained intact and undamaged and displayed normal operating and lubrication signatures.

All six cylinders remained attached to their respective cylinder bays. Examination of the cylinders and pistons revealed that the bottom of the No.1 cylinder, the skirt of the No.1 piston, and the skirt of the No. 2 piston displayed damage consistent with contacting portions of the engine's crankshaft assembly. The cylinders, valve heads, and overhead components displayed normal operating signatures, and the piston faces displayed normal operating and combustion signatures.

The No. 1 main bearings had shifted slightly out of the support and displayed deformation. The No. 2 main bearings displayed bearing shift signatures. One was missing, and the other had extruded out of the bearing support. Multiple pieces of the missing bearing were found in the oil sump.

The No. 3 main bearings were intact and had moved in a clockwise direction when viewed from the back of the engine, had shifted slightly out of the support, and the oil passage holes were partially blocked. The Nos. 4 and 5 main bearings were intact and undamaged. The bearing surfaces displayed normal operating and lubrication signatures.

The crankshaft was fractured between the No. 2 main journal and the No. 2 connecting rod journal. The No. 2 connecting rod journal displayed incipient signatures of lubrication distress. The remaining journals displayed normal lubrication signatures. The counterweights were secured to their hangers, and the connecting rods were secured to their journals. The connecting rod bearings displayed normal operating and lubrication signatures except for the No. 2 connecting rod bearings, which displayed incipient signatures of lubrication distress.

According to Continental Aerospace Technologies, cylinder removal regardless of compression should not be done unless a borescope inspection reveals a definite problem.

Removal of a cylinder requires removal of a total of eight-cylinder hold-down nuts that secure the cylinder base flange to the crankcase. Six of these hold-down nuts are threaded onto short deck studs that are mounted in threaded holes in the crankcase. The other two hold-down nuts are threaded onto a pair of through-bolts that pass all the way through the crankcase.

The left and right banks of cylinders are staggered so that each pair of through-bolts run from the front hold-down nuts on a left-bank (even-numbered) cylinder to the rear hold-down nuts on a right-bank (odd-numbered) cylinder. The engine has four pairs of these through-bolts, and they are primarily responsible for holding the two crankcase halves firmly together.

The crankcase contains precisely machined semicircular main bearing saddles that hold the main bearings to support the crankshaft. The main bearings are semicircular shells consisting of steel back plates laminated to bearing surfaces made of a softer material called "babbit" to prevent scratching the

crankshaft journals. The main bearing shells have oil supply holes that must line up precisely with oil passages machined into the crankcase halves.

When the engine is assembled, the ends of the main bearing shells stick out slightly above the mating surfaces of the crankcase bearing saddles. As the case halves are mated during engine assembly by torquing the through bolts, the bearing shells are forced firmly into the crank-case saddles in a process known as "crushing."

If a bearing shifts for any reason after removal of one or more cylinders or during replacement of one or more cylinders, the oil holes in the bearing can become misaligned with the oil passages in the crankcase, partially cutting off the oil supply to the bearing. If the engine is then put back into service, the reduced oil supply to the bearing can cause increased heat and friction that can result in the bearing shifting more, further reducing its oil supply. Eventually, the bearing can shift enough to cause the oil supply to be cut off completely, resulting in a catastrophic failure. This is usually referred to as a "spun bearing."

To help prevent a "spun bearing" from occurring, proper cylinder installation requires a multiple step torquing process. When doing the cylinder torque procedure, the cylinder base stud threads, through bolt threads, and nuts must be lubricated with clean 50 weight aviation oil, and through bolt nuts at cadmium plated washers will require a lower torque value to achieve the same pre-load on the through bolt, since the lubricity of the cadmium plating reduces the friction in the fastener joint.

Continental Aerospace Technologies warned that: "Failure to torque through bolt nuts on both sides of the engine can result in a loss of main bearing crush with main bearing shift and subsequent engine failure."

Review of engine maintenance records revealed that all the cylinders had been replaced with overhauled cylinders, new pistons, and reconditioned lifters and seals at 1,250 total hours of operation since major overhaul (about 500 hours before the accident).

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	25,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; 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):	Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	May 16, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 20, 2017
Flight Time:	2400 hours (Total, all aircraft), 800 hours (Total, this make and model), 2371 hours (Pilot In Command, all aircraft), 200 hours (Last 90 days, all aircraft), 50 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N4615X
Model/Series:	U206 G	**Aircraft Category:**	Airplane
Year of Manufacture:	1979	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	U20605513
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	August 28, 2017 100 hour	**Certified Max Gross Wt.:**	3600 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	7359.1 Hrs as of last inspection	**Engine Manufacturer:**	Continental
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	IO-520F
Registered Owner:	WATERS AERO-MARINE INC	**Rated Power:**	300 Horsepower
Operator:	WATERS AERO-MARINE INC	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Penobscot Island Air	**Operator Designator Code:**	O59A

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	IWI,70 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	16:53 Local	**Direction from Accident Site:**	45°
Lowest Cloud Condition:	Few / 6500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots / 22 knots	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	17°C / 1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	ROCKLAND, ME (RKD)	**Type of Flight Plan Filed:**	Company VFR
Destination:	PORTLAND, ME (PWM)	**Type of Clearance:**	VFR;VFR flight following
Departure Time:	16:45 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Minor	**Latitude, Longitude:**	43.819999,-69.919998(est)

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	James Mills; FAA / FSDO; Portland, ME John Kent; Continental Motors; Mobile, AL
Original Publish Date:	January 20, 2022
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95938