



Aviation Investigation Final Report

Location:	Tonopah, Nevada	Accident Number:	WPR18LA156
Date & Time:	May 30, 2018, 11:08 Local	Registration:	N191HL
Aircraft:	Beech A36	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (total)	Injuries:	2 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The private pilot reported that, after the airplane reached about 8,000 ft mean sea level for the personal, cross-country flight, he began to smell smoke and then heard a popping sound. The engine then began to lose power, and he initiated a return to the airport. During the descent, the engine lost all power, and the pilot maneuvered the airplane to land on a highway. Due to obstructions, the pilot subsequently landed the airplane on a highway median. The airplane landed hard, which resulted in substantial damage to the fuselage and wings.

Examination of the engine revealed signatures consistent with detonation, which led to the failure of the No. 4 piston, the crankcase becoming pressurized, oil being pumped overboard, and the eventual oil starvation of the engine components.

A review of data from the engine data monitor (EDM) revealed that, during the flight that occurred earlier that day, the fuel flows and engine temperatures were appropriate. However, the EDM data for the accident flight revealed that the fuel flow was significantly lower during the takeoff and en route climb portions of the flight and that the cylinder head, turbine inlet, and oil temperatures reached extremely high values.

The pilot stated that he could not specifically recall the steps he took to manage the fuel/air mixture during the flight. The low fuel flow recorded on the EDM along with the excessive temperatures suggests that the mixture was set lean. Additionally, following the accident, the mixture control appeared to be leaned for cruise flight, rather than at full rich. However, the aircraft flight manual specified that the fuel mixture should be set to full rich during all operational phases from engine start through cruise climb. Given the evidence, it is likely that the pilot improperly leaned the fuel/air mixture and that he did not adequately monitor critical engine parameters via the cockpit gauges, which led to the high engine temperatures going undetected and resulted in oil starvation and the subsequent catastrophic engine failure.

Probable Cause and Findings

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

The pilot's failure to properly lean the fuel/air mixture and to monitor critical engine parameters during the en route climb to cruise level, which resulted in excessive engine heat and oil starvation and the subsequent catastrophic engine failure.

Findings

Personnel issues	Use of equip/system - Pilot
Personnel issues	Monitoring equip/instruments - Pilot
Aircraft	(general) - Incorrect use/operation
Aircraft	Oil - Not specified

Factual Information

History of Flight

Enroute-climb to cruise	Miscellaneous/other
Enroute-climb to cruise	Loss of engine power (total) (Defining event)
Landing	Off-field or emergency landing
Landing	Hard landing

On May 30, 2018, at 1108 Pacific daylight time a Beech A36 airplane, N191HL, landed hard on a highway near Tonopah, Nevada, following a loss of engine power during the enroute climb to cruise. The private pilot and passenger sustained minor injuries, and the airplane sustained substantial damage. The airplane was registered to and operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions prevailed, and no flight plan had been filed for the cross-country flight. The flight departed Tonopah Airport at 1048, and was destined for Dodge City Regional Airport, Dodge City, Kansas.

The pilot reported that during the preflight inspection he checked the engine oil, and the dipstick indicated an oil level of 12 quarts. The departure was uneventful, and after reaching an altitude of about 8,000 ft mean sea level, he began to smell smoke, and then heard a popping sound. The engine then began to lose power, and he initiated a return to the airport. During the descent the engine lost all power, and the pilot maneuvered the airplane to land on a highway. The pilot stated that the landing approach was obscured by obstacles including a set of power distribution cables, and the airplane landed hard on the highway median.

The airplane sustained substantial damage to the lower fuselage and both wings.

Pilot Information

Certificate:	Private	Age:	60,Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	3-point
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:	September 11, 2017
Occupational Pilot:	No	Last Flight Review or Equivalent:	August 20, 2017
Flight Time:	225 hours (Total, all aircraft), 99 hours (Total, this make and model)		

The pilot held a private pilot's certificate with a rating for airplane single-engine land, that was issued in October 2015. He reported a total flight time of 225 hours, with 99 hours in the

accident make and model. According to Federal Aviation Administration (FAA) records, he purchased the airplane about 10 months before the accident.

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	Registration:	N191HL
Model/Series:	A36 A36	Aircraft Category:	Airplane
Year of Manufacture:	1979	Amateur Built:	
Airworthiness Certificate:	Utility	Serial Number:	E-1437
Landing Gear Type:	Retractable - Tricycle	Seats:	4
Date/Type of Last Inspection:	May 18, 2018 Annual	Certified Max Gross Wt.:	3600 lbs
Time Since Last Inspection:	3 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	4384 Hrs as of last inspection	Engine Manufacturer:	Continental Motors
ELT:	C126 installed, not activated	Engine Model/Series:	IO-520-BB
Registered Owner:		Rated Power:	285 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

The airplane was equipped with a six-cylinder Continental IO-520-BB engine. In December 2013, it was fitted with a Western Skyways turbo-normalizing system in accordance with Supplemental Type Certificate (STC) SA8676SW.

The normal procedures section of the FAA approved flight manual supplement that was included with the STC stated that the fuel mixture should have been set to "FULL RICH" during all operational phases from engine start to cruise climb. Mixture adjustments were then permitted once the airplane had leveled off in cruise flight.

The supplement stated that during cruise climb fuel flow up to the critical altitude (approximately 18,000 ft pressure altitude) should be between 26.5 and 28.5 gph.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KTPH, 5434 ft msl	Distance from Accident Site:	3 Nautical Miles
Observation Time:	17:56 Local	Direction from Accident Site:	235°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/ 16 knots	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.87 inches Hg	Temperature/Dew Point:	26°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	TONOPAH, NV (TPH)	Type of Flight Plan Filed:	None
Destination:	DODGE CITY, KS (DDC)	Type of Clearance:	None
Departure Time:	10:48 Local	Type of Airspace:	Class E

Airport Information

Airport:	TONOPAH TPH	Runway Surface Type:	
Airport Elevation:	5429 ft msl	Runway Surface Condition:	Dry
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced landing

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:	38.077499,-117.042221(est)

Engine Examination

Post-accident examination revealed that all fuel lines, oil lines, and ancillary components were intact. Five holes were observed in the engine crankcase, and the entire belly of the airplane was covered in oil. Within the cabin, the throttle and propeller controls were in the full forward position, and the mixture was about 1 inch aft of the full forward (rich) position. Both the cowl flaps, and the cowl flap controls were in the open position, and the auxiliary fuel pump switch was in the "OFF" position (the flight

supplement required that it be set to LO at all altitudes above 10,000 and HIGH for engine priming).

The engine was removed and shipped to the facilities of Continental Motors, Inc. for examination under the supervision of an NTSB investigator. A complete engine examination report is contained in the public docket, the following is a summary of findings.

The fuel pump, fuel metering unit, and fuel manifold valve were tested on production test stands in the as-received, field-adjusted conditions. Though none of the units met production test standards, the units were able to pump, meter, and flow fuel appropriately. The fuel pressure and flows on the pump and metering unit were above nominal values throughout all tested ranges. Fuel flowed in equal quantities from each fuel injection line, and the fuel injectors were free of blockage.

Disassembly of the engine case revealed evidence of oil starvation and catastrophic engine failure. The piston rods for cylinders 3, 4, 5, and 6 had all broken away from the crankshaft, and all tappets had seized within their sleeves. The camshaft had evidence of thermal discoloration.

The corners of the number 4 piston crown had melted down to the compression ring land, and the entire crown surface had a blackened and frosted appearance. On one side of the piston, a channel was present from the crown down to the piston pin, exposing and damaging the oil scraper ring.

The crowns of the remaining pistons, along with the cylinder head combustion surfaces had a sand-blasted and peened appearance, with almost no deposit buildups. According to technical representatives from Continental Motors, this damage, along with the damage to the crown of piston number 4, was consistent with the effects of pre-ignition and detonation.

Engine Monitor

The airplane was equipped with a G3 Graphic Engine Monitor, manufactured by Insight Instrument Corporation. The unit was configured to record parameters including fuel flow, manifold pressure, engine RPM, turbine inlet temperature, and both cylinder head and exhaust gas temperatures.

According to the pilot, the flight originated earlier in the day from Haigh Field Airport (O37), Orland, California. Data recovered from the G3 unit revealed that for the first 12 minutes of that flight following engine start, the fuel flow remained at about 5 gallons per hour (gph), the manifold pressure held steady at about 13 inches of mercury (inHg), while the cylinder head temperatures (CHT) climbed to an average of about 250°F. In a manner consistent with takeoff and climb, the fuel pressure, manifold pressure, and engine speed then increased to about 33 gph, 29 inHg, and 2,730 RPM respectively as the CHT's climbed to about 340°F, and the turbine inlet temperature (TIT) reached about 1,200°F. About 8 minutes later, the fuel flow dropped to about 31 gph, and another 7 minutes later, presumably as the airplane entered the enroute cruise phase, the fuel flow dropped to about 14 gph, while the CHT's all equalized at an average of about 400°F. Oil temperatures during the flight varied between 127°F and 166°F.

For the accident flight, similar values were observed during the 8 minutes after engine start. For the takeoff and climb portion, the manifold pressure reached 30.1 inHg, and the engine speed climbed to 2,700 RPM, however the fuel flow never exceeded 19.4 gph. As the flight progressed, the CHT's and

TIT began to climb, reaching an average of about 530°F and 1,500°F respectively, about 4 minutes after takeoff. Three minutes later, the CHT for cylinders 4, 5, and 6 began to rise until cylinder 4 reached the highest recorded temperature of 771°F, 3 minutes later. For the last 8 minutes, all CHT's began to drop, reaching about 200°F as the data ended. Oil temperatures climbed to 204°F during the climb phase, and peaked at 217°F coincident with the highest recorded CHT temperature for cylinder 4.

Additional Information

The pilot stated that he could not specifically recall the mixture setting during the takeoff and climb phase of the accident flight, but presumed that because the engine failure occurred during climb, it was likely to have been in the full rich position. He reported that the airplane had been serviced with 100-low lead aviation gasoline while in Tonopah, and that he landed there because his wife, who was the passenger, was becoming nauseous. He stated that she had recovered prior to departing on the accident flight.

The "Transition to Complex" section of the FAA Airplane Flying Handbook (FAA-H-8083-3A) states the following regarding heat management of turbocharged engines:

"High heat is detrimental to piston engine operation. Its cumulative effects can lead to piston, ring, and cylinder head failure, and place thermal stress on other operating components. Excessive cylinder head temperature can lead to detonation, which in turn can cause catastrophic engine failure. Turbocharged engines are especially heat sensitive. The key to turbocharger operation, therefore, is effective heat management.

The pilot monitors the condition of a turbocharged engine with manifold pressure gauge, tachometer, exhaust gas temperature/turbine inlet temperature gauge, and cylinder head temperature. The pilot manages the "heat system" with the throttle, propeller r.p.m., mixture, and cowl flaps. At any given cruise power, the mixture is the most influential control over the exhaust gas/turbine inlet temperature. The throttle regulates total fuel flow, but the mixture governs the fuel to air ratio. The mixture, therefore, controls temperature."

Administrative Information

Investigator In Charge (IIC):	Simpson, Elliott
Additional Participating Persons:	John C Waugh; Federal Aviation Administration FSDO; Las Vegas, NV Nicole Charnon; Continental Motors; Mobile, AL
Original Publish Date:	December 16, 2019
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=97359

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](#).