Aviation Investigation Final Report

Location:	Wikieup, Arizona	**Accident Number:**	WPR13FA169
Date & Time:	March 28, 2013, 11:19 Local	**Registration:**	N6018X
Aircraft:	Mooney M20A	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

According to air traffic control records, during the cross-country flight, the pilot reported that the engine had lost oil pressure. About 10 minutes later, he reported that the engine was running roughly and that there was smoke in the cockpit. He then stated that he was shutting down the engine. The pilot then made a forced landing in rough terrain. An examination of the wreckage site revealed black viscous fluid on the belly of the fuselage from the engine compartment to the tail skid. The ground underneath the fuselage was also stained with black fluid.

Postaccident examination of the engine determined that several of the connecting rod journals and the No. 2 connecting rod had overheated and that the No. 2 connecting rod had fractured and separated. A nonstandard shim was found installed between the propeller hub and the crankshaft propeller flange. A review of the maintenance logbooks found no documentation or entries indicating when the nonstandard shim was manufactured or installed nor who made it. Further examination revealed that the No. 1 main bearing journal and crankshaft propeller flange were misaligned relative to the Nos. 2 and 3 main bearing journals and that the crankshaft was bent. The orientation of the misalignment in both the flange and the No. 1 journal matched, indicating that they were related. The thickness variation in the shim also matched the orientation and magnitude of the propeller flange misalignment, indicating that it had been machined to compensate for the flange misalignment.

The heat tinting observed on the connecting rod journals and on the No. 2 connecting rod was consistent with overheating of the bearings typically associated with either improper clearance or insufficient oil pressure at the bearing surface. The misalignment of the crankshaft likely affected both the clearances and the oil pressures at the connecting rod bearings, which led to the overheating of the bearings during flight. The continued use of a bent crankshaft led to the secondary failure of the No. 2 connecting rod.

Probable Cause and Findings

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

The manufacture and installation of a nonstandard part by unknown maintenance personnel to compensate for a bent, misaligned crankshaft propeller flange, which resulted in the improper clearance of the bearings on the crankshaft journal, a loss of oil pressure, overheating of the bearings, and the failure of a connecting rod during cruise flight.

Findings

Aircraft	Recip engine power section - Incorrect service/maintenance
Personnel issues	Modification/alteration - Other
Environmental issues	Mountainous/hilly terrain - Contributed to outcome

Factual Information

History of Flight

Enroute-cruise	Loss of engine power (total) (Defining event)
Landing-flare/touchdown	Off-field or emergency landing

On March 28, 2013, about 1119 mountain standard time, a Mooney M20A, N6018X, made an off airport forced landing near Wikieup, Arizona. The pilot/owner was operating the airplane under the provisions of Title 14 Code of Federal Regulations (CFR) Part 91. The private pilot and one passenger sustained serious injuries; one passenger sustained fatal injuries. The airplane sustained substantial damage from impact forces. The cross-country personal flight departed Sedona, Arizona, with a planned destination of Shafter, California. Visual meteorological (VMC) conditions prevailed, and no flight plan had been filed.

The Federal Aviation Administration (FAA) reported that the pilot contacted Albuquerque Air Route Traffic Control Center (ABQ ARTCC) at 1028:07 requesting visual flight rules flight following. The estimated position was about 15 miles west of Sedona at 8,600 feet msl. At 1106:01, the pilot informed the controller that the engine lost oil pressure, and he needed vectors to the closest airport. The controller provided vectors to Bagdad airport (elevation 4,183 ft), and at 1109:30, the pilot advised that the airplane was losing altitude. The controller contacted another airplane in the area at 1111:16, and requested that airplane provide assistance. At 1113:28, the accident airplane was 5 miles from Bagdad at 6,600 feet. At 1115:56, the pilot stated that the engine was running rough, then within 1 minute that there was smoke in the cockpit, and he was shutting the engine off. The controller advised the pilot to look for an open field, clean the airplane up, and shut the fuel off. The pilot advised that he could see an open area. The last transmission from the pilot was at 1118:07, when he responded to the assist airplane that he had a cell phone; although the number was not recorded, the assist airplane's readback was recorded at 1118:49.

The pilot made a forced landing in rough terrain. The pilot and front seat passenger were pinned in the wreckage. His son in the back seat sustained a serious injury, but was able to egress from the airplane.

A witness was camping about 1 mile from the accident site. He stated that the airplane flew about 300-400 feet over him, and the wings were rocking about 3-4 feet as if the pilot was waving to him. He said that the engine was silent, but he could not recall if the propeller was stopped or turning. He noted that the landing gear was down, and he did not observe any smoke or fluids emanating from the airplane. He did not hear the crash, and had observed airplanes flying low over this area on previous occasions.

Pilot Information

Certificate:	Private	**Age:**	48
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Lap only
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	February 22, 2013
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	October 11, 2011
Flight Time:	156 hours (Total, all aircraft)		

A review of FAA airman records revealed that the 48-year-old-pilot held a private pilot certificate with a rating for airplane single-engine land. The pilot held a third-class medical certificate issued on February 22, 2013, with the limitation that it was not valid for any class after February 22, 2014.

No personal flight time records were received from the pilot. The IIC obtained the aeronautical experience listed in this report from a review of the FAA airmen medical records on file in the Airman and Medical Records Center located in Oklahoma City, Oklahoma. The pilot reported on his medical application that he had a total time of 156 hours with 5 hours logged in the previous 6 months. A logbook excerpt recorded a biennial flight review and FAR 61.31(e) endorsement for operating a complex airplane on October 11, 2011.

Aircraft and Owner/Operator Information

Aircraft Make:	Mooney	**Registration:**	N6018X
Model/Series:	M20A	**Aircraft Category:**	Airplane
Year of Manufacture:	1960	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1606
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	October 3, 2012 Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:	16 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	3761 Hrs as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	C91A installed, activated, did not aid in locating accident	**Engine Model/Series:**	O-360-A1D
Registered Owner:	Vidson Chan	**Rated Power:**	180 Horsepower
Operator:	Vidson Chan	**Operating Certificate(s) Held:**	None

The airplane was a Mooney M20A, serial number 1606. A review of the airplane's logbooks revealed that the airplane had a total airframe time of 3,761.8 hours at the last annual inspection dated October 3,

2012. The tachometer read 1,048.8 hours at the last inspection. The tachometer read 1,053.8 hours at the last recorded maintenance (an oil change) on February 1, 2013; it read 1,064.37 hours at the accident scene.

The airplane was not equipped with shoulder harnesses.

The engine was a 180 horsepower Lycoming O-360-A1D, serial number L-9731-36A. Total time on the engine at the last annual inspection was 3,739.6 hours, and time since major overhaul was 1,179.8 hours.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KIGM	**Distance from Accident Site:**	
Observation Time:	10:51 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	16 knots / 23 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	220°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.05 inches Hg	**Temperature/Dew Point:**	21°C / 0°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Sedona, AZ (SEZ)	**Type of Flight Plan Filed:**	None
Destination:	Shafter, CA (MIT)	**Type of Clearance:**	VFR flight following
Departure Time:	10:30 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal, 1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 2 Serious	**Latitude, Longitude:**	34.605556,-113.491111

The NTSB investigator-in-charge (IIC) examined the wreckage at the accident scene.

The airplane came to rest upright in mountainous terrain on the crest of a descending ridge. The first identified point of contact (FIPC) was on the upslope of the ridge; it was an ocotillo cactus plant with the top branches broken off about 4-6 feet above the ground. There was a ground scar about 15 feet left and upslope of the cactus. About 12 feet forward and 10 feet to the left of the FIPC was a 1-foot by 1-foot piece of the outboard leading edge of the left wing, which contained the red navigation light.

Twenty feet from the FIPC was the principal impact crater (PIC) ground scar, which was about 5 feet wide and 10 feet long. A damaged bush was about 10 feet right of the PIC.

The main wreckage was about 60 feet from the FIPC on the debris path centerline.

The last major piece of wreckage was the pilot's window at 65 feet 4 left.

There was black viscous fluid on the belly of the fuselage all the way to the tail skid and end of the tail cone. The ground underneath the fuselage had some black liquid stains as well.

The belly of the airplane was crushed up and aft from the spinner to the engine compartment and through the bottom of the cabin area. The nose gear was crushed up and aft into the airframe.

The Johnson bar landing gear operating handle was in the vertical position with the locking arm in place.

The ignitions switch was in the off position.

Both control yokes had the hand grips intact.

Tests and Research

The IIC and investigators from the FAA and Lycoming examined the wreckage at Air Transport, Phoenix, Arizona, on March 30, 2013.

A full report is contained within the public docket for this accident.

Engine

The top spark plugs were removed; all center electrodes were circular, and clean with no mechanical deformation. The spark plug electrodes were gray, which corresponded to normal operation according to the Champion Aviation Check-A-Plug AV-27 Chart.

The engine crankshaft would not rotate.

The propeller was removed and a non-Lycoming manufactured shim was located between the face of the propeller hub and the crankshaft propeller flange that varied in thickness. From a review of the airplane's logbooks, it could not be determined who manufactured and installed the shim, or when it was installed.

The magnetos were manually rotated, and both magnetos produced spark at all posts.

A visual inspection of the engine revealed a fracture that emanated from the top of the cam follower area of the crankcase at the number two cylinder.

No oil registered on the dipstick, and a burning smell emanated from the filler tube. The oil filter was removed and cut open; the filter element displayed magnetic and bronze material impregnated in the element. The oil sump was removed, and approximately 1/2 quart of a black fluid was observed in the bottom; the liquid had a burnt smell. There were numerous pieces of debris in the oil pan including parts of the number two connecting rod end cap, beam, and pieces of rod bolts and nuts along with plasticized rod bearing material. The oil suction screen was removed, and it was obscured with magnetic material.

All cylinders were removed from the crankcase. All cylinder skirts were impact damaged, and pry bars were required to remove the cylinders. The cylinder bores did not exhibit scoring or scraping. All pistons displayed normal carbon deposit on their tops.

The crankcase was disassembled. It was noted that the two crankcase halves were coated with a substance consistent with automotive Permatex gasket sealer on the mating surfaces.

The number one connecting rod moved freely on its journal.

The number two piston remained in the cylinder; its connecting rod beam fractured and separated at the crankshaft rod journal. The fracture surface sustained heavy mechanical damage. The connecting rod cap, saddle, nuts and bolts separated at the connecting rod.

The crankshaft rod journal for the number two connecting rod beam was thermally damaged and scored. The number two connecting rod bearing was not in place.

The number three connecting rod was thermally seized to the crankshaft.

The number four connecting rod was moveable, but thermal and impact damage was evident in the area of the connecting rod bearing.

The crankshaft was dimensionally examined using V blocks and a dial indicator. The flange was ~0.87 out of round. The manufacturer's limits for a run-out (out of round) were 0.002 inch minimum and 0.005 inch maximum.

Materials Laboratory Examinations

The crankshaft, the shim, and rod end nut pieces were sent to the NTSB Office of Research and Engineering Materials Laboratory for examination. A full report is in the public docket.

The main journals were labeled M1, M2, and M3, and the connecting rod journals were labeled C1, C2, C3, and C4 for reference. The crankshaft journals showed varying levels of heat tinting and scoring. Journals C2 and C4 had the highest levels of damage with smeared deposits and scoring.

The edges of the propeller flange showed numbers marked in black ink at several of the attachment bolt holes. Numbers 3, 4, 5, and 6 were marked in sequence next to four of the attachment bolts moving counterclockwise. No similar marks were observed adjacent to the other two attachment bolt locations. For reference in this report, the bolt hole corresponding to the number 1 position was referenced as the 12 o'clock position.

The shim was removed from the forward face of the crankshaft. Black ink markings were observed on the forward face of the crankshaft. Asterisks were marked at the 5 o'clock and the 11 o'clock positions. IN was marked at the 1 o'clock position, and OUT was marked at the 7 o'clock position.

The positions of the main journals and their orientation relative to the forward face of the propeller flange were measured. Software was used to analyze the geometry of the position measurements. The positions of the journal faces were determined along the length of each main journal at multiple locations around each circumference. The position of the flange forward face was also determined by probing around the circumference. According to the analysis of the measured data, the axes of main journals M2 and M3 were oriented within 0.0023 degree of each other. However, the axis of journal M1 was angled 0.097 degree relative to the axis of journal M3. The forward end of the journal M1 axis was tilted toward the 10 o'clock position relative to the axis of journal M3.

The normal vector for the forward face of the propeller flange was angled relative to the journal M3 axis. The angle between the journal M3 axis and the flange normal was 0.726 degree. The orientation of the flange normal relative to the journal M3 axis was such that the flange was bent aft at the 4 o'clock position and bent forward at the 10 o'clock position.

The propeller flange had a nominal diameter of 6 inches. With the flange tilted 0.726 degree relative to the plane perpendicular to the journal M3 axis, the outer edge would be displaced forward up to 0.038 inch and aft up to 0.038 inch relative to the center of the flange.

The shim was flat on the aft face, and had a concentric polygon-shaped step pattern on the forward face. Thickness varied across the shim; the thinnest location was at the 11 o'clock position, where the thickness measured 0.0035 inch. The thickest location was located at the 4 o'clock position, where the thickness measured 0.0884 inch.

Maintenance Logbook Information

A logbook entry on November 21, 2006, indicated that the original Lycoming engine was sent to a repair facility for a propeller strike inspection.

An entry in the logbooks on March 26, 2007, indicated that the airplane had been repaired after a gear-up landing. Total time on the airframe was 3,661.42 hours at a tachometer time of 936.42 hours.

A logbook entry dated December 11, 2008, recorded a 100-hour inspection by an Airframe and Powerplant (A&P) mechanic. It noted replacement of the original engine with the accident engine. Total time on the accident engine was 3,598.8 hours, and time since major overhaul was 1,039.0 hours. The propeller was replaced with a Hartzell HC-92WF-8D, serial number 8781. The propeller total time was 2,486.0 hours. It had been overhauled on September 18, 2002, and had 21.0 hours since overhaul. This entry noted that one belly skin was replaced, the wheel well doors were adjusted, and one landing gear bolt was replaced.

A mechanic with Inspection Authorization (IA) recorded an annual inspection on December 13, 2008. The entry recorded that the total time on the airframe was 3,680.0 hours, and the tachometer read 958.0

hours.

An entry for April 2, 2010, noted an annual inspection at a tachometer time of 963.0 hours.

A review of FAA registration information indicated that the accident pilot purchased the airplane in January 2011.

An entry dated April 14, 2011, noted a 100-hour inspection by an A&P mechanic. The tachometer time was 965.1 hours.

An entry dated June 1, 2011, recorded an annual inspection by an IA. The tachometer time was 978.7 hours with a total time of 3,700.7 hours.

The logbooks contained an entry for an annual inspection on October 3, 2012. Total time in service was 3,761.8 hours; the tachometer read 1,048.8 hours.

There were no logbook or Form 337 entries to indicate when the nonstandard shim was manufactured, installed, or who made it.

Administrative Information

Investigator In Charge (IIC):	Plagens, Howard
Additional Participating Persons:	Thomas Dickerson; FAA FSDO; Scottsdale, AZ John Butler; Lycoming; Willaimsport, PA
Original Publish Date:	April 7, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=86539