Aviation Investigation Final Report

Location:	Baker City, Oregon	**Accident Number:**	WPR18FA218
Date & Time:	August 11, 2018, 10:17 Local	**Registration:**	N231EC
Aircraft:	Mooney M20K	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and student pilot-rated passenger were in a high-performance airplane and inbound for landing. Multiple witnesses saw the airplane on the downwind leg of the airport traffic pattern; one witness estimated that the airplane was lower and closer to the runway than a typical traffic pattern. Witnesses then saw the airplane begin a left turn, and one reported that the airplane then rapidly transitioned to a nose-down descent.

The wreckage location corresponded to an extended downwind-to-base turn; there was ample space available for the pilot to initiate the turn to final without excessive flight control inputs. The airplane appeared to be in the landing configuration, and debris distribution and damage indicated a near vertical, nose-down impact, consistent with the airplane impacting the ground while in a spin.

Postaccident examination did not reveal any anomalies with the airframe or engine that would have precluded normal operation, and the engine appeared to be operating at the time of impact; however, evidence suggested that the airplane's engine-driven vacuum pump had recently failed. Such a failure would have resulted in multiple visual alerts, caused the vacuum-operated instruments to become inoperative, and prevented operation of the airplane's speed brakes. The airplane was equipped with a backup vacuum system; however, impact damage prevented an accurate assessment of its operational status at the time of the accident. The vacuum pump had exceeded its manufacturer's recommended replacement life and had been subjected to multiple sudden engine stoppage events, each of which required replacement of the pump; however, there was no indication in the airplane's logbooks that the pump had been replaced following these events.

Although none of the systems that relied on the vacuum pump were critical for visual flight rules operation, such a failure would have presented an operational distraction to the pilot that would have competed for his attention while flying in the pattern. Based on witness reports and the location of the wreckage, it is possible that he extended the downwind leg to attempt to manage the failure or in an effort to slow the airplane further in order to land without the speed brakes.

The presence of a systems failure may have exceeded the pilot's capability to appropriately divide his attention between airplane control and systems management. The pilot had relatively low flight experience and had demonstrated poor situational awareness and pilot resource management during his initial private pilot practical test, which he failed on the first attempt. He was also involved in a hard landing with the accident airplane about 2 months before the accident, resulting in damage to the propeller and landing gear. His flight instructor expressed concern that the complex, high-performance airplane was too fast and advanced for the pilot's level of experience. He recounted how the pilot often struggled with maintaining a stabilized landing approach and often allowed the airplane to "get ahead of him."

It is likely that the pilot became distracted during the landing approach and allowed the airplane to slow down and exceed its critical angle of attack during the turn from the downwind to base leg, resulting in an aerodynamic stall and spin at an altitude too low for recovery.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's exceedance of the airplane's critical angle of attack during the landing approach as a result of his diversion of attention after a series of non-essential aircraft systems became inoperative following the failure of the engine-driven vacuum pump, which resulted in an aerodynamic stall/spin.

Findings

Aircraft	Angle of attack - Capability exceeded
Aircraft	Airspeed - Not attained/maintained
Personnel issues	Aircraft control - Pilot
Personnel issues	Attention - Pilot
Aircraft	(general) - Fatigue/wear/corrosion
Personnel issues	Total experience w/ equipment - Pilot

Factual Information

History of Flight

Enroute	Flight instrument malf/fail
Approach-VFR pattern base	Loss of control in flight (Defining event)
Approach-VFR pattern base	Aerodynamic stall/spin
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On August 11, 2018, at 1017 Pacific daylight time a Mooney M20K, N231EC, was substantially damaged when it was involved in an accident near Baker, Oregon. The private pilot and student pilot-rated passenger were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

About 1015, a pilot who was in his hangar about 1,300 ft southwest of the runway 31 midfield at Baker City Municipal Airport (BKE), observed a low-wing airplane flying directly overhead toward the south. It caught his attention because it was inside the normal left downwind traffic pattern but was flying lower than appropriate, between 600 and 700 ft above ground level (agl). He then heard the airplane reduce engine power to a setting that seemed appropriate for an airplane descending to land. He did not see the airplane emitting any smoke or vapors. He anticipated watching the airplane land, but did not see it.

About the same time, the owner of a local fixed base operator located on the airfield heard the pilot of the accident airplane report that he was on final for runway 31. She did not hear the pilot make any additional calls, and did not hear the airplane land.

Multiple witnesses located south of the airport recounted seeing a low-wing airplane flying south-southeast in a direction typically followed by airplanes making a landing similar to the approach for runway 31. Two witnesses saw the airplane begin a left turn out of view beyond trees, followed by the sound of an impact. One witness saw the airplane turn, then immediately transition to a rapid, nose-down descent. Another witness located under the approach path for runway 31 saw the airplane fly overhead to the south and then off into the distance. Based on its location, he assumed it had just taken off, and a short time later, he looked back and could no longer hear the airplane, but saw that it was in a nose-dive.

Pilot Information

Certificate:	Private	**Age:**	77,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:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	January 31, 2018
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	January 5, 2018
Flight Time:	248 hours (Total, all aircraft), 50.4 hours (Total, this make and model), 21 hours (Last 90 days, all aircraft), 3.2 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Student pilot Information

Certificate:	Student	**Age:**	70,Female
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	January 31, 2018
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	40 hours (Total, all aircraft), 6 hours (Total, this make and model)		

Pilot

The pilot held a private pilot license certificate with a rating for airplane single-engine land, issued on December 7, 2016. The pilot's most recent flight instructor stated that he was initially approached by the pilot after another instructor had provided initial flight training. After his initial assessment, the instructor was concerned that the training would take a long time to complete, and after about 70 hours of instruction, the pilot was ready to solo. As the training progressed, the instructor was still concerned that the pilot was not learning and developing quickly enough and often flew "behind the power curve," allowing the airplane to "get ahead of him."

The pilot initially failed the practical test for his private pilot certificate on November 28, 2016. His disapproval notice stated, "Demonstrated poor situational awareness and single pilot resource management during cross country execution. Power on stall with turn was unsat[isfactory] as well." He was reexamined, and passed the practical exam on his second attempt.

The pilot had 101 hours of flight experience (69.5 hours dual) by the time he was issued his private pilot license, the majority of which was in a Cessna 152. After receiving his pilot's license, the pilot told the instructor that he was looking for a faster airplane to commute in and was interested in a Mooney. The instructor expressed concern that the Mooney was too fast and complex for the pilot's level of

experience.

The pilot transitioned to a Piper PA-28-180 and continued to receive flight instruction. He received his high-performance/complex airplane endorsement on January 5, 2018, after 7.5 hours of instruction in a Cessna 210.

The instructor stated that, after the first 5 flight lessons while training for his high-performance/complex airplane endorsement, the pilot was insistent that he was ready to fly solo, but the instructor disagreed, and as a test, they performed a short cross-country flight with the instructor observing. The instructor reported that the flight did not go well and that as they approached an airport for landing, the pilot selected the wrong advisory frequency, flew the downwind approach well above traffic pattern altitude (2,000 ft agl), and did not see another airplane that was on the runway. The instructor interjected, and the pilot continued to fly the airplane at high speed, past the airport, while trying to establish a stabilized approach. Eventually, the instructor asked him to turn onto the base leg, and by the time they had reached the final leg, he had still not extended the landing gear. When the instructor asked him to go-around, he instead extended the landing gear, and then forgot to retract it during the subsequent climbout.

The instructor stated that the pilot consistently had difficulty maintaining the correct approach speeds and often landed hard. He had trained the pilot in the use of speed brakes during the landing approach. About 2 months before the accident, the pilot landed the airplane so hard that it sustained a propeller strike and the nose gear was damaged.

The pilot continued to receive flight training, and by the time of the accident, he had accrued 50.4 hours of flight experience in the accident airplane make and model, 32.4 hours of which were solo. He last received flight instruction on June 9, 2018.

The pilots flight logbooks indicated that he had flown to BKE one time before, on April 18, 2018, for what was a solo flight in the accident airplane.

Student Pilot-Rated Passenger

The passenger was the partner of the pilot. She held a student pilot certificate issued on April 9, 2018, and a third-class medical certificate issued on January 31, 2018. At the time of examination, she reported 6 total flight hours in the preceding 6 months. No pilot logbooks were recovered; however, the pilot's instructor stated that the passenger had about 40 hours of flight experience.

The pilot's daughter stated that her father typically likes to fly with pilots who are more experienced than him. Likewise, an acquaintance of the passenger also stated that the pilot was interested in having a "flying buddy" fly with him. Both the instructor and the acquaintance stated that in recent discussions, the passenger had confided that both her and the pilot still found landing problematic, and that the pilot often had problems slowing the airplane, particularly for landing. The passenger also stated that she had learnt to fly because she was not confident in the pilots flying abilities, and that his skills were not improving.

Aircraft and Owner/Operator Information

Aircraft Make:	Mooney	**Registration:**	N231EC
Model/Series:	M20K No Series	**Aircraft Category:**	Airplane
Year of Manufacture:	1979	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	25-0167
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	January 2, 2018 Annual	**Certified Max Gross Wt.:**	2900 lbs
Time Since Last Inspection:	56 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	3439.3 Hrs as of last inspection	**Engine Manufacturer:**	Continental Motors
ELT:	C91A installed, activated, did not aid in locating accident	**Engine Model/Series:**	TSIO-360LB(1)
Registered Owner:	On file	**Rated Power:**	210 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The pilot purchased the airplane on February 15, 2018. Since purchase, the maintenance was primarily performed by the pilot's instructor, who also held a mechanic certificate with airframe and powerplant ratings and inspection authorization.

The most recent maintenance entry in the engine logbook, dated June 4, 2018, was for a crankshaft dye penetrant inspection and propeller replacement after the propeller ground strike event involving the accident pilot.

The airplane was equipped with a Century 41 Autopilot. According to the instructor, the pilot preferred to hand-fly the airplane and never engaged the system.

The airplane was last serviced with 37.65 gallons of fuel on July 28, 2018, which was also the date of the last entry in the pilot's logbook.

The Mooney M20K Pilot's Operating Handbook (POH) Before Landing checklist stated the following:

CAUTION - From a flaps retracted trimmed condition, the force required for nose up pitch control will rapidly increase when power is reduced to idle and as flaps are fully extended. Timely trimming action should be accomplished to minimize forces. Control force change with extending landing gear is minimal."

According to the pilot's instructor, full nose-up trim was appropriate for the accident airplane during landing, as in his experience, the nose-down forces during landing were significant.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KBKE,3373 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	17:53 Local	**Direction from Accident Site:**	340°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.02 inches Hg	**Temperature/Dew Point:**	28°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Caldwell, ID (EUL)	**Type of Flight Plan Filed:**	None
Destination:	Baker City, OR (BKE)	**Type of Clearance:**	None
Departure Time:	10:30 Local	**Type of Airspace:**	Class D

Airport Information

Airport:	Baker City Muni BKE	**Runway Surface Type:**	Asphalt
Airport Elevation:	3373 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	31	**IFR Approach:**	None
Runway Length/Width:	5085 ft / 100 ft	**VFR Approach/Landing:**	Traffic pattern

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	44.813331,-117.793891

The wreckage was located in a pasture about 1 1/4 miles south-southeast of the runway 31 threshold, about 2,250 ft left of the extended runway centerline. The fuselage came to rest on a heading of about 090° magnetic and had sustained crush damage from the nose to the forward edge of the vertical stabilizer. Both wings exhibited leading-edge crush damage perpendicular to the wing chord, and the smell of aviation fuel was present at the site.

Airframe

The cabin flight controls and instrument panel were heavily damaged, along with the control yoke, rudder pedals, and all associated bellcranks and push-pull tubes, which were either fragmented, bent, or crushed through to their respective control surfaces. Each separation exhibited failure features consistent with overload. The throttle, mixture, and propeller controls were in the full forward position. The landing gear and flaps were found in their fully-extended positions, and the speed brakes were retracted.

Both wings remained attached to their respective wing roots at all attach points. Both sustained leading-edge crush damage, which compressed the aileron control cavity and buckled the skins to the main spar.

The moving tail section remained attached to the aft bulkhead, and the elevators remained attached at their respective hinges. Sixteen threads were visible on the stabilizer trim jackscrew actuator, which corresponded to a full nose-up trim position (about 25% beyond the power-off landing position). The elevator and rudder push-pull tubes were continuous from their control arms to the forward cabin.

The fuel supply lines from the tank to the forward cabin were intact and all fittings were secure. The remaining components of the fuel system sustained crush and fragmentation damage, and the gascolator was breached. The gascolator fuel filter was clear, and the fuel selector valve was in the left tank position.

Engine

The engine remained partially attached to the airframe via fuel lines, electrical wires, and engine controls. The fuel manifold valve and engine driven fuel pump supply lines contained fuel that had the odor of aviation gasoline, and was negative for water when tested with water-detecting paste.

The top spark plugs were undamaged. Their electrodes were coated in light grey deposits and exhibited "worn out – normal" wear signatures when compared to the Champion AV-27 Aviation Check-A-Plug chart. Visual inspection of the combustion chambers did not reveal any evidence of foreign object damage or detonation, and all combustion surfaces exhibited light grey deposits consistent with normal operation. There was no evidence of catastrophic engine failure, and mechanical continuity was established from the crankshaft through to the valve train and accessory section.

The turbocharger remained attached to the engine and its v-band clamps were secure. The inner surface of the exhaust pipe was coated in light brown deposits. The turbine wheel was coated in similar deposits, appeared undamaged, and could be rotated smoothly by hand.

Propeller

The propeller and hub had separated from the engine crankshaft and were buried about 12 inches into the turf just forward of the main wreckage at what appeared to be the initial impact point. Both blades had cut through the turf, which resulted in the propeller effectively becoming burrowed into the ground. Both propeller blades exhibited chordwise abrasions, and the separation point on the crankshaft exhibited a conical 45° shear lip around its entire circumference, with serrated, ratchet-like tear features around most of the crown.

Vacuum Pump

The airplane was equipped with a dry air vacuum pump, model 211CC, manufactured by Airborne. The pump remained attached to its accessory pad on the engine, and removal revealed that its plastic drive coupling had sheared. The separation surfaces exhibited a spiral scar at the core, with smear damage to the outer radius. Oil was present within the pump cavity, the rotor had shattered, and all six vanes were intact.

According to the Airborne Pneumatic System Maintenance Manual and Airborne Service Letter (SL) 43A, any oil contamination within the pump may cause failure, and requires replacement of the pump. Likewise, SL 38 stated that any vacuum pump installed on an engine that had sustained a sudden stoppage, such as a propeller strike during a gear-up landing, be replaced before the next flight. SL 58 prescribed mandatory pump replacement intervals and called for replacement at 500 aircraft hours or 6 years from date of manufacture, whichever occurred first.

The vacuum pump was manufactured and installed in 1994 and had accumulated about 1,400 hours of total flight time. During that period, the airplane had been involved in three propeller strikes, and the engine had been replaced twice. Maintenance records did not indicate that the pump had been replaced or serviced since installation.

The airplane was equipped with a standby vacuum system manufactured by Precise Flight in accordance with supplemental type certificate SA2168NM and SE1780NM. The system included an, "Instrument Source Pump Inop Warning" indicator composed of a red light emitting diode mounted on the left side of the instrument panel. The indicator was designed to alert the pilot of a vacuum pump failure. The airplane was also equipped with a vacuum pressure gauge along with a vacuum malfunction indicator light, which was designed to flash should the vacuum pressure drop to below 4 inches of mercury. The standby vacuum actuation cable had broken away from the actuation handle, and the pump shuttle valve sustained impact damage; therefore, the operational status of the system could not be determined.

The pilot's instructor/mechanic, who performed the last annual inspection and flew the airplane with the pilot on June 9, 2018, stated that the vacuum pump was operative at that time, and the pilot had not mentioned a failure since that time.

Speed Brakes

The airplane was equipped with a speed brake system manufactured by Precise Flight in accordance with supplemental type certificate SA2174NM. The system was driven by the airplane's vacuum system and comprised wing-mounted speed brake paddles operated by a suction bellows in the tailcone area. The brakes could be operated by a push button switch on the pilot's control yoke and a toggle switch on the instrument panel. In the event of a vacuum failure, closure springs retracted the speed brakes back into the wings.

The flight manual stated that the speed brake system was used for expedited descent at low cruise power, glide path control, and "lift dumping" in the landing roll.

Stall Warning System

The airplane was equipped with a vane-actuated stall warning switch installed in the left wing, which energized a stall warning horn located in the cabin. The switch had sustained crush damage to its forward bracket, but appeared to be functional when electrically tested. The pilot was utilizing a noise-cancelling headset; however, according to the instructor, the stall warning horn could be heard with the headset.

Medical and Pathological Information

According to the autopsy report from the Oregon State Police – State Medical Examiner, the cause of death for both occupants was multiple blunt force injuries. The examination was limited by the degree of injury; however, no significant natural disease for either occupant was identified.

Pilot

Toxicology testing performed by the FAA's Forensic Sciences Laboratory identified losartan and 6-beta-naltrexol in urine and liver for the pilot. Losartan is a prescription blood pressure medication and is not generally considered impairing. 6-beta-naltrexol is a metabolite of naltrexone. Records from the pilot's personal physician revealed that he had a history of Hashimoto's thyroiditis treated with a low dose of naltrexone. Thyroid treatment is an off-label use of the drug.

Student Pilot-Rated Passenger

The student pilot had not reported any medical conditions or medication use during her FAA medical examination.

Toxicology testing performed by the FAA's Forensic Sciences Laboratory did not identify any tested-for substances for the passenger.

Additional Information

The POH indicated a stall speed 56.4 KIAS (knots indicated airspeed) at a gross weight of 2,900 lbs, with full flaps, and forward center of gravity. At bank angles of 30°, 45°, and 60°, the stall speed increased to 60.2, 68.6, and 82.3 KIAS, respectively. The maximum flap extension speed was 112 KIAS, and the recommended final approach speed was 75 KIAS.

Based on the accident location relative to the runway 31 extended centerline, the turn radius required to turn from the downwind leg to the final approach would have been about 1,125 ft.

Airplane turning performance from Aerodynamics for Naval Aviators (NAVWEPS 00-80T-80), Figure 2.29, General Turning Performance (Constant Altitude, Steady Turn) indicated that an airplane with a true airspeed of 75 knots would have to bank 28° in order to fly a turn with a radius of 1,125 ft. At 112 knots, the bank angle required would have been 45°.

Preventing Similar Accidents

Prevent Aerodynamic Stalls at Low Altitude (SA-019)

The Problem

While maneuvering an airplane at low altitude in visual meteorological conditions, many pilots fail to avoid conditions that lead to an aerodynamic stall, recognize the warning signs of a stall onset, and apply appropriate recovery techniques. Many stall accidents result when a pilot is momentarily distracted from the primary task of flying, such as while maneuvering in the airport traffic pattern, during an emergency, or when fixating on ground objects.

What can you do?

- Be honest with yourself about your knowledge of stalls and your preparedness to recognize and handle a stall situation in your airplane. Seek training to ensure that you fully understand the stall phenomenon, including angle-of attack (AOA) concepts and how elements such as weight, center of gravity, turbulence, maneuvering loads, and other factors affect an airplane's stall characteristics.
- Remember that an aerodynamic stall can occur at any airspeed, at any attitude, and with any engine power setting.
- Remember that the stall airspeeds marked on the airspeed indicator (for example, the bottom of the green arc and the bottom of the white arc) typically represent steady flight speeds at 1G at the airplane's maximum gross weight in the specified configuration. Maneuvering loads and other factors can increase the airspeed at which the airplane will stall. For example, increasing bank angle can increase stall speed exponentially. Check your airplane's handbook for information.
- Reducing AOA by lowering the airplane's nose at the first indication of a stall is the most important immediate response for stall avoidance and stall recovery.
- Manage distractions when maneuvering at low altitude so that they do not interfere with the primary task of flying.
- Resist the temptation to perform maneuvers in an effort to impress people, including passengers, other pilots, persons on the ground, or others via an onboard camera.

"Showing off" can be a deadly distraction because it diverts your attention away from the primary task of safe flying.
- Understand that the stall characteristics of an unfamiliar airplane may differ substantially from those of airplanes with which you have more flight experience.

See https://www.ntsb.gov/Advocacy/safety-alerts/Documents/SA-019.pdf for additional resources.

The NTSB presents this information to prevent recurrence of similar accidents. Note that this should not be considered guidance from the regulator, nor does this supersede existing FAA Regulations (FARs).

Administrative Information

Investigator In Charge (IIC):	Simpson, Eliott
Additional Participating Persons:	Robert Nance; Federal Aviation Adminstration FSDO; Boise, ID Michael H Council; Continental Motors; Mobile, AL
Original Publish Date:	August 25, 2020
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=98042