Aviation Investigation Final Report

Location:	Mountainaire, Arizona	**Accident Number:**	WPR13FA244
Date & Time:	May 28, 2013, 11:43 Local	**Registration:**	N999PK
Aircraft:	RAYTHEON AIRCRAFT COMPANY A36	**Aircraft Damage:**	Destroyed
Defining Event:	Collision during takeoff/land	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot had purchased the Beechcraft airplane about 18 months before the accident and based it at his home airport, which was located at an elevation of about 80 ft mean sea level (msl). The pilot flew the Beechcraft to an airport that was at an elevation of about 7,100 ft msl. A few days after his arrival, he returned to the airport for his planned departure and spent about 15 minutes asking the fixed base operator owner, who was also a pilot, multiple questions about the route to his next planned destination. According to the owner, he was surprised by the nature of the pilot's questions, his lack of basic aeronautical information knowledge for area restrictions, and his lack of formal planning for his flight.

No witnesses reported anything unusual about the engine start or taxi. At the time the pilot was cleared by the air traffic control tower controller for takeoff, the airport density altitude was about 9,000 ft. No ground witnesses reported observing anything unusual with the takeoff, but a Cessna 172 pilot who was behind the Beechcraft reported that the Beechcraft's climbout was slow. Shortly after his own takeoff, about 75 seconds after the Beechcraft, the Cessna pilot asked the tower controller about the Beechcraft's situation and intentions because the Cessna was already well above the Beechcraft. This prompted the controller to ask the Beechcraft pilot if he needed assistance, and the pilot responded that he was climbing "very slowly" and would remain near the airport. Shortly after that, the Cessna pilot saw the Beechcraft impact trees. The accident site was about 3 miles southeast of the airport at an elevation about 300 ft below that of the departure airport. A postimpact fire obscured or destroyed a significant amount of evidence.

Review of the Beechcraft's published performance data revealed that, for the given conditions, the airplane should have been able to successfully depart the airport and climb at a rate of about 500 feet per minute.

Most of the engine components and all of the propeller components that survived the accident, displayed no evidence of preimpact mechanical deficiencies. The engine cylinder conditions were indicative of a history of generally lean operation. In addition, the No. 5 cylinder exhaust valve's appearance was consistent with excessively lean operation for an undetermined period of time, and the fuel injector nozzle for that cylinder was found to be partially occluded. Excessively lean operation will reduce engine power output, and will manifest itself as abnormally high exhaust and cylinder head temperatures and possible engine roughness. Further, if the No. 5 cylinder's injector was occluded for the flight, it would have resulted in overly lean operation of and reduced power output from that cylinder, yielded higher exhaust and cylinder head temperatures, and likely manifested itself as engine roughness. (Some witnesses close to the impact site reported that the engine was making "popping" noises.) Although the airplane was equipped to monitor, display, and record temperatures for each cylinder, it could not be determined whether the pilot monitored that display, and fire damage prevented the recovery of that data from the engine monitor. Further, there was insufficient evidence to determine the source of the injector's occlusion, quantify its effects on engine power output, determine its relation to the condition of the exhaust valve, or determine if it was present for the takeoff or an artifact of the postimpact fire.

Although the engine was developing power at impact, there was insufficient evidence to quantify the actual power output for the climb or at the time of impact. There was also insufficient evidence to determine whether the pilot ensured that the throttle and propeller controls were set to and remained in their appropriate positions for the departure or whether the pilot adjusted the mixture properly (not overly lean).

It is likely that the pilot lifted off prematurely at a speed lower than the prescribed value and was unable to accelerate or climb the airplane once it exited the ground effect regime. Because the surrounding terrain and the impact point were lower than the elevation of the airport, the pilot was able to continue to fly the airplane before crashing. This scenario is at least partially corroborated by the pilot's reported lack of preparation for the flight, which could have included a lack of performance planning. This scenario is also partially corroborated by the observed repetitive minor banking of the airplane, which often occurs when an airplane is flying very slowly.

A premature liftoff or a climb attempt at a speed significantly below the prescribed value would place the airplane in a situation where the power required for level flight was very near to or exceeded the available power. A recovery would require the pilot to lower the nose in order to accelerate the airplane to obtain a positive rate of climb. Such an action is counterintuitive when low to the ground and requires accurate problem recognition, knowledge of the correct solution, and sufficient terrain clearance to accomplish.

During the departure, the pilot reduced his options by deciding to turn to the east instead of continuing straight ahead to the south. Review of topographic data revealed that a four-lane highway was located just beyond the south end of the runway, and was situated in a north-south valley that descended to the south. However, instead of tracking over that highway, which could have been used as an off-airport emergency landing site, and its descending valley, which provided increasing terrain clearance, the pilot opted to turn east, toward higher, wooded terrain. Although that turn was consistent with both a left traffic pattern (in order to remain close to the airport as the pilot reported to the air traffic controller), and toward the pilot's on-course heading, by making that turn, the pilot reduced the likelihood of a partially or fully successful outcome to the flight.

Probable Cause and Findings

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

The pilot's inability to maintain a climb after departure in high-density altitude conditions, which resulted in a collision with trees and terrain. Contributing to the accident were the pilot's decision not to track the four-lane highway just beyond the departure runway, which he could have used as an alternate landing site; his premature rotation of the airplane; and degraded engine performance that affected the airplane's climb ability.

Findings

Aircraft	Climb rate - Attain/maintain not possible
Environmental issues	High density altitude - Effect on operation
Personnel issues	Decision making/judgment - Pilot
Personnel issues	Incorrect action performance - Pilot
Aircraft	(general) - Damaged/degraded
Environmental issues	Tree(s) - Not specified
Environmental issues	Mountainous/hilly terrain - Not specified

Factual Information

History of Flight

Initial climb	Low altitude operation/event
Initial climb	Collision during takeoff/land (Defining event)

On May 28, 2013, about 1143 mountain standard time, a Beechcraft A36, N999PK, was destroyed when it impacted trees and terrain in the Coconino National Forest adjacent to Mountainaire, Arizona, shortly after takeoff from Flagstaff Pulliam airport (FLG), Flagstaff, Arizona. A large post-impact fire ensued immediately. The owner/private pilot and the one passenger received fatal injuries. The personal flight was operated under the provisions of Title 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed, and no flight plan was filed for the flight.

According to relatives of the pilot, he based the airplane at McClellan Airfield (MCC) Sacramento, California. The pilot and his wife (the passenger) departed MCC on the morning of May 25, 2013, and arrived at FLG that same day. According to personnel and documentation from a fixed base operator (FBO) at FLG, the couple rented a car the day they arrived, and returned the car to the FBO about 1100 on the day of the accident. On their return, the pilot requested that 20 gallons of fuel be loaded into each of the main tanks, and then queried the FBO owner for about 15 minutes about route and other considerations for a flight to Bryce Canyon Airport (BCE), Bryce Canyon, Utah. The airplane was refueled, and the pilot and his wife loaded their belongings into the airplane.

According to the communications recordings from the FLG air traffic control tower (ATCT), after startup and taxi out, the pilot requested and was granted a turnout to the northeast. The airplane took off from runway 21, and was observed to be climbing very slowly by a pilot in a Cessna 172, which departed shortly after the Beechcraft.

According to the Cessna pilot, once it was beyond the end of the runway, the Beechcraft followed a slightly meandering course initially to the south, and then turned further left towards the south-southeast. The Cessna pilot then witnessed the Beechcraft impact trees adjacent to a semi-rural neighborhood about 3 miles from FLG. The Cessna pilot reported the accident to the ATCT controller. The terrain between the airport and the accident site was forested, gently undulating, and generally lower than the airport.

Several residents of the accident neighborhood were outside, and witnessed the final portion of the flight. Most reported that the engine was making "popping" noises, and was not trailing any dark smoke. Some of those eyewitnesses were the first responders to the accident. They immediately began fire suppression efforts using portable fire extinguishers, shovels of dirt, and household/garden hoses. All those individuals reported that the fire was large and intense, but that their efforts were partially successful in suppressing or containing the fire.

Pilot Information

Certificate:	Private	**Age:**	59
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	September 7, 2012
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	540 hours (Total, all aircraft)		

Federal Aviation Administration (FAA) records indicated that the 59-year-old pilot held a private pilot certificate with an airplane single-engine land rating. That certificate was issued in May 2010. The pilot's most recent FAA third-class medical certificate was issued in September 2012. On the application for that medical certificate, the pilot indicated that he had a total flight experience of 540 hours.

FAA records indicated that the pilot purchased a turbo-charged Cessna 182 in December 2008; he retained that airplane, and purchased the non-turbocharged accident airplane (Beechcraft) in November 2011.

The pilot's fire-damaged flight logbook was recovered from the wreckage. Review of the logbook indicated that the pilot began flight training in 2008, and that at the time of the accident, had accumulated about 611 total hours of flight experience. The logbook indicated that the pilot completed a flight review in the Cessna in February 2013. Damage to the logbook precluded a determination of the pilot's total flight experience in each airplane.

The pilot's nephew stated that the Cessna was "not flown much" subsequent to the purchase of the Beechcraft. The nephew also reported that the pilot was familiar with high elevation airports, and noted that the pilot flew into Truckee California "regularly." Truckee-Tahoe airport (TRK) has an elevation of 5,901 feet above mean sea level (msl).

The pilot had flown the Beechcraft with at least two different certified flight instructors (CFI). The first CFI flew a total of about 33 hours in the airplane with the pilot; their first flight together was to transport the airplane from Colorado to California following the pilot's purchase of the airplane. Subsequent flights were conducted initially to satisfy insurance requirements, and then to increase the pilot's proficiency with the airplane. The second CFI began flying with the pilot in May 2012, when the pilot began training for an instrument rating. That CFI flew a total of about 3 hours with the pilot in the accident airplane.

Aircraft and Owner/Operator Information

Aircraft Make:	RAYTHEON AIRCRAFT COMPANY	**Registration:**	N999PK
Model/Series:	A36	**Aircraft Category:**	Airplane
Year of Manufacture:	2001	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	E-3380
Landing Gear Type:	Retractable - Tricycle	**Seats:**	6
Date/Type of Last Inspection:	June 1, 2012 Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	893 Hrs as of last inspection	**Engine Manufacturer:**	CONT MOTOR
ELT:	Installed	**Engine Model/Series:**	IO-550 SERIES
Registered Owner:	On file	**Rated Power:**	300 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

FAA information indicated that the airplane was manufactured in 2001 as Beechcraft serial number E-3380, and was equipped with a Continental Motors IO-550 series engine. The airplane was purchased by, and first registered to, the pilot in late 2011.

The airplane was equipped with multiple factory- and post-delivery options. These included factory-installed cabin air conditioning, J.L. Osborne-brand wing tip tanks (20 gallons/side), Precise Flight-brand electric speedbrake system, a JPI-brand EDM-700 engine data monitor, AMSAFE- brand inflatable pilot and copilot dual shoulder harness restraint system, Garmin 430 and 530 nav-com units, and an Aerospace Systems & Technology-brand TKS de-icing system.

All those modifications had been accomplished prior to the pilot's purchase of the airplane. According to those records, the most recent annual inspection was completed on June 1, 2012, when the airplane had a total time (TT) in service of about 893 hours. The records indicated that a "top overhaul" of the engine was completed in April 2004, when the engine had a TT of about 243 hours.

In an interview with the NTSB, one of the pilot's CFIs indicated that the airplane was well-maintained, and that the CFI did not notice any problems or shortcomings with its climb capability, which he pays attention to when flying a new (to him) airplane. NTSB interviews with FLG ground personnel indicated that the airplane was not heavily loaded, and NTSB review of the specific information indicated that for the accident departure, the airplane was likely within its weight and balance envelope.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	FLG,7014 ft msl	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	11:57 Local	**Direction from Accident Site:**	10°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	17 knots / 26 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	210°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	18°C / -4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Flagstaff, AZ (FLG)	**Type of Flight Plan Filed:**	None
Destination:	Bryce Canyon, UT (BCE)	**Type of Clearance:**	None
Departure Time:	18:42 Local	**Type of Airspace:**	

On May 25, the day that the airplane arrived at FLG, the daily maximum recorded temperature of 22 degrees C was reached about noon, and lasted until about 1500 local time.

On May 28, the day of the accident, 1157 FLG automated weather observation included wind from 210 degrees at 17 knots, gusting to 26 knots, visibility 10 miles, clear skies, temperature 18 degrees C, dew point minus 4 degrees C, and an altimeter setting of 29.95 inches of mercury.

Airport Information

Airport:	Flagstaff Pulliam Airport FLG	**Runway Surface Type:**	Asphalt
Airport Elevation:	7014 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	21	**IFR Approach:**	None
Runway Length/Width:	8800 ft / 150 ft	**VFR Approach/Landing:**	None

FAA information indicated that the pilot's home airport, MCC, was situated at an elevation of 77 feet above mean sea level.

FAA information indicated that FLG runway 3/21 measured 8,800 by 150 feet, and the airport elevation was listed as 7,140 feet above mean sea level. The runway was served by a single parallel taxiway ("alpha") with 9 access taxiways between the two. There was no dedicated runup area at either runway threshold. A dedicated runup area was situated on taxiway alpha about midway between the ramp and the runway 21 threshold, and the end of the taxiway could also be utilized for that purpose.

The airport was situated in a 2- to 3-mile wide valley that was oriented approximately north-south, with a gentle continuous descent to the south.

Calculations using the meteorological conditions at the time of the accident resulted in an airport pressure altitude of 6,983 feet, and a density altitude of 8,983 feet for FLG.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	2 Fatal	**Latitude, Longitude:**	35.082778,-111.667778(est)

The accident site was located in the semi-rural neighborhood of Mountainaire, on moderate- to heavily-forested Coconino National Forest (CNF) property. The impact location was about 2.9 nautical miles (nm) from the departure end of FLG runway 21, on a true bearing of 170 degrees (158 magnetic) from that runway location. Impact site elevation was 6,815 feet. Review of topographic data revealed that virtually all of the terrain between the departure end of FLG runway 21 and the impact location was lower than the airport.

The impact site was situated about 1 nm to the east of the southern end of a straight section of a four-lane north-south highway that measured 1.15 nm in length, began about 1.17 nm from the threshold of runway 3, and was at an elevation of about 6,700 feet.

The airplane struck several tall pine trees before it struck the ground. The first tree impact was situated about 40 feet above ground level. The depression angle of the flight path through the trees was about 14 degrees. The distance from the first tree strike to the main wreckage, which primarily consisted of the fuselage from tail to propeller, was 135 feet, on a true heading of 180 degrees.

All major components were accounted for on scene. No evidence consistent with in-flight fire or in-flight structural failure was observed. Propeller and tree damage was consistent with the engine developing power at the time of impact.

The fuselage came to rest upright, on an approximate true heading of 322 degrees. Tree impacts had separated the right wing and the outboard section of the left wing from the airplane. The engine was separated from all four engine mounts, but remained adjacent to the firewall. The propeller remained attached to the engine. The fire consumed or severely damaged a significant portion of the fuselage, including the cockpit instruments and controls, and the cabin and its contents. Due to the fire damage, no useful information was able to be obtained from any cockpit instruments, switches, circuit breakers, or engine controls.

Communications

Partial transcripts of the FLG ATCT ground and local communications surrounding the flight and accident were developed and provided by Serco, the company contracted by the FAA to staff and operate the ATCT.

At 1125:45, the pilot first radioed the ground controller, and advised that he was "ready to taxi," but did not specify any additional intentions. The controller cleared the airplane to runway 21 via the alpha and alpha one taxiways, which the pilot acknowledged. About 5 minutes later the pilot advised the ground controller that he did not realize that there was no run-up area near the runway 21 threshold, and asked for instructions to prevent a conflict with a twin-Cessna behind him. The controller and other pilot rectified the situation by routing the twin-Cessna via another taxiway. At 1136:21, the pilot of the Cessna 172 N3923Q who later witnessed the accident, contacted the controller for taxi clearance to runway 21.

At 1137:20, the Beechcraft pilot first radioed the local controller, and advised that he was "ready for takeoff headed to Tuba City." A few seconds later, the controller cleared the airplane for takeoff, to which the pilot responded "ready for takeoff taking runway two one can you tell me which way for a uh uh downwind departure?" The controller instructed the pilot to make a left downwind, and the pilot acknowledged that communication.

At 1139:24, Cessna 172 N3923Q radioed the local controller that he was ready for takeoff from runway 21, requested a left turnout, and was cleared for same a few seconds later. At 1141:44, the Cessna pilot stated that he was making his left turn, and asked the controller whether the Beechcraft was "okay, he is awful low." At 1141:51, the controller asked if the Beechcraft pilot needed any assistance, and the pilot responded "yah...I'm climbing very slowly and uh I'm climbing very slowly and staying close to the airport." At 1142:15, the Cessna pilot radioed that he did not "understand why he didn't stay over the interstate." At 1142:47, the Cessna pilot radioed that the Beechcraft had crashed and was on fire; the pilot circled the impact location for several minutes in an attempt to guide first responders to the site.

After the accident, the ground controller and the local controller each provided a written statement regarding the flight and accident. Neither statement explicitly cited whether its author actually witnessed the takeoff or climbout. The local controller's statement reported that he was advised of the Beechcraft climb problem by the subsequently-departing Cessna.

Medical and Pathological Information

The Coconino County (Arizona) Office of the Medical Examiner autopsy report indicated that the cause of death was "thermal injuries." The FAA Civil Aeromedical Institute conducted forensic toxicology examinations on specimens from the pilot, and reported that no cyanide or ethanol was detected. The reported blood carbon monoxide level was 15 percent. Alpha-hydroxyalprazolam, a metabolite of alprazolam (trade name Xanax), was detected at a level of 0.009 micro-grams per milliliter in the urine, but was not detected in the blood. No other screened drugs were detected.

Additional Information

Airframe Examination Details

About 8 feet of the left wing, and the entire right wing, were fracture-separated from the airplane. The left tip tank did not contain any fuel, and did not display any signatures of hydraulic deformation. The right tip tank was breached, did not contain any fuel, and did not reveal any hydraulic deformation. Significant portions of each wing, including both fuel tank bladders were significantly or completely consumed by fire.

Both ailerons remained attached to their respective wings at all mounting hinges, and sustained thermal damage. Aileron cable continuity was established from the right and left control column sprockets to the right and left aileron bellcranks. The aileron trim actuator remained intact and attached to the left wing. The aileron trim actuator extension equated to 2 degrees left tab trailing edge up.

The flaps and flap actuators were all found to be in the flaps-retracted position. Although significantly fire-damaged, the speedbrakes appeared to be in the retracted position at impact.

The horizontal stabilizers remained attached to the aft fuselage and displayed post-impact fire exposure. The left and right elevators, including their balance weights, remained attached to the horizontal stabilizers at the hinges. Elevator control cable continuity was established from the control column to the elevator bellcrank.

The left and right elevator trim surfaces remained attached to their respective elevators at their hinges. The elevator trim actuator extensions equated to approximately 6 degrees tab trailing edge down. Elevator trim cable continuity was confirmed from its cockpit control wheel to the actuators in the empennage.

The vertical stabilizer was fracture-separated from the aft fuselage at its spar roots. A portion of the rudder torque tube, the rudder bellcrank, and fragments of the rudder remained attached to the aft fuselage. The remainder of the fracture-separated rudder, including the rudder balance weight, was found near the aft fuselage. Continuity determination of the rudder control system was limited due to fire damage.

No pre-impact anomalies such as corrosion, wear, or misrouting, were observed on the primary or secondary flight control cables, but thermal and impact damage precluded a complete determination of the cables' pre-accident condition. All cable damage was attributed to impact overload and/or thermal exposure.

Both main landing gear assemblies were found in their retracted positions. The nose landing gear appeared to be in a near-retracted position.

Engine and Fuel System Examination Details

The engine came to rest upright, leaning towards its left side. The throttle, propeller, and mixture control cables remained attached to the throttle quadrant and their respective engine components.

The two magnetos were found properly secured to their mounting pads on the engine. Magneto-to-engine timing testing determined that both magnetos were timed to within 1 degree of the manufacturer's setting, and within 1 degree of each other. Due to the thermal damage the magnetos were shipped to Continental Motors. Examination of the magnetos did not reveal any pre-impact anomalies. After the thermally-damaged capacitor in each magneto was replaced, the right magneto functioned normally, but the left magneto only operated intermittently. That failure was attributed to additional internal thermal damage to the magneto.

The ignition leads remained attached to the magnetos and spark plugs, but sustained significant thermal damage. All spark plugs were removed, and displayed a "normal worn" condition. However, the top and bottom spark plugs from the number 5 cylinder bore very light soot, and the number 5 top plug also held a globule of solidified lead down in its barrel, at the base of the insulator. There was no evidence of lead fouling on any of the other spark plugs. Oil on the number 2 bottom, number 4 bottom, and number 6 top and bottom spark plug electrodes was attributed to the engine orientation after it came to rest. With the exception of the top spark plug from the number 6 cylinder, which had a cracked insulator, all spark plugs produced sparks during bench testing.

Once the spark plugs were removed, the crankshaft was rotated manually. Thumb compressions were obtained on all six cylinders, which confirmed crankshaft, camshaft, connecting rod, and rocker arm continuity. With the exception of cylinder number 5, examination did not note any anomalies with the cylinder barrels, pistons, valves, or valve seats. The cylinder number 5 exhaust valve bore signatures characteristic of excessively lean operation and a possible exhaust gas leak.

No anomalies with the engine lubrication system were noted.

The electric boost pump motor was recovered and was observed to be significantly fire damaged. The pump was not recovered, and presumed to have been consumed by fire.

The engine driven fuel pump (EDP) remained securely attached to the engine, with all fuel lines and fittings in place. The EDP drive coupling was intact. Manual rotation of the drive coupling while installed in the EDP drive shaft resulted in rotation of the shaft; however, there was some binding noted, likely due to internal coking from post accident thermal exposure. Disconnection of the flexible fuel lines resulted in charred material exiting from some of those lines. Removal of the fuel line fittings from the EDP revealed a significant amount of accumulated material in the vapor return outlet port and fitting; no other ports contained similar material. Some material was removed and sent to the NTSB Materials Laboratory for examination. Spectral analysis yielded a strong match for polyester, which is often used as a braided interlayer in flexible fuel lines.

Additional unidentified accreted deposits were found in the EDP swirl chamber. The NTSB Materials Laboratory reported that there was not enough material from the swirl chamber of the EDP to analyze. No non-thermal anomalies were noted with the EDP.

The throttle body was consumed by fire. The throttle plate remained attached to the throttle shaft and lever. The throttle and mixture control levers remained securely attached to their respective control shafts. The mixture control shaft could not be rotated in the fuel metering unit via manual manipulation of the mixture control lever. Examination of the mixture control shaft revealed charred debris adhering to the shaft and walls of the metering unit. The fuel inlet and return fittings remained attached to the fuel metering unit. The fuel inlet screen was found to be unobstructed.

The fuel manifold valve and the injector lines remained intact and securely attached. The manifold valve diaphragm was observed to be stuck to the cap and the housing of the manifold valve, and tore when the cap was removed. The diaphragm was brittle; this was attributed to its post impact fire exposure. The plunger was secured to the diaphragm and the screen was clear. No obstructions or other anomalies were noted.

The fuel nozzles were removed from their respective cylinders. The nozzle from the number 5 cylinder displayed some debris within its discharge orifice, partially obstructing the nozzle. None of the other nozzles displayed any orifice obstructions.

The fuel selector valve was found set to the left main tank. The port from the left main fuel tank was open to the port leading to the engine, and the passageway was confirmed to be unobstructed.

The engine monitor was recovered from the wreckage and sent to the NTSB Recorders Laboratory for possible data download. Thermal damage precluded the recovery of any data from the device.

Propeller Examination

The three-bladed Hartzell propeller remained attached to the crankshaft propeller flange. All three propeller blades remained attached to the propeller hub, but two of the blades were separated from their pitch change links. The tips of both of those blades had been fracture-separated from the blades, but both tips were recovered on site. One of those blades had deep leading edge gouges, and the other one had moderate leading edge gouges. The third blade was bent aft about 30 degrees at its mid-span point. Its tip was curled aft more than 180 degrees, and the blade displayed heavy leading edge gouging, primarily on the outboard span section. All damage was consistent with the propeller being driven under power at impact.

Detailed examination at the Hartzell facility confirmed that the propeller model was appropriate for the airplane, and did not reveal any pre-impact anomalies.

Cabin Air Conditioning System

The compressor of the refrigerative-type cabin air conditioning system was powered by a pulley-drive system on the engine accessory face. The system was operable on ground and in flight. The system was manually turned on or off by a dedicated toggle switch on an instrument panel subpanel, and delivered cooled air via the cabin ventilation "eyeball outlets."

An automatically-positioned three position air intake door was located on the fuselage belly. The door was closed when the system was off. When the system was operating, the door opened to an intermediate position in flight, and to its maximum limit when the airplane was on the ground. When the door was extended to its maximum position, an "AC DOOR EXTEND" annunciation light on the instrument panel would be illuminated.

The system was prohibited from use during takeoff, but could be turned on during climb by the pilot once obstacle clearance was assured. In the event of a go-around while the system was operating during a landing approach with the landing gear extended, when full throttle was applied, a throttle control limit switch would deactivate the compressor to terminate power extraction from the engine, and retract the intake door to reduce drag. Once the landing gear was retracted or the throttle was retarded, following a 20-second delay, the system would resume operation; the intake door would re-open, and the compressor would re-engage.

The only performance-related information in the Pilot's Operating Handbook (POH) was that cruise speed and range values were to be decremented by 5 percent with the air conditioning operating. The POH did not provide any information regarding the horsepower usage by the system, or system usage on climb performance.

FBO Fuel

As noted previously, the airplane was fueled with 40 gallons from the FBO on the morning of the accident. Several other airplanes were refueled from the same source prior to the accident airplane, and at least two (including the FBO owner's twin-engine airplane) were refueled after the accident airplane; all those airplanes were operated successfully and uneventfully after their respective refuelings. A fuel sample was obtained and tested in accordance with the fuel vendor's procedures; the FBO owner reported that no anomalies or problems with the fuel were detected.

Witness Information Regarding the Pilot

The CFI who helped the pilot fly the accident airplane to California after its purchase, and who conducted the pilot's February 2013 flight review in that airplane, stated that the pilot met the minimum standards for the flight review, and that there was nothing remarkable about the review. The CFI who was working with the pilot on his instrument rating stated that the pilot was "pretty cautious," and that his "basic stick and rudder skills" were "solid;" the CFI had "no doubt" about the pilot's flying abilities.

On the morning of the accident, the lodging proprietor asked the pilot if he was used to flying at high elevation airports; the pilot responded that he was "not familiar" or "used to" such operations. The pilot then stated that he was planning to fly to Bryce and Zion National Parks, in Utah, north-northwest of FLG. He also stated that FLG was 300 feet lower than that next destination, but that he was not particularly concerned about that trip segment.

According to the owner of the FBO, the pilot asked about a recommended route of flight to Bryce

Canyon and Zion National Parks. The FBO owner provided that guidance, and showed the pilot the routing on a chart. The pilot was unfamiliar with the fact that the Grand Canyon, which was situated between FLG and the pilot's destination, had designated airspace constraints, and that there was a dedicated VFR chart for that airspace. The pilot was also unfamiliar with the procedures and constraints of Military Operations Areas. Because of the pilot's age, and the sophistication and complexity of the airplane that he was flying, the FBO owner was surprised by, and not favorably impressed with, the pilot's lack of knowledge and preparation.

Airplane loading and other pre-flight preparations appeared to be relatively normal, but the FBO owner noted that the pilot made several inexplicable trips between the airplane and the FBO, possibly as a result of "absentmindedness."

Cessna Pilot Witness Information

The pilot of the Cessna 172 that departed about 75 seconds behind the Beechcraft observed a portion of its flight and the accident. He did not observe the Beechcraft take off. The Cessna pilot observed the Beechcraft climbing "very slowly" on the runway heading. He reported that the Beechcraft maintained the runway heading until it was beyond the end of the runway, and then it turned slightly left, towards the south, and initially appeared to be following the nearby four-lane highway (Interstate 17). By the time the Cessna reached the end of the runway, it was higher than the altitude of the Beechcraft ahead. The Cessna pilot initially thought that perhaps the Beechcraft pilot was sightseeing. However, because the Beechcraft continued to remain extremely low, and appeared to be descending, the Cessna pilot queried the controller about the Beechcraft's situation. The Cessna pilot observed the Beechcraft making repeated small banks to the left and right, and watched the Beechcraft ground track become south-southeasterly, divergent from the interstate highway. The Cessna pilot then observed the Beechcraft continue to make repeated small banks as it descended, and then impact the trees and burst into flames. During his conversation with investigators, the Cessna pilot stated that he observed the Beechcraft turn towards rising terrain, and could not understand why its pilot did not either turn towards lower terrain (the descending valley to the south), or remain over the nearby four-lane interstate highway.

Air Traffic Control Radar Information

FAA air traffic control ground tracking radar data was examined to ascertain whether the accident flight was tracked by the radar system, and to derive a flight path if possible. The geographic locale is primarily served by two FAA radar antennae. One was situated about 73 miles west-northwest, and the other was situated about 80 miles south of FLG. Antenna site distances from the accident site, combined with mountainous topography, yielded a radar coverage floor estimated to be about 8,500 feet msl. The radar systems did not detect the airplane on its accident flight. The radar systems did intermittently detect the eyewitness Cessna 172; the minimum altitude detected was 8,700 feet msl.

Estimated Airplane Performance Capability

The investigation was unable to obtain any current or previous airplane empty weight or center of gravity (CG) information. Interviews with relatives and witnesses at FLG indicated that the pilot and passenger did not have a significant amount of luggage, and that the fuel tanks were not filled. FAA records did not indicate that the airplane maximum takeoff weight of 3,650 lbs had been increased via any supplemental type certificates (STCs).

Although the evidence suggested that the airplane was significantly below its maximum allowable takeoff weight, for conservatism, the investigation assumed that the airplane was at a weight of 3,600 lbs for the departure, and also assumed zero-wind conditions. Best angle of climb speed was 84 knots, and best rate of climb speed was 100 knots.

The POH provided performance data for takeoff using both zero flaps and "approach flaps" (12 degrees); the actual takeoff flap setting was not able to be determined. For zero flaps, the prescribed rotation speed was 72 knots, and the speed at 50 feet was 83 knots. For approach flaps, those speeds were 67 and 77 knots, respectively.

According to the manufacturer's performance data, for zero flaps, the takeoff ground roll would have been about 2,875 feet, and the total distance to 50 feet above ground level (agl) would have been about 5,270 feet. For a takeoff with approach flaps, the ground roll would have been about 2,336 feet, with a total distance to 50 feet agl of about 4,552 feet. The initial climb rate after flap retraction would have been about 512 feet per minute (fpm).

Factors Affecting Climb Performance

An airplane's climb capability is a function of its "excess power," which is defined as the difference between the power required to fly level at a given speed, and the power available at that same speed. When the power available exceeds the power required, the airplane will have a positive climb capability. Several factors can adversely affect airplane takeoff performance and climb capability, by either affecting the power required or the power available.

Power required is due to aerodynamic drag. Increased drag can be due to exit from ground effect, airplane condition or configuration (e.g. flap setting, or landing gear or air conditioning door extended), speedbrake deployment, incorrect climb speed, or increased weight.

Power available is a combination of engine power output, and the ability of the propeller to convert that power to thrust. In non-turbocharged piston engines, power output decreases with altitude. Propeller thrust typically decreases with speed; therefore, overall power available typically decreases directly as speed and altitude increase. Other factors that can decrease the power available include improper throttle or mixture setting, throttle or mixture malfunction; improper propeller blade pitch due to improper setting or malfunction; or air conditioning compressor operation.

The power output of a normally aspirated engine decreases with the decrease in air density that is due to increased altitude or increased density altitude. Turbocharging reduces or eliminates power losses due to increases in altitude or density altitude. On a comparative basis, at the high elevation, high density altitude departure airport, the takeoff and climb performance of the pilot's turbocharged Cessna would likely not have been adversely affected, whereas the takeoff and climb performance of his non-turbocharged Beechcraft was significantly reduced from its sea-level capability.

Ground Effect

The following paragraphs are synopsized from the Airplane Flying Handbook (AFH, FAA-8083-3).

Ground effect is a condition of improved performance encountered when the airplane is operating very close to the ground. The performance improvement is a result of a reduction in induced aerodynamic drag. Ground effect is most significant during takeoff when the airplane lifts off and accelerates to climb speed, and during the landing flare before touchdown.

The takeoff roll, lift-off, and beginning of the initial climb take place in the ground effect regime. As the airplane lifts off and climbs out of ground effect, the airplane will experience an increase in induced drag, and therefore thrust required, to maintain that speed or accelerate. The airplane will experience a pitch-up tendency, and will require less elevator deflection, due to the increase in downwash at the horizontal tail.

Due to the reduced drag in ground effect, the airplane may appear to be able to take off below the prescribed airspeed. However, as the airplane rises out of ground effect with an insufficient airspeed, initial climb performance may prove to be marginal, because of the increased drag. Under conditions of high-density altitude and/or maximum gross weight, the airplane may be able to become airborne at an insufficient airspeed, but unable to climb out of ground effect. Consequently, the airplane may not be able to clear obstructions.

Additional power is required to compensate for the increased drag that occurs as the airplane leaves ground effect. However, during an initial climb, because the engine controls have already been set to develop maximum (takeoff) power, the only alternative is to lower pitch attitude to gain airspeed, which will result in an altitude loss. Therefore, for takeoffs under marginal conditions, it is imperative that the airplane be operated at the prescribed airspeeds, in order to provide adequate initial climb performance.

Aerodynamic Drag Factors

The as-found condition of the airplane indicated that the landing gear, flaps, and speedbrakes were retracted, which was the proper minimum drag climb configuration. The investigation was unable to determine when the landing gear was retracted, or whether the speedbrakes had been extended for the takeoff and climb attempt. Post-accident position of the cabin air conditioning system intake door was not determined, but operational procedures and system design precluded a takeoff and initial climb with the intake door open, a configuration that would have increased drag. No preimpact anomalies that would have increased the basic aerodynamic drag of the airplane were observed.

Climb Speed

The power required versus speed curve is roughly "U" shaped, with the bottom of the "U" denoting the minimum drag speed. Normal operating climb speeds are typically set near the minimum drag speed of the airplane, with some additives for factors such as stall margin and engine cooling. Because there was no ground tracking radar or applicable onboard data available, the investigation was unable to determine whether the pilot adhered to the manufacturer-specified climb speed schedule. Deviations from the specified speed could reduce the airplane climb capability, and a speed much below the best angle of climb speed of 84 knots could significantly affect climb capability.

The power-off clean stall speed was about 69 knots; the manufacturer did not publish power-on stall speeds for the airplane. Power-on stall speeds are typically several knots lower than power-off stall speeds. The repetitive, small, left and right bank angles observed by the Cessna pilot were consistent with the behavior of an airplane approaching a stall, but those motions could have been caused by other factors, including pilot input and turbulence. There was no evidence to indicate that the airplane fully stalled during any portion of the flight.

Airplane Weight and Balance

As noted previously, all evidence was consistent with the airplane being within its certificated weight and balance envelope.

Engine Power

Engine power was directly affected by throttle and mixture settings. The POH specified that full throttle was to be used for takeoff and climb. There was insufficient evidence to enable a determination of whether the pilot set and maintained full throttle for the takeoff and climb attempt.

According to the POH, the takeoff mixture was to be set "as required by field elevation," by adjusting the full throttle fuel flow as a function of engine rpm, in accordance with a schedule in the POH. According to that schedule, based on the pressure altitude of 7,000 feet, the full-throttle fuel flow values should have been 23.2 gallons per hour (gph) at 2,700 rpm, or 21.2 gph at 2,500 rpm. The airplane was equipped with a fuel flow transducer and cockpit display to enable compliance with the schedule, and thus proper mixture setting. The investigation was unable to determine the pilot's familiarity with this procedure, or what mixture-setting procedures, if any, he conducted prior to the accident takeoff, or during the climb attempt.

Off-Schedule Fuel Mixture Effects

The pre-takeoff leaning schedule of the fuel mixture for high-elevation airport operations is designed to enable the engine to produce best power in the decreased-air-density environment. In contrast, engine leaning during cruise is accomplished to both adjust the mixture for the air density, as well as adjust the engine power for values below full power, and thereby, modulate the fuel economy.

In general, engines operated at off-schedule fuel mixtures will exhibit certain characteristic signatures which indicate whether the mixture was overly rich or overly lean. Engines that are operated on an overly rich fuel mixture will accrete unburned fuel in the form of dark carbon deposits in the cylinders and exhaust system, and can emit exhaust visible as dark smoke. In contrast, engines that are operated on an overly lean fuel mixture will be characterized by cylinders and exhaust systems with either a "clean" appearance, or fine whitish, tan, or light gray deposits. The investigation was unable to locate any detailed or substantiated data regarding the development or disappearance of these signatures as a function of time that an engine is operated at a particular off-schedule mixture.

As part of the engine certification process, CMI conducted engine power tests that measured power output as a function of fuel flow (and thus, mixture) for two different baseline, but less than full, power settings. Review of the test data indicated that power increased as a function of fuel flow (in pounds per hour, pph) to a certain point, then peaked or flattened out, and then decreased. Using either that peak, or the peak brake specific fuel consumption (BSFC, pounds of fuel per HP per hour) as the dividing line, the rate of power change per pph of fuel flow was greater on the lean sides of those lines than it was on the rich sides of the lines. Furthermore, when the peak BSFC line was used as the dividing point, the rate of power change per pph was significantly greater on the lean side than it was on the rich side.

The investigation did not obtain any similar mixture variation data for full power settings, and therefore was unable to determine the effects of off-schedule fuel mixtures on engine power for takeoff and initial climb.

Partially Obstructed Fuel Nozzle

A 1997 article in "Aviation Maintenance Technology" magazine stated that the most common form of fuel nozzle contamination happens as fuel evaporates in the nozzles after hot engine shut-downs. This evaporative process leaves deposits of varnish residue which buildup over time, and inhibits the free flow of metered fuel to the cylinders. If left unattended, nozzles begin to become blocked, but the contamination is not typically limited to a single nozzle.

The airplane was equipped with a turbine/rotary fuel flow transducer, as opposed to the pressure-type flow transducer. Because the rotary-type transducers measure the flow directly, they are not subject to the erroneous fuel flow indications of the pressure-type transducers when one or more fuel nozzles become partially or fully blocked.

The number 5 cylinder fuel injector nozzle was found to be partially blocked, which could result in lean operation and reduced power output of that cylinder, possibly accompanied by engine roughness and altered CHT and EGT values; the effect on each parameter would be proportional to the degree of blockage. The exhaust valve for that cylinder bore signatures characteristic of excessively lean operation. There was insufficient evidence to enable the investigation to determine the source of the blockage, quantify its effects, or its relation to the condition of the exhaust valve. There was also insufficient evidence to determine when the blockage occurred, including whether it was an artifact of the post-impact fire.

Engine-Driven Fuel Pump Debris

The investigation was unable to determine when the deposits were formed in the vapor return outlet or the swirl chamber of the engine-driven fuel pump, but their appearances were consistent with the results of a post impact fire. Partial or complete blockage of the vapor return line would result in an enrichment of the mixture, because that line is the primary flow path for the return of excess fuel from the pump output, which is utilized in a venturi setup to aid in vapor extraction. There was insufficient information to determine the engine power effects, if any, of that mixture change if the vent line was partially or completely blocked during the accident flight. The swirl chamber deposits did not occlude any orifices, or appreciably reduce the volume of the swirl chamber.

Backfiring and Detonation

Some of the signatures of backfiring and detonation were consistent with the available physical or witness report evidence.

According to the FAA Aviation Maintenance Technician Handbook, Powerplant (FAA-8083-32), "an extremely lean mixture either does not burn at all or burns so slowly that combustion is not complete at the end of the exhaust stroke. The flame lingers in the cylinder and then ignites the contents in the intake manifold or the induction system when the intake valve opens. This causes an explosion known as backfiring." The Handbook stated "A point worth stressing is that backfiring rarely involves the whole engine... In practically all cases, backfiring is limited to one or two cylinders. Usually, it is the result of ... defective fuel injector nozzles, or other conditions that cause these cylinders to operate leaner than the engine as a whole." Backfiring will result in a loss of power and characteristic "popping" sounds from the engine, which is congruent with the available evidence.

According to the Pilot's Handbook of Aeronautical Knowledge (PHAK, FAA-8083 25), detonation "is an uncontrolled, explosive ignition of the fuel/air mixture within the cylinder's combustion chamber" that can result in engine overheating, roughness, or loss of power. The PHAK cited one common cause of detonation as "operation of the engine at high power settings with an excessively lean mixture," and cited one preventative measure that pilots should "develop the habit of monitoring the engine instruments to verify proper operation according to procedures established by the manufacturer."

The FAA Aviation Maintenance Technician Handbook, Powerplant (FAA-8083-32) stated that "Unless detonation is heavy, there is no flight deck evidence of its presence," and the "effects of detonation are often not discovered until after teardown of the engine."

Although the No. 5 cylinder condition was consistent with excessively lean operation, none of the cylinder assemblies, including No. 5, displayed any evidence of detonation.

Propeller Blade Pitch Setting

The blade pitch angles for the installed model propeller were measured at the 30-inch blade station, with a certificated travel range of 13 to 36 degrees. Takeoff procedures specified that the propeller pitch cockpit control be set to full forward. According to information provided by Beechcraft, at takeoff power, at a speed of 90 knots for the given ambient conditions, the estimated propeller blade angle would have been 17.7 degrees. Impact witness marks indicated that the blade pitch setting was about 25 degrees. Evidence found at the accident site indicated that the propeller sliced through a number of trees and tree branches before contacting the rocky ground. Therefore, the investigation was unable to determine when the witness marks were made, and could not discount alteration of the blade pitch angles, without producing any witness marks, as the airplane descended through the relatively soft pine trees. Therefore the investigation was unable to determine whether the propeller blade pitch was set correctly for the takeoff and climb attempt.

Cabin Air Conditioning Operational Status

The recorded air temperature at FLG about the time of the accident was 18 degrees C (64 degrees F), which was not consistent with the use of cabin air conditioning. Even if the ambient temperature was conducive to the use of air conditioning, operational procedures and system design safeguards prevented the cabin air conditioning system compressor from extracting power from the engine during a takeoff and initial climb. The investigation was unable to determine the operational status of the air conditioning compressor during the takeoff and climb attempt.

Administrative Information

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Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=87011