Aviation Investigation Final Report

Location:	Climax, North Carolina	**Accident Number:**	ERA23FA188
Date & Time:	April 11, 2023, 11:32 Local	**Registration:**	N543GM
Aircraft:	MILLER GLENN F RV-12	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of engine power (partial)	**Injuries:**	1 Fatal, 1 Serious
Flight Conducted Under:	Part 91: General aviation - Flight test		

Analysis

Two commercial pilots departed for a local flight in the experimental amateur-built airplane that was undergoing Phase 1 flight testing. The purpose of the flight was to perform aerodynamic stall testing. Earlier in the day, the right-seat pilot had completed a solo flight. Upon returning to the airport, the left-seat pilot boarded the airplane and they taxied for takeoff. During the climb, about 400 ft above ground level, the airplane sustained an abrupt partial loss of engine power. The airplane immediately stopped climbing and the pilot entered a left turn, then turned left again to fly over a highway that paralleled the departure runway.

The pilots attempted to troubleshoot the partial loss of engine power by adjusting the throttle and mixture, and by ensuring that both fuel pumps were on, but were unable to restore engine power. The airplane continued toward an overpass, under which a semi-truck was parked, and near which powerlines spanned across the highway. The pilots attempted to fly under the powerlines and over the overpass, but entered an extreme bank angle and impacted the overpass before coming to rest inverted below it. A post-crash fire ignited immediately. The right-seat pilot was pulled from the wreckage by motorists; the left-seat pilot was fatally injured.

Examination of the engine found that the Nos. 1 and 2 cylinder spark plug electrode tips were obliterated. The Nos. 3 and 4 cylinder spark plug electrode tips remained intact, but were found blackened. There was no evidence that any of the spark plugs had sustained impact-related damage. A bench test of the spark plugs found that the Nos. 1 and 2 plugs would produce a spark at low compression, but would extinguish under the higher compression levels produced during normal engine operation. The Nos. 3 and 4 cylinder spark plugs produced normal spark at the bench test's maximum compression. It is likely that the partial loss of engine power was due to the damaged Nos. 1 and 2 spark plug electrode tips.

The owner/builder of the airplane stated that he used low-grade 87 octane automotive fuel with the engine in its first 9 hours of operation about two years before the accident. The engine manufacturer required that the engine be operated with at least 89 octane automotive fuel or higher grade. The manual and engine manufacturer further reported that using low grades of automotive fuel could result in engine detonation and/or catastrophic failure.

The operations manual further stated that, when stored for 3 months or longer, the airplane should be stored with 100 low lead aviation fuel. The airplane owner reported that the airplane sat idle for nearly two years, during which occasional engine run-ups were performed, and that the fuel onboard during this time was automotive fuel with a fuel preservative/additive.

Despite the surviving pilot reporting that he fueled the airplane with 93 octane automotive fuel for his recent flight activity and the accident flight, it is likely that the estimated first 9 hours of engine operation with the lower grade of fuel, and old automotive fuel, likely contributed to the degradation and ultimate failure of the Nos. 1 and 2 spark plug electrodes during the accident flight. Although the engine lacked other signatures of detonation, it is likely that the spark plug damage was due to detonation occurring at some point in the airplane's 20 total hours of engine operation. There was no evidence that the spark plugs had been inspected or replaced during the required annual condition inspection seven months before the accident.

According to the pilot's operating handbook, the landing distance was 525 ft. During the pilots' engine troubleshooting, they overflew more than 4,000 ft of a multilane highway with a wide grass median. Had either pilot decided to make an immediate precautionary off-airport landing either on the grass median or the highway, rather than continuing the engine troubleshooting at low altitude, the conflict with powerlines and the collision with the overpass likely could have been prevented.

It is also likely that the partial loss of engine power, rather than a total loss of power, exacerbated the confusion and indecision by both pilots on whether an immediate precautionary landing should be made. The engine examination findings and testing of the spark plugs supported a scenario in which the engine likely would continue to run, but could not produce sufficient power to climb.

Toxicology testing for the fatally injured left-seat pilot detected Carboxyhemoglobin at 15%, consistent with smoke inhalation after the accident, glucose, and acetaminophen. The testing was negative for ethanol.

Probable Cause and Findings

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

The airplane owner/builder’s inappropriate use of a lower grade fuel than that required by the airplane and engine operations manual, which resulted in engine detonation and the degradation and eventual obliteration of the Nos. 1 and 2 cylinder spark plug electrode tips. Contributing to the outcome was the pilots’ decision to continue flight at low altitude following a partial loss of engine power instead of performing an immediate precautionary landing, which resulted in collision with an overpass and terrain.

Findings

Personnel issues	Decision making/judgment - Flight crew
Aircraft	(general) - Incorrect use/operation
Aircraft	Spark plugs/igniters - Damaged/degraded
Aircraft	Fuel - Fluid type
Environmental issues	Bridge/overpass - Contributed to outcome

Factual Information

History of Flight

Prior to flight	Wrong fuel
Initial climb	Loss of engine power (partial) (Defining event)
Landing	Collision with terr/obj (non-CFIT)

On April 11, 2023, at 1132 eastern standard time, an experimental amateur-built RV-12 airplane, N543GM, was destroyed when it was involved in an accident near Climax, North Carolina. The commercial pilot seated in the left seat was fatally injured, and the commercial pilot in the right seat sustained serious injuries. The airplane was operated as a Title 14 *Code of Federal Regulations(CFR)* Part 91 test flight.

According to the surviving pilot, the accident airplane was undergoing Phase 1 flight testing. On the morning of the accident, he flew one solo flight and returned to the departure airport. Shortly after, the other pilot boarded the airplane for the accident flight, the purpose of which was to perform aerodynamic stall testing. The airplane had 12 gallons of fuel on board, which was 93 octane fuel the pilot purchased from a gas station near the departure airport.

The surviving pilot reported that the left-seat pilot was the pilot flying and the takeoff from runway 35 was normal. The airplane climbed to 400 ft above ground level, where the engine rpm dropped, the engine lost partial power, and the pilot made two left turns to fly southbound over the highway parallel to the runway (US Highway 421). While flying over the highway, both fuel pumps were on, and the surviving pilot reported that he was adjusting the mixture and throttle. The engine continued to produce partial power while they overflew the highway; however, an overpass bridge was located ahead of the airplane, along with a semi-truck that had stopped under the overpass. Additionally, multiple powerlines spanned across the highway.

The surviving pilot reported that he knew they would not be able to gain sufficient altitude to fly above the powerlines, nor fly under the overpass due to the semi-truck, so they attempted to fly below the powerlines, but above the overpass. During this maneuvering, the airplane collided with the overpass, and subsequently impacted terrain inverted. A post-impact fire ignited after the impact with terrain. Motorists pulled the right-seat pilot, who was already partially outside the cockpit, away from the wreckage area.

Review of surveillance video provided by the airport revealed that the airplane departed on the accident flight at 1127. The airplane accelerated down runway 35 and, shortly before reaching the runway midpoint, the acceleration slowed, and no rotation was observed. The airplane back-taxied to the start of runway 35 and a takeoff was observed at 1131.

The airplane climbed after takeoff, gained altitude for about 30 seconds, and then immediately stopped climbing and entered an abrupt left turn. The airplane turned left again and began flying over US Highway 421 southbound near treetop level. The airplane came in and out of camera view near treetop level as it paralleled the full length of runway 35, before exiting the camera view south of the airport.

Multiple witnesses on the highway reported observing the airplane flying low over the highway. One witness described that she first saw the airplane about 50 ft above ground level over the northbound lanes near the airport, then observed the airplane cross over the grass median to fly over the southbound lanes.

Another witness observed the airplane flying low over the southbound lanes. She observed the airplane enter a sharp turn and “tilt sideways” immediately before striking the overpass and stated that the “wing tips were straight up in the air.” She could not recall hearing engine noise, or whether the propeller was turning.

The witness provided three photographs from her position on the northbound lanes of the highway, which shows the airplane low over the highway about 500 ft from the overpass (see figure 1).

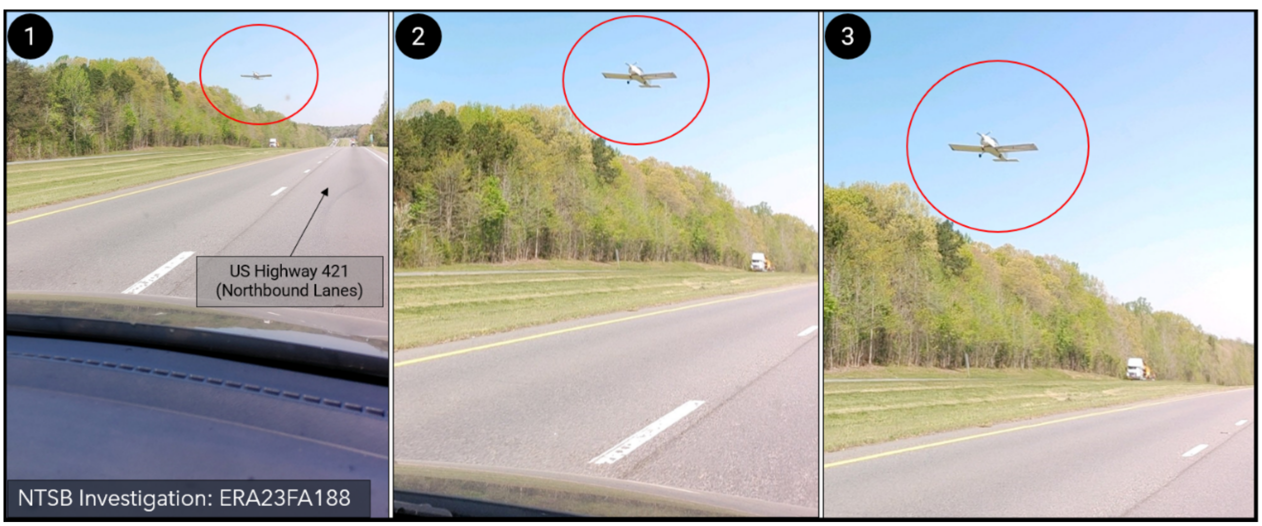

Figure 1 - Witness provided photographs of the airplane flying low over the highway about 500 ft from the overpass bridge.

Impact marks were observed on the overpass bridge railing. The airplane subsequently came to rest inverted just past the overpass on a hill next to the highway about .40 nautical mile south of the departure airport. About 40 ft past the overpass, multiple low-voltage powerlines spanned the entire distance across the highway, paralleling the overpass. There was no evidence the airplane impacted the lines.

Figure 2 below provides an overview of the estimated flight track of the airplane as reported by the surviving pilot, surveillance video, and witnesses. The total distance the airplane traveled over the highway, from abeam the north end of runway 35 to the overpass, was about 4,300 ft. US Highway 421 was a 4-lane highway with a sloping grass median that was about 60 ft wide. Photographs reviewed at the time of the accident and witness reports found that the traffic was not heavy in either direction.

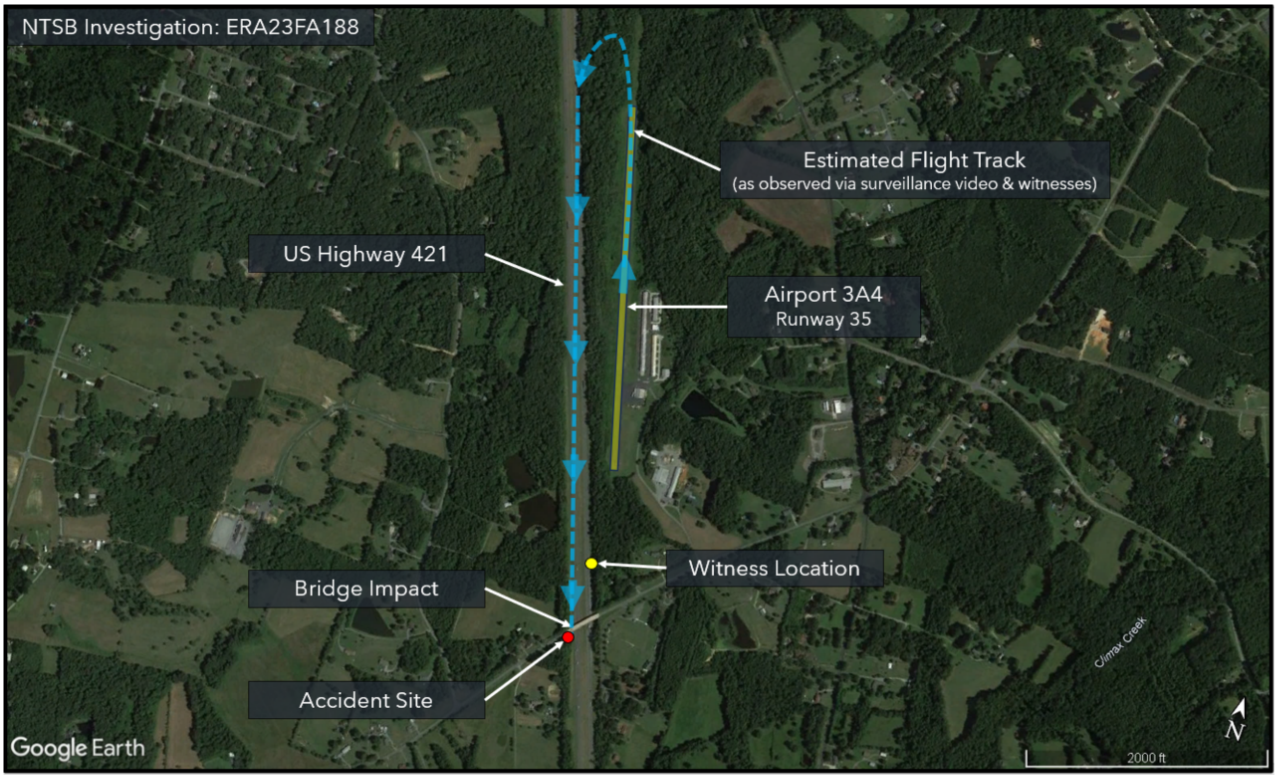

Figure 2 - Overview of the airplane's estimated flight track, witness location, and accident site.

Pilot Information

Certificate:	Commercial	**Age:**	52,Male
Airplane Rating(s):	Single-engine land; Multi-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:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	February 2, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 1355 hours (Total, all aircraft), 8 hours (Total, this make and model)		

Co-pilot Information

Certificate:	Commercial	**Age:**	38,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	February 8, 2023
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	October 14, 2021
Flight Time:	(Estimated) 935 hours (Total, all aircraft), 6 hours (Total, this make and model)		

According to the surviving pilot, he had flown the airplane 6 hours, and the pilot seated in the left seat, who was the pilot flying, had 8 hours in the airplane.

Aircraft and Owner/Operator Information

Aircraft Make:	MILLER GLENN F	**Registration:**	N543GM
Model/Series:	RV-12 NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2021	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	001
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	September 1, 2022 Condition	**Certified Max Gross Wt.:**	1320 lbs
Time Since Last Inspection:	13 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	22 Hrs as of last inspection	**Engine Manufacturer:**	Viking
ELT:	Not installed	**Engine Model/Series:**	110
Registered Owner:	On file	**Rated Power:**	110 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

According to Federal Aviation Administration (FAA) airworthiness records, the airplane was issued a special airworthiness certificate on August 30, 2021. The airworthiness certificate outlined multiple limitations during Phase 1 flight testing. One limitation required a total of 40 hours to be flown within certain prescribed geographic areas, which included the departure airport.

According to the airplane owner, who was also the builder of the airplane and was not onboard the airplane for the accident flight, there were several-month gaps in engine operation between 2021 and 2023. Review of an airplane log found entries denoting ground engine operation and flight activity from October 5, 2021, through August 27, 2022. A total of 8.6 hours was logged, and within those hours 3 hours were flight hours logged in 2021. According to the log and the owner, he did not fly the airplane in 2022 or 2023. The right-seat pilot reported that he and the other pilot flew about 14 hours in the airplane, which resulted in about 22 hours of total flight time for the airplane.

According to the owner, in March 2023, he and the right-seat pilot had an agreement to complete the remainder of the 40 hours required to complete Phase 1 flight testing.

The airplane owner reported that he recalled there being about 1/2 of a tank of fuel onboard the airplane for the more than a year that it did not fly. He recalled that he added an additive to the tank to help preserve the automotive gas. He recalled performing an engine run-up in October 2022 and did not experience any issues.

The airplane owner further reported that he used automotive gasoline with the engine. He reported specifically that he used 87 grade octane and that the engine was a small car engine from a Honda Fit, and he “felt comfortable” using the “lower grade” 87. He never used 100 low lead (100LL) aviation fuel with the airplane. The owner also reported that he never had any discussions with either accident pilot on what type of fuel they should use for the test flights.

Pilot's Operating Handbook

The pilot's operating handbook (POH) stated that the airplane's aerodynamic stall speed with flaps extended was 41 knots and 45 knots with flaps retracted. The published landing distance was estimated to be 525 ft at maximum gross weight.

The fuel capacity was 19.8 gallons. According to the POH, approved fuel types were 89 octane or higher automotive fuel with 10% ethanol as a maximum. It further stated that 100LL could be used when automotive fuel was not available.

Engine

The engine was a 110-horsepower fuel-injected Viking Aircraft Engine, Model 110. Viking Aircraft Engines produce experimental aircraft engines from originally manufactured Honda Fit car engines.

The Viking Aircraft Engines operating handbook, Chapter 5, Engine Operation, stated to use only 100LL when 90 or higher octane fuel is not available. The handbook further stated:

FUEL: These are high compression, high performance engines! Use 89 or higher octane fuel. Up to 10% ethanol is permitted. Never run lower grade fuels! It can and will destroy your engine.

The manual further stated, "the engine should never be left with auto type fuel in the fuel rail or fuel pumps for longer than 3 month intervals. The approved storage fuel is 100LL aviation fuel. 100LL was used to test run the engine at the factory, prior to shipping."

According to a representative with Viking Aircraft Engines, the normal compression for a Viking 110 engine was 180 to 210 psi. The spark plugs to be used were NGK brand Iridium Spark Plugs. The representative further reported that the engine may exhibit detonation should 87 octane be used.

Maintenance Records

Review of the airframe logbook revealed that the most recent condition inspection was recorded on September 1, 2022; however, the endorsement was not signed.

The engine and propeller logbook were not located; however, they were later shipped by the airplane owner to the NTSB for review. The engine logbook contained one entry, dated July 8, 2021, denoting that the engine was inspected in accordance with 14 *CFR* Part 43 Appendix D. The inspection was signed by the airplane owner/builder. There were no other entries noted in the engine logbook.

The propeller logbook contained one entry, dated July 8, 2021, denoting that the propeller was inspected in accordance with Part 43 Appendix D. The inspection was signed by the airplane owner/builder. There were no other entries noted in the propeller logbook. There were no entries to indicate that the spark plugs had been inspected or replaced since 2021.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	BUY,607 ft msl	**Distance from Accident Site:**	12 Nautical Miles
Observation Time:	11:54 Local	**Direction from Accident Site:**	56°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.35 inches Hg	**Temperature/Dew Point:**	18°C / 2°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Climax, NC	**Type of Flight Plan Filed:**	None
Destination:	Climax, NC	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

Airport Information

Airport:	Greensboro Executive Airport 3A4	**Runway Surface Type:**	Asphalt
Airport Elevation:	739 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	35	**IFR Approach:**	None
Runway Length/Width:	3063 ft / 30 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Fatal, 1 Serious	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 1 Serious	**Latitude, Longitude:**	35.933896,-79.683809

The airplane came to rest inverted, the wreckage was fragmented, and was located in a compact area. All major portions of the airframe were located at the accident site. The engine was co-located with the cockpit and firewall debris. A postcrash fire consumed significant portions of the fuselage, cockpit, and left wing.

Flight control continuity was confirmed from the cockpit to the rudder and elevator surfaces. Multiple breaks consistent with impact-related forces and severe thermal damage were observed within the aileron control push-pull rods. All cockpit switches, instrumentation, the center fuel tank, and non-volatile memory were destroyed by the postimpact fire (see figure 3).

Figure 3 - Overview of the accident site as viewed from the overpass the airplane impacted. Note the powerlines above the overpass, which spanned across the entire highway from east to west.

The engine sustained extensive thermal damage. The engine examination revealed no evidence of catastrophic failure. The gear reduction box rotated freely and normally with the propeller hub when removed from the engine. The oil filter was free of contaminants. The main fuel line on the engine was secure but was thermally damaged. The chain tensioner was intact and had melted.

The camshaft gear, when moved by hand, moved all the rocker arms and valves. The main crankshaft bearings were intact and displayed clean oil signatures. The pistons and valves were intact and displayed normal combustion signatures.

The composite, three-bladed propeller WAS manufactured by Warp Drive. All three blades splintered from the propeller hub. Two of the blades were located in the debris. One blade exhibited a leading edge gouge.

Spark Plugs

The NGK brand iridium spark plugs were found securely installed and were free of impact damage. When the spark plugs were removed and examined, the Nos. 1 and 2 cylinder spark plug ground electrode tips were found obliterated and the remainder of the electrodes on both spark plugs exhibited blackening. The Nos. 3 and 4 cylinder spark plugs were blackened; however, their electrode tips remained intact.

Spark Plug Test

The spark plugs were tested with bench test equipment. The test equipment used compressed air to simulate engine compression.

The Nos. 1 and 2 spark plugs exhibited a spark around 60 to 70 psi, but with compression at 70 to 80 psi both spark plugs would immediately lose their continuous spark and would extinguish.

The Nos. 3 and 4 spark plugs operated normally and produced a continuous spark throughout a range of low pressure up to 80 psi. Figure 4 provides an overview of the spark plug electrodes.

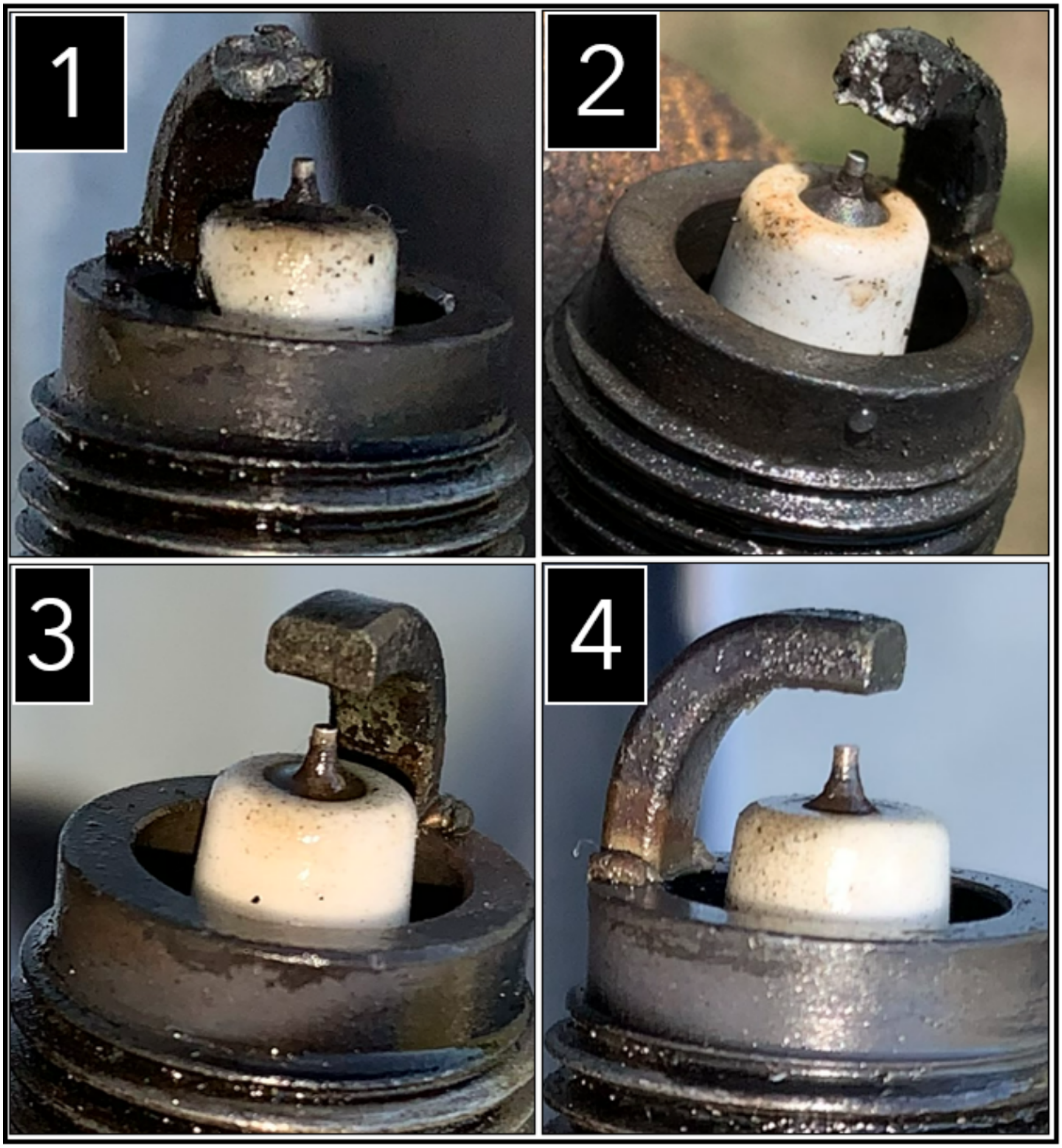

Figure 4: View of the spark plug electrode tips. Note the Nos. 1 and 2 cylinder spark plug tips were found obliterated.

Medical and Pathological Information

According to the autopsy report for the left-seat pilot, from the Office of the Chief Medical Examiner, North Carolina Department of Health and Human Services, the pilot's cause of death was blunt force injury of the leg, thermal injury, and inhalation of products of combustion.

Toxicology testing for the fatally injured left-seat pilot, performed by the FAA Forensic Sciences Laboratory, detected Carboxyhemoglobin at 15%, consistent with smoke inhalation after the accident, glucose, and acetaminophen. The testing was negative for ethanol.

Toxicology testing was not performed on the surviving pilot.

Additional Information

According to the FAA Airplane Flying Handbook (FAA-H-8083-3C),Chapter 18: Emergency Procedures, there are multiple types of emergency landings. A precautionary landing was described as:

Precautionary landing—a premeditated landing, on or off an airport, when further flight is possible but inadvisable. Examples of conditions that may call for a precautionary landing include deteriorating weather, being lost, fuel shortage, and gradually developing engine trouble.

A precautionary landing, generally, is less hazardous than a forced landing because the pilot has more time for terrain selection and the planning of the approach. In addition, the pilot can use power to compensate for errors in judgment or technique.

Research by the Australian Transportation Safety Board (ATSB) found that a partial loss of engine power can be more challenging as compared to a total loss of engine power due to a variety of factors including the choices confronting the pilot and general lack of training for such an event. The research stated, in part:

A partial engine power loss presents a more complex scenario to the pilot than a complete engine power loss. Pilots have been trained to deal with a complete power loss scenario with a set of basic checks and procedures before first solo flight. Furthermore, this training, which [emphasizes] the limited time available to respond, is continually drilled in an attempt to make it second nature. However, pilots are not generally trained to deal with a partially failed engine. Following a complete engine failure, a forced landing is inevitable, whereas in a partial power loss, pilots are faced with making a difficult decision whether to continue flight or to conduct an immediate forced landing.

The course of action chosen following such a partial power loss after takeoff can be strongly influenced by the fact that the engine is still providing some power, but this power may be unreliable. As the pilot, you may also have a strong desire to return the aircraft to the runway to avoid aircraft damage associated with a forced landing on an unprepared surface. The complexity of decision making in such circumstances is further compounded by the general lack of discussion and training on this issue. In dealing with this, you will need to rely on your knowledge and experience.

As occurrences of partial engine power loss occur three times more often than a total power loss, your pre-flight planning should consider a partial engine power loss scenario as much as a complete power loss scenario.

The research also provided a figure that shows the conceptual hazard following a partial loss of engine power after takeoff, drawn from the findings of ATSB fatal accident investigations. When the amount of power lost is close to that experienced with a complete loss, the pilot is likely to identify the severity of the situation readily and take action similar to that expected for a total power loss. At the other end of the spectrum, where the remaining engine power allows the aircraft to climb, more options are available to the pilot, such as climbing slowly into the airport traffic pattern or carefully turning back to the airport, while maintaining glide-speed and height. The region of heightened uncertainty is most prevalent with a mid-range power loss.

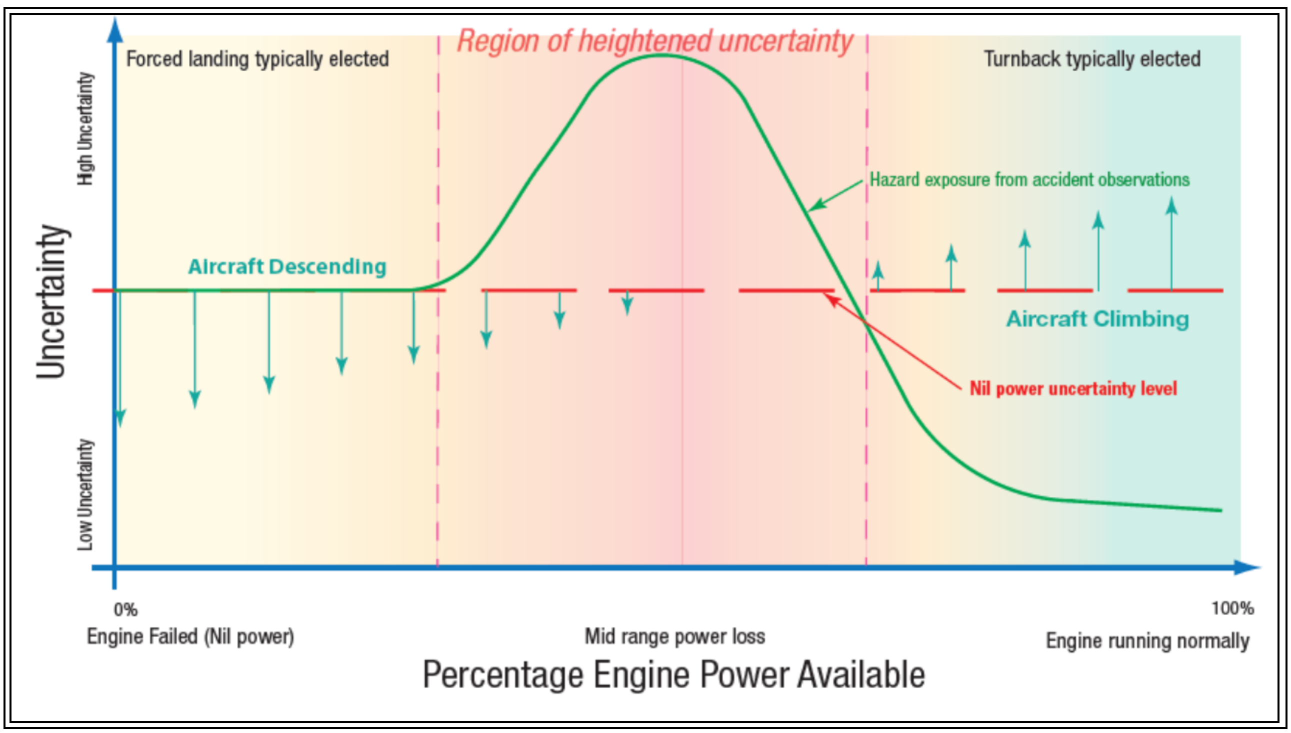

Figure 5 - Partial Loss of Engine Power Regions of Uncertainty Chart (ATSB Research, Canberra, 2013)

Refence the ATSB Transport Safety Report – Managing partial power loss after takeoff in single-engine aircraft (Canberra, 2013).

The FAA Pilot’s Handbook of Aeronautical Knowledge (FAA-H-8083-25C), Chapter 7, provides information on piston engine combustion, detonation, and pre-ignition. Below is a summary:

Combustion

During normal combustion, the fuel-air mixture burns in a very controlled and predictable manner. In a spark ignition engine, the process occurs in a fraction of a second. The mixture actually begins to burn at the point where it is ignited by the spark plugs. It then burns away from the plugs until it is completely consumed. This type of combustion causes a smooth build-up of temperature and pressure and ensures that the expanding gases deliver the maximum force to the piston exactly the right time in the power stroke.

Detonation is an uncontrolled, explosive ignition of the fuel-air mixture within the cylinder’s combustion chamber. It causes excessive temperatures and pressures which, if not corrected, can quickly lead to failure of the piston, cylinder, or valves. In less severe cases, detonation causes engine overheating, roughness, or loss of power.

Detonation is characterized by high cylinder head temperatures and is most likely to occur when operating at high power settings. Common operational causes of detonation are:

- ? *Use of a lower fuel grade than that specified by the aircraft manufacturer.*
- ? *Operation of the engine with extremely high manifold pressures in conjunction with low rpm.*
- ? *Operation of the engine at high power settings with an excessively lean mixture*
- ? *Maintaining extended ground operations or steep climbs in which cylinder cooling is reduced.*

Detonation may be avoided by following these basic guidelines during the various phases of ground and flight operations:

- ? *Ensure that the proper grade of fuel is used.*
- ? *Keep the cowl flaps (if available) in the full-open position while on the ground to provide the maximum airflow through the cowling.*
- ? *Use an enriched fuel mixture, as well as a shallow climb angle, to increase cylinder cooling during takeoff and initial climb.*
- ? *Avoid extended, high power, steep climbs.*
- ? *Develop the habit of monitoring the engine instruments to verify proper operation according to procedures established by the manufacturer.*

Preignition occurs when the fuel-air mixture ignites prior to the engine’s normal ignition event. Premature burning is usually caused by a residual hot spot in the combustion chamber, often created by a small carbon deposit on a spark plug, a cracked spark plug insulator, or other damage in the cylinder that causes a part to heat sufficiently to ignite the fuel-air charge. Preignition causes the engine to lose power and produces high operating temperature. As with *detonation, preignition may also cause severe engine damage because the expanding gases exert excessive pressure on the piston while still on its compression stroke.*

Detonation and preignition often occur simultaneously and one may cause the other. Since either condition causes high engine temperature accompanied by a decrease in engine performance, it is often difficult to distinguish between the two. Using the recommended grade of fuel and operating the engine within its proper temperature, pressure, and rpm ranges reduce the chance of detonation or preignition.

Administrative Information

Investigator In Charge (IIC):	Gerhardt, Adam
Additional Participating Persons:	Patricia Chriscoe; FAA/FSDO; Greensboro, NC
Original Publish Date:	June 5, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=107039