



Aviation Investigation Final Report

Location:	Victoria, Minnesota	Accident Number:	CEN21FA360
Date & Time:	August 7, 2021, 17:40 Local	Registration:	N9156Z
Aircraft:	Mooney M20M	Aircraft Damage:	Destroyed
Defining Event:	Loss of control in flight	Injuries:	3 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and two passengers (one of whom was a student pilot) departed on a personal flight. The pilot was cleared by air traffic control (ATC) to fly an instrument landing system (ILS) approach in instrument meteorological conditions (IMC). About 10 miles from the runway while on final approach, the airplane slowed to 80 knots, tracked left of the approach course, accelerated to about 140 knots, and descended about 300 ft. The airplane subsequently turned right and descended below the designated altitude for the approach, which triggered a low-altitude alert that the controller transmitted, and the pilot acknowledged.

The airplane then abruptly turned left and entered a steep descent. The airplane continued in a left-turning spiral and descended below an overcast ceiling. The airplane subsequently impacted the ground upright about 8 miles west of the destination airport. Both wings and the right stabilizer were deflected upward in a vertical position. No preaccident mechanical failures or malfunctions were found with the airframe and engine that would have precluded normal operation. The airplane debris on the ground—the left horizontal stabilizer, left elevator, and part of the main wing spar upper cap splice plate—showed that an in-flight breakup occurred during the final seconds of flight.

The performance study for this accident revealed that the airplane exceeded its maximum positive load factor during the spiral descent. As the airplane descended below the overcast ceiling, a rapid groundspeed increase and heading change occurred, which were consistent with the pilot (or possibly the student pilot) attempting to recover the airplane from a nose-low attitude after seeing the ground. The spiral descent and attempted recovery overstressed the airplane, which caused the in-flight breakup.

The left horizontal stabilizer, left elevator, and spar cap were found southwest of the accident site. Postaccident examinations of the airplane revealed that both wing main spars and both sides of the horizontal stabilizer had fractured due to overstress. The wings fractured first, and the horizontal stabilizer, elevator, and spar cap fractured immediately afterward.

While the pilot was flying the final approach, several of his radio transmissions to ATC were either delayed or disjointed, indicating that the pilot was task-saturated. The performance study showed that, when the airplane made the series of turns while on final approach, erratic altitude and airspeed fluctuations occurred. These airspeed and altitude fluctuations and the tight spiraling turn that began afterward were consistent with the pilot becoming spatially disoriented due to the lack of visual references while the airplane was operating in IMC. The pilot's spatial disorientation led to his loss of airplane control.

A friend of the accident pilot stated that the pilot had adopted an instrument flying habit in the Mooney airplane that involved making turns on approach primarily with the rudder and adjusting pitch attitude with the pitch trim. If the pilot controlled the airplane in such a manner during the accident flight, especially in response to the controller's low-altitude alert, the application of rudder could have exacerbated the pilot's erratic airplane control inputs while on approach.

The pilot's electronic logbook did not show any logged instrument approach procedures in 2021, and the accident pilot did not fly with his usual safety pilot during 2021. The pilot's last flight review, in October 2020, did not include any instrument approach procedures. Neither the safety pilot nor the accident pilot's flight instructor knew whether the accident pilot had flown with another safety pilot to log instrument time. As a result, the investigation was unable to determine if the accident pilot met the Federal Aviation Administration's regulatory requirements for instrument experience.

Diphenhydramine (commonly marketed as Benadryl) was detected in the pilot's liver and heart tissue; no blood specimen was available to assess therapeutic levels. Diphenhydramine causes sedation and can slow psychomotor responses and reaction times, which can contribute to susceptibility to spatial disorientation. However, without a diphenhydramine blood level, the investigation was unable to determine whether the effects of the pilot's use of diphenhydramine contributed to this accident.

Probable Cause and Findings

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

The pilot's loss of airplane control due to spatial disorientation during final approach, which led to a spiral dive that overstressed the airplane and resulted in an in-flight breakup.

Findings

Personnel issues	Aircraft control - Pilot
Personnel issues	Spatial disorientation - Pilot
Aircraft	Spar (on wing) - Capability exceeded
Environmental issues	Clouds - Contributed to outcome

Factual Information

History of Flight

Approach-IFR final approach	Loss of control in flight (Defining event)
Approach-IFR final approach	Aircraft structural failure

On August 7, 2021, about 1740 central daylight time, a Mooney M20M airplane, N9156Z, was destroyed when it was involved in an accident near Victoria, Minnesota. The private pilot and two passengers (one of whom was a student pilot) sustained fatal injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

A review of automatic dependent surveillance-broadcast (ADS-B) information revealed that the airplane departed Chandler Field Airport (AXN), Alexandria, Minnesota, about 1654 on an instrument flight rules (IFR) flight plan and climbed to 5,000 ft mean sea level (msl) while en route to Flying Cloud Airport (FCM), Minneapolis, Minnesota. After the pilot descended the airplane to 3,000 ft msl, he was cleared to fly the instrument landing system (ILS) approach to runway 10R at FCM. At 1738:39, the pilot contacted the FCM tower controller and stated, "Mooney 56 Zulu...ah...with you." The pilot did not respond, so the controller repeated the clearance; the pilot did not respond to this transmission as well.

About 10 miles from the runway while on final approach, the airplane tracked left of the ILS course and descended below 2,700 ft msl. At 1739:22, the controller again provided the landing clearance, to which the pilot stated, "ah 56 Zulu." The airplane then made a right turn back toward the approach course and continued to descend, which triggered a low-altitude alert to the FCM tower controller. The controller transmitted the low-altitude alert to the pilot, which he acknowledged. No further transmissions were received from the pilot. The airplane subsequently made an abrupt left turn and began a rapid descent, during which radar contact was lost. The airplane subsequently impacted the ground, and a postimpact fire ensued.

Several witnesses heard a loud popping noise and observed the airplane in a rapid descent with at least one of the wings "folded up." Review of a doorbell security video near the accident site revealed that the airplane was upright and in a nose-high attitude at ground impact and that both wings and the right stabilizer were deflected upward in a vertical position (see figure 1). A King Air pilot who heard the accident pilot's communications with the controller stated that the pilot sounded "stressed" and "confused."



Figure 1. Screen capture of airplane just before impact (Source: doorbell security video).

Pilot Information

Certificate:	Private	Age:	72, Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Unknown
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	BasicMed	Last FAA Medical Exam:	August 31, 2015
Occupational Pilot:	No	Last Flight Review or Equivalent:	October 30, 2020
Flight Time:	972 hours (Total, all aircraft), 922 hours (Total, this make and model), 25 hours (Last 90 days, all aircraft), 11 hours (Last 30 days, all aircraft)		

Student pilot Information

Certificate:	Student	Age:	41, Male
Airplane Rating(s):	None	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	Unknown
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:	July 9, 2020
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:	(Estimated) 70 hours (Total, all aircraft), 10 hours (Total, this make and model)		

Passenger Information

Certificate:		Age:	37, Female
Airplane Rating(s):		Seat Occupied:	Rear
Other Aircraft Rating(s):		Restraint Used:	Unknown
Instrument Rating(s):		Second Pilot Present:	Yes
Instructor Rating(s):		Toxicology Performed:	
Medical Certification:		Last FAA Medical Exam:	
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:			

The pilot transitioned from a paper to an electronic logbook in February 2021. No instrument approach procedures were logged in the pilot's electronic logbook, and the last instrument approach procedure in the pilot's paper logbook was November 2020.

The pilot's most recent flight review was conducted with visual procedures only; no instrument approach procedures were flown. The flight instructor reported the pilot was "very safety conscious" and "detail oriented." The flight instructor was not aware of a safety pilot who flew with the accident pilot (to log instrument time) during the 6 months before the accident.

A friend of the accident pilot, who had accumulated about 3,000 hours of flight experience, stated that he flew frequently with the accident pilot. The pilot's friend reported that the accident pilot flew with a yoke-mounted Garmin 650 that he used as an electronic flight bag for navigation purposes. The friend was "confident" that the accident pilot would have attempted to have the autopilot engaged during the accident instrument approach because the airplane was operating in instrument conditions at the time. The friend was also "certain" that the pilot would not have allowed the passenger who was a student pilot to fly the airplane while in instrument conditions.

The pilot’s friend described that, in Mooney airplanes, airspeed increases fairly rapidly when the airplane is pitched nose down and that pitch control is “challenging.” The accident pilot and his friend discussed using pitch trim to adjust the airplane’s attitude to facilitate pitch control while flying in instrument conditions. They also discussed making half-standard-rate turns primarily with rudder control, which the friend described as “pedal turns.” The friend was “fairly certain” that the pilot used these two methods during instrument flight. A review of ADS-B data from a January 2021 flight by the accident pilot revealed that he made a series of shallow turns for about 50 minutes. The friend reviewed the data for this flight and thought the pilot was likely practicing “pedal turns.”

The pilot’s friend often acted as the safety pilot when the pilot practiced instrument approaches, but both pilots had not flown together in 2021 due to the COVID pandemic. The friend stated the accident pilot’s personal weather minimum was an 800-ft ceiling and that, during practice instrument flying, the accident pilot usually flew GPS approaches and did not frequently fly ILS approaches. The friend was not aware of another safety pilot with whom the accident pilot flew in 2021. The friend was also not aware of the accident pilot using a flight simulator during the years preceding the accident.

Aircraft and Owner/Operator Information

Aircraft Make:	Mooney	Registration:	N9156Z
Model/Series:	M20M	Aircraft Category:	Airplane
Year of Manufacture:	1992	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	27-0142
Landing Gear Type:	Retractable - Tricycle	Seats:	4
Date/Type of Last Inspection:	August 14, 2020 Annual	Certified Max Gross Wt.:	3564 lbs
Time Since Last Inspection:		Engines:	1 Reciprocating
Airframe Total Time:	2390 Hrs as of last inspection	Engine Manufacturer:	LYCOMING
ELT:	Installed, not activated	Engine Model/Series:	T10-540-AF1B
Registered Owner:	On file	Rated Power:	310 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

The Limitations section of the *Airplane Flight Manual* lists the maximum positive load factor with flaps up as 3.8 Gs. The airplane’s maneuvering speed (V_A), which is the speed above

which full deflection of any flight control should not be attempted because of the risk of damage to the aircraft structure, is listed as between 111 and 126 knots calibrated airspeed.

In 2017, the pilot reported to his insurance company that he lost directional control during landing and that the airplane subsequently struck runway edge lights, which resulted in damage to the right horizontal stabilizer. (The NTSB did not investigate this event.) The damage was repaired in 2018. The pilot’s friend stated that the runway excursion was due to “a distraction during the landing rollout.”

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	Condition of Light:	Day
Observation Facility, Elevation:	KFCM,907 ft msl	Distance from Accident Site:	8 Nautical Miles
Observation Time:	16:53 Local	Direction from Accident Site:	101°
Lowest Cloud Condition:		Visibility	9 miles
Lowest Ceiling:	Overcast / 1100 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	10 knots / None	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	80°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	29.77 inches Hg	Temperature/Dew Point:	22°C / 20°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Alexandria, MN (AXN)	Type of Flight Plan Filed:	IFR
Destination:	Minneapolis, MN (FCM)	Type of Clearance:	IFR
Departure Time:	16:56 Local	Type of Airspace:	Class E

The pilots of a King Air that landed immediately before the accident were interviewed about the conditions that the airplane encountered. The pilot who flew the approach and landing stated that the airplane entered the clouds at an altitude of about 4,500 ft msl and broke out of the clouds on final approach at an altitude of about 1,000 ft above ground level. The pilot who monitored the approach recalled that the airplane entered and broke out of the clouds at altitudes similar to those reported by the pilot flying. . The monitoring pilot reported that no turbulence was occurring while the airplane was in the clouds.

Airport Information

Airport:	FLYING CLOUD FCM	Runway Surface Type:	Asphalt
Airport Elevation:	906 ft msl	Runway Surface Condition:	Dry
Runway Used:	10R/28L	IFR Approach:	ILS
Runway Length/Width:	5000 ft / 100 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:	2 Fatal	Aircraft Fire:	On-ground
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	3 Fatal	Latitude, Longitude:	44.859074,-93.663331

The airplane impacted the ground on a northerly heading (see figure 2). The left horizontal stabilizer and left elevator were found about 720 and 800 ft southwest of the accident site, respectively. A 6-inch section of the main wing spar upper cap splice plate was found about 300 ft southwest of the accident site.



Figure 2. Airplane at accident site with parametric data overlaid.

Postaccident examination revealed the flap actuator jackscrew threads were consistent with the flaps in the retracted position. The speedbrakes extended and retracted freely and had no deformations.

Both vacuum pumps were disassembled, and all components were accounted for. The vanes and drive couplers were intact, and the attitude gyro and turn/slip rotors showed indications of rotation at impact.

The propeller had separated from the crankshaft due to impact damage. All three blades exhibited chordwise and leading-edge scaring.

The left horizontal stabilizer separated about 10 inches outboard of the airplane centerline. The left elevator was separated from the horizontal stabilizer and fractured into two pieces. The left elevator hinges were intact on the horizontal stabilizer, and the hinge blocks were pulled from the elevator. The damage and deformation of the left horizontal stabilizer and elevator was consistent with separation in an upward direction.

The left elevator control rod attach bolt remained installed in the left elevator but was deformed inboard about 45°. The bolt threads had some smearing, and the nut and cotter pin were not located in the recovered wreckage. No evidence indicated fretting on the elevator around the bolt location.

Both wings were fractured near the outboard ends of their respective main landing gear wheel well. The lower spar cap on both wings showed no deformation adjacent to the main spar fracture locations, whereas the upper spar caps exhibited S-bending. All the examined fractures had a dull, grainy appearance consistent with overstress separation, and no evidence indicated corrosion or pre-existing fractures.

No preaccident mechanical failures or malfunctions with the airplane or engine were observed that would have precluded normal operation.

Medical and Pathological Information

The Midwest Medical Examiner's Office, Ramsey, Minnesota, performed an autopsy on the pilot. His cause of death was multiple blunt force injuries.

Toxicology testing performed by the FAA Forensic Sciences Laboratory detected diphenhydramine in the pilot's liver and heart tissue. Ethanol was not detected in the pilot's brain tissue, and the testing was inconclusive regarding the presence of ethanol in his liver tissue. Blood specimens from the pilot were not available for testing.

Diphenhydramine is a sedating over-the-counter antihistamine (commonly marketed as Benadryl) and is used to treat colds, allergies, and insomnia. Diphenhydramine carries the warning that use of the medication may impair mental and physical ability to perform potentially hazardous tasks, including driving or operating heavy machinery.

FAA guidance on wait times before flying after using this medication indicates that the postdose observation time is 60 hours. The medication is not for daily use.

An FAA study found that pilots who had used an antihistamine such as diphenhydramine were involved in more fatal accidents while flying in instrument meteorological conditions than pilots who had used nonsedating antihistamines.

Tests and Research

The NTSB conducted a performance study for this accident based on ADS-B data. The study found that, after 1739:00, the airplane made increasingly tight turns at speeds above V_A (see figure 3).



Figure 3. Flightpath showing increasingly tight turns with times and altitudes (in msl).

The study also found that, while on the runway heading during final approach, the airplane's airspeed slowed to about 80 knots. About 1738:45, the airspeed increased to about 140 knots, the flight track diverged to the left of the approach course, and the airplane descended about 300 ft. The airplane then turned right, and the descent continued. During the turns, erratic altitude and airspeed fluctuations occurred.

About 1739:25, the airplane began its final left turn. About 13 seconds later, the left-turn radius tightened markedly (see figure 4). The airplane began to descend at more than 7,000 ft per minute, and its airspeed increased to more than 180 knots. As the airplane's left turn tightened and airspeed increased, the resulting bank angle and load factor increased.

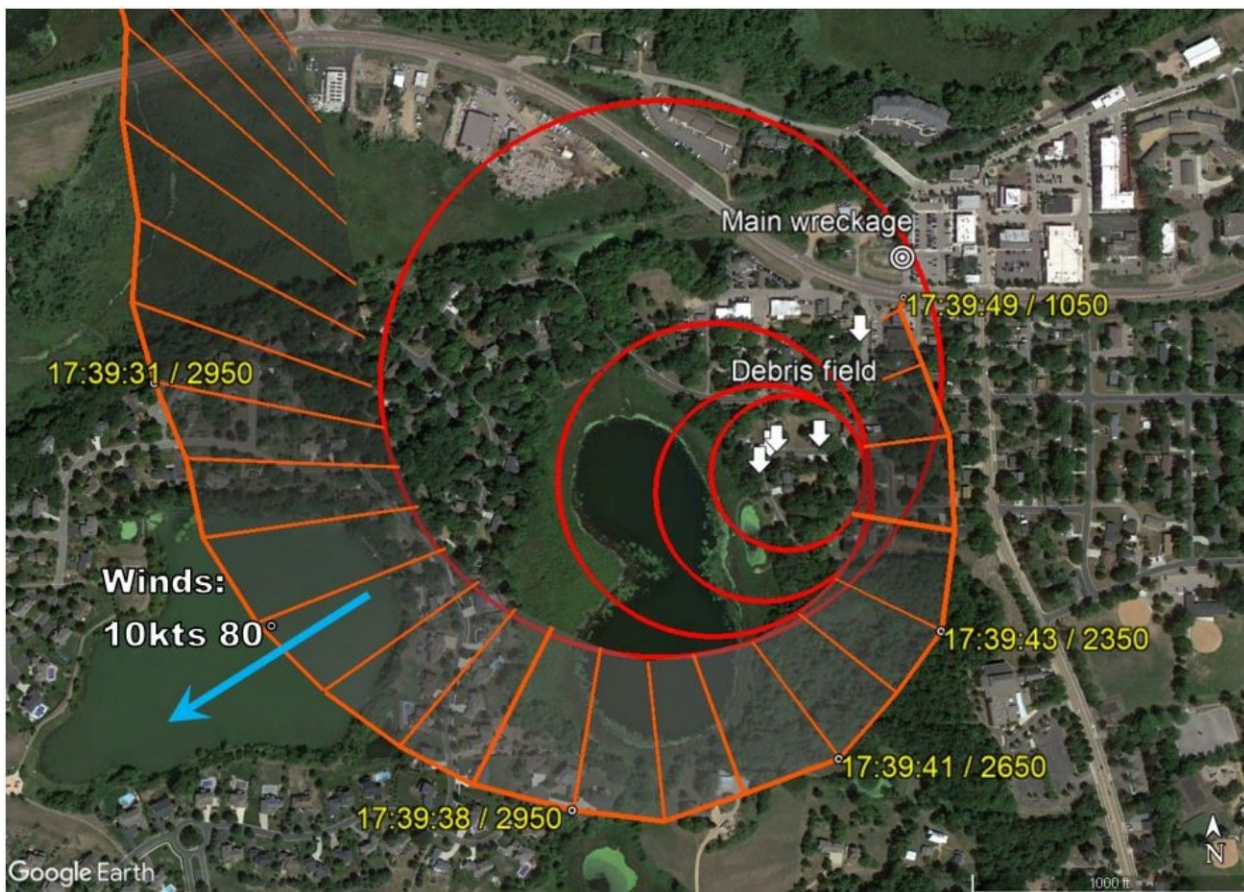


Figure 4. Final turn with time and altitudes (in msl). The red circles near the center of the figure depict the radius of the airplane's final left turn at four different points.

By 1739:43, the 4.8-G estimated load factor exceeded the manufacturer's maximum positive load factor for the airplane. About 1 second later, the increased speed and tighter turn resulted in a load factor that was more than 8 Gs. From 1739:43 to 1739:45, the airplane's groundspeed increased about 40 knots, and the left turn rate accelerated with a 046° heading change.

During this same 2-second timeframe, the airplane descended below the altitude of the overcast cloud deck.

Additional Information

Spatial Disorientation

The Federal Aviation Administration's (FAA) *Airplane Flying Handbook* (FAA-H-8083-3B) described some hazards associated with flying when the ground or horizon are obscured. The handbook states, in part, the following:

The vestibular sense (motion sensing by the inner ear) in particular can and will confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in airplane attitude, nor can they accurately sense attitude changes that occur at a uniform rate over a period of time. On the other hand, false sensations are often generated, leading the pilot to believe the attitude of the airplane has changed when, in fact, it has not. These false sensations result in the pilot experiencing spatial disorientation.

Instrument Experience

FAA regulations specify that a pilot must conduct and log a minimum of six instrument approach procedures every 6 months to maintain instrument flight rules currency. According to the FAA's Information for Operators 15012, dated September 8, 2015, the FAA allows the following methods for conducting and logging instrument approach procedures:

- o actual instrument flight conditions flown in an aircraft;
- o simulated instrument flight conditions, using a view-limiting device, flown in an aircraft with a safety pilot;
- o simulated instrument conditions conducted in any FAA-approved flight simulator/full flight simulator, flight training device, or aviation training device; and
- o a combination of the three above-mentioned methods.

Administrative Information

Investigator In Charge (IIC): Folkerts, Michael

Additional Participating Persons: Gregory Thurston; Flight Standards District Office; Minneapolis, MN
Nikolas Halatsis; Flight Standards District Office; Minneapolis, MN
Troy Helgeson; Lycoming Engines; Williamsport, PA
Kevin Hawley; Mooney International Corp.; Kerrville, TX
Bill Gill; Honeywell; Olathe, KS

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Investigation Class: [Class 3](#)

Note:

Investigation Docket: <https://data.nts.gov/Docket?ProjectID=103651>

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