



Aviation Investigation Final Report

Location:	Williamsburg, Pennsylvania	Accident Number:	CEN18FA144
Date & Time:	April 19, 2018, 08:43 Local	Registration:	N451TD
Aircraft:	CIRRUS DESIGN CORP SR22	Aircraft Damage:	Destroyed
Defining Event:	Loss of control in flight	Injuries:	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The private pilot was conducting a personal, cross-country flight with one passenger onboard. According to air traffic control (ATC) communications and radar data, while en route to the destination airport about 5,425 ft mean sea level, the pilot reported to ATC that the airplane was accumulating ice, and he requested to divert to the nearest airport. However, due to the overcast cloud layer at 200 ft above ground level (agl) at the nearest airport, the pilot chose to attempt an instrument landing system (ILS) approach into another airport with a slightly higher overcast cloud layer of 500 ft agl. During the descent to intercept the localizer for the ILS approach, the pilot flew through the localizer path, and he did not realize it until the controller notified him that he had done so. The pilot subsequently requested additional vectors to attempt to intercept the localizer again, and the controller instructed the pilot to turn left. The airplane subsequently turned left toward the north. About 39 seconds into the turn, the airplane began to descend, and the airspeed increased. About 10 seconds later, the left turn tightened, and the airplane began to spiral until the radar data ended. The airplane subsequently impacted the ground in a steep, nose-low, wings-level attitude.

A review of weather information current at the time of the flight revealed that the airplane likely encountered instrument meteorological conditions (IMC) about 500 ft agl on the initial climbout from the departure airport and remained in IMC and conditions favorable to icing for the rest of the flight. The airplane likely encountered some turbulence along the flight route in the cloud cover and would have had to climb above 10,400 ft msl to escape the IMC and icing conditions. Super-cooled liquid droplets (SLD) and icing conditions were likely present along the flight route throughout the flight.

Before the flight, a forecast icing potential (FIP) indicated that light-to-moderate intensity icing existed near the accident site, and a current icing potential product indicated that SLD existed near the accident site; this information would have been available to the pilot before the accident flight departed.

The pilot received a weather briefing via the ForeFlight application on his mobile device about 10 hours before the accident flight. At that time, the forecast showed cloud cover, snow showers, and instrument

flight rules conditions. Since the AIRMET received in the weather briefing expired at 0500 the pilot should have requested an updated briefing with the valid AIRMET. In the time between the weather briefing and the accident, an AIRMET was issued for moderate icing, IFR/mountain obscuration, and low-level turbulence, and was valid until 1100. An updated AIRMET advisory was recorded via the flight plan identification number less than 2 hours before departure. No records were found indicating whether the pilot retrieved any other weather information before or during the flight. Therefore, although the pilot had sufficient weather forecast information available to him before departure to have known about the existing icing conditions along the flight route, the investigation could not determine whether he received all of the pertinent information before the flight.

Although the pilot reported that the airplane had accumulated ice, the investigation could not determine if the airplane was significantly affected by structural icing during the approach. The airplane was not equipped with an anti-icing or deicing system, which prohibited the pilot from flying into known icing conditions per Title 14 *Code of Federal Regulations* Section 91.527, "Operating in Icing Conditions."

Although postaccident examination of the wreckage was limited due to postimpact fire damage, the examinations of the airframe and engine did not reveal evidence of any preaccident mechanical malfunctions or anomalies that would have precluded normal operation. The examination revealed that the Cirrus Airframe Parachute System (CAPS) handle remained in its holder, and that its safety pin, which was supposed to be removed before flight, remained installed. The CAPS was found deployed, and the CAPS solid rocket propellant was expended. All evidence revealed that the CAPS was not activated in flight but rather that it deployed due to impact forces and thermal exposure.

The autopsy of the pilot revealed that he had heart disease; however, this would not have affected his decision-making, his ability to identify and respond to icing on the plane, or his ability to fly the airplane in IMC; therefore, his heart disease did not contribute to the accident. Although toxicology testing detected ethanol in the pilot's liver tissue, no ethanol was found in his muscle tissue. Given that, after absorption, ethanol is uniformly distributed throughout all tissue and body fluids, it is likely that the ethanol detected in the liver occurred postmortem and did not contribute to the accident. The toxicology testing also detected two impairing psychoactive substances, diphenhydramine and clonazepam, in tissue specimens. These drugs alone or in combination could have affected the pilot's decision-making and/or slowed his detection of potential hazards and his reaction to them. However, antemortem levels of these two drugs could have been low enough to not have affected him, but, because antemortem levels cannot be calculated from tissue levels, it could not be determined whether effects from the pilot's use of diphenhydramine and clonazepam contributed to the accident.

The radar data showed that the airplane was flying a relatively smooth and consistent flightpath with altitude and heading changes that were indicative of the pilot using the autopilot for a majority of the flight, until the final turn after flying through the localizer course. The pilot's failure to recognize that he had not intercepted the localizer is consistent with his failure to appropriately configure the avionics for the approach or with his attention being diverted from navigational tasks due to his workload while trying to conduct the approach. Conditions conducive to the development of spatial disorientation, including restricted visibility and IMC while maneuvering, existed. Further, the accident circumstances, including the spiraling radar track data and the subsequent high-velocity impact were consistent with the known effects of spatial disorientation. Therefore, the airplane's entry into a descending left turn while the pilot was being vectored back toward the localizer course, which subsequently tightened, was likely due to the pilot experiencing the effects of spatial disorientation due to a vestibular illusion referred to as

a "graveyard spiral," which can occur when an airplane returns to level flight following a prolonged bank turn. The spatial disorientation resulted in the pilot's loss of airplane control and a high-velocity impact with terrain.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's failure to obtain an updated weather briefing before the flight and his subsequent loss of airplane control due to spatial disorientation while maneuvering in instrument meteorological conditions during a diversion to an alternate airport after encountering forecast icing conditions.

Findings

Personnel issues	Use of available resources - Pilot
Personnel issues	Spatial disorientation - Pilot
Aircraft	Lateral/bank control - Not attained/maintained
Aircraft	Altitude - Not attained/maintained
Environmental issues	Low ceiling - Effect on personnel
Environmental issues	Clouds - Effect on personnel
Environmental issues	Equipment/operational - Effect on personnel
Personnel issues	Aircraft control - Pilot
Environmental issues	(general) - Awareness of condition
Environmental issues	(general) - Timing of related info
Environmental issues	(general) - Contributed to outcome
Environmental issues	(general) - Effect on operation
Environmental issues	Freezing rain/sleet - Effect on equipment

Factual Information

History of Flight

Prior to flight	Preflight or dispatch event
Enroute-cruise	Structural icing
Approach-IFR initial approach	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)
Post-impact	Fire/smoke (post-impact)

On April 19, 2018, at 0843 eastern daylight time, a Cirrus SR22 airplane, N451TD, impacted terrain near Williamsburg, Pennsylvania. The private pilot and one passenger were fatally injured. The airplane was destroyed, and a postimpact fire consumed most of the wreckage. The airplane was registered to CPD-JJD, LLC, and operated by the pilot as a Title 14 *Code of Federal Regulations (CFR)* Part 91 personal flight. Instrument meteorological conditions (IMC) prevailed along the flight route about the time of the accident, and an instrument flight rules (IFR) flight plan had been filed. The airplane departed Lancaster Airport (LNS), Lancaster, Pennsylvania, at 0734 and was initially en route to South Bend International Airport (SBN), South Bend, Indiana, but the pilot chose to divert toward Altoona-Blair County Airport (AOO), Altoona, Pennsylvania.

The pilot received a weather briefing the night before the accident and filed a flight plan. Refer to the Meteorological Information section for more information. A review of air traffic control (ATC) communications and radar data provided by the Federal Aviation Administration (FAA) revealed that, about 0828, while the airplane was en route to SBN on a 284° heading and about 5,425 ft mean sea level (msl), the pilot contacted an approach controller at John Murtha Johnstown-Cambria County Airport (JST), Johnstown, Pennsylvania, and requested to divert to JST (18 miles southwest of the airplane's position) due to ice accumulation on the airplane. The controller advised the pilot that the clouds at JST were overcast at 200 ft above ground level (agl) and that the clouds at AOO (30 miles southeast of the airplane's position) were overcast at 500 ft agl. About 0831, the pilot requested vectors to AOO for an instrument landing system (ILS) approach. After the controller provided the vectors, the pilot requested to descend to 4,000 ft msl, but the controller cleared him to 4,500 ft msl, which was the lowest altitude he could clear the airplane to descend to in that geographical area. Figure 1 shows a Google Earth overlay of the airplane's radar track in red, the AOO approach localizer path in white.

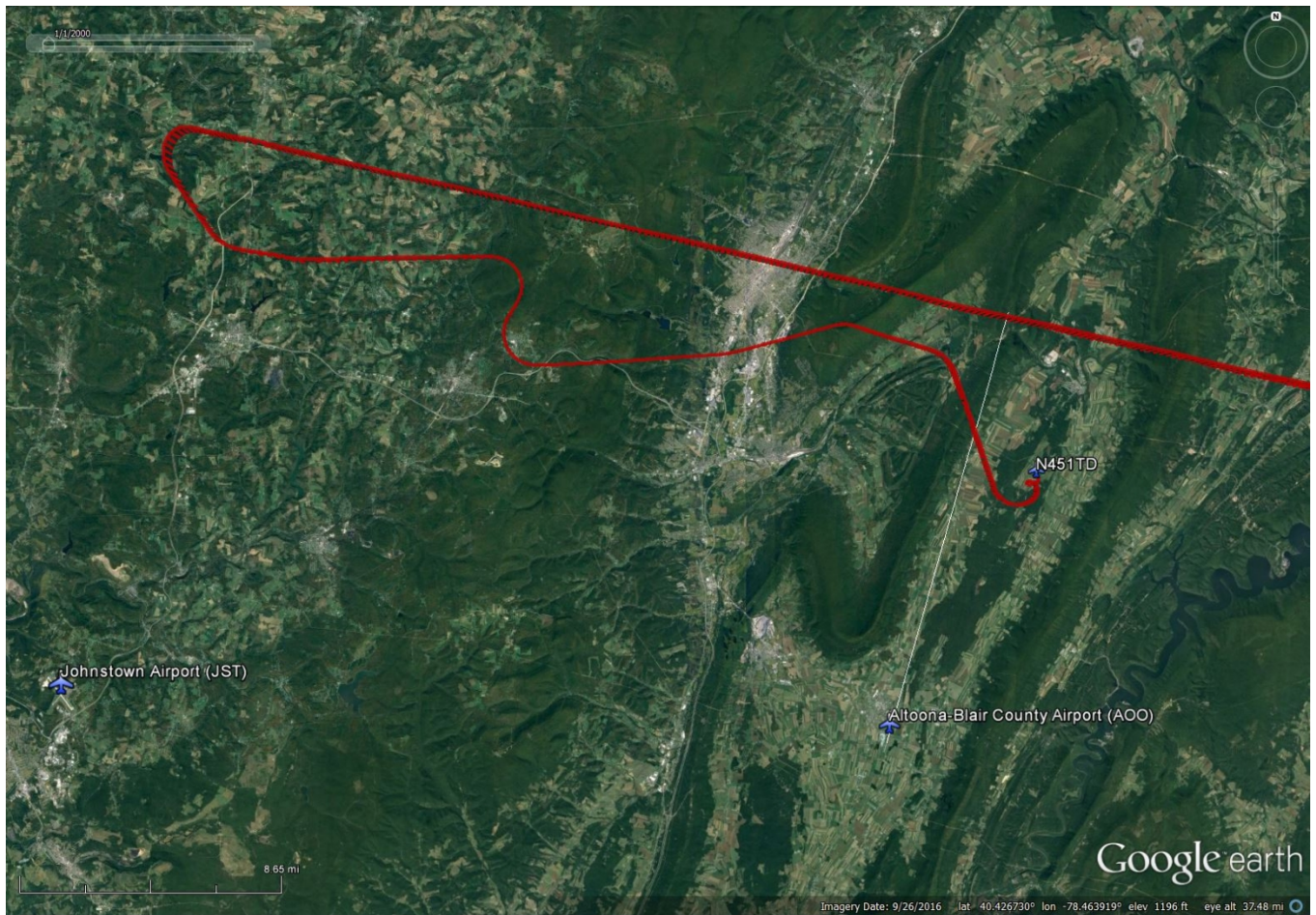


Figure 1. Radar track and accident location (Google Earth overlay)

About 0842, the controller advised the pilot that the airplane had passed through the localizer for the ILS approach to runway 21 at AOO, and the pilot stated that he still wanted to land at AOO and requested vectors to intercept the localizer. The controller issued additional vectors for the pilot to make a box pattern to intercept the localizer; the airplane then turned left turn toward the north. At 0842:33, the airplane began a left standard rate turn and remained about 4,000 ft msl. At 0843:12, the airplane started to descend, and the airspeed increased. At 0843:38, the airplane descended through 2,525 ft msl and continued in a tight, left spiral turn. The final radar point was recorded at 0843:52 at 1,850 ft msl, at which point the airplane was still in a tight, left spiraling turn. Subsequently, radar contact was lost, and no additional communications were received from the pilot. See figure 2 for a radar track showing the initial left turn followed by the spiraling left turns.

Pilot Information

Certificate:	Private	Age:	65, 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:	No
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	May 3, 2017
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:	(Estimated) 495.6 hours (Total, all aircraft), 244.8 hours (Total, this make and model), 10.3 hours (Last 90 days, all aircraft), 5.4 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Passenger Information

Certificate:		Age:	65, Male
Airplane Rating(s):		Seat Occupied:	Right
Other Aircraft Rating(s):		Restraint Used:	Unknown
Instrument Rating(s):		Second Pilot Present:	No
Instructor Rating(s):		Toxicology Performed:	No
Medical Certification:		Last FAA Medical Exam:	
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:			

A review of the pilot's logbook revealed that he accumulated 70 hours of total flight experience from 1980 to 1985. He did not log any additional flight time until 2011. He first flew the accident airplane on January 31, 2014, and then exclusively logged flights in the accident airplane from April 9, 2014, until the accident date.

The pilot's flight instructor stated that he had flown with the pilot six times in the 6 months before the accident. Four of the flights were conducted for the purpose of maintaining instrument currency and proficiency. Their most recent flight was on November 30, 2017, during which the pilot completed ILS and GPS approaches in simulated IMC.

The pilot's logbooks showed that he had completed the recent instrument experience requirements in accordance with 14 *CFR* Section 61.57, "Recent flight experience: Pilot in command."

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	Registration:	N451TD
Model/Series:	SR22 G1	Aircraft Category:	Airplane
Year of Manufacture:	2001	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	0064
Landing Gear Type:	Tricycle	Seats:	4
Date/Type of Last Inspection:	January 19, 2018 Annual	Certified Max Gross Wt.:	3400 lbs
Time Since Last Inspection:		Engines:	1 Reciprocating
Airframe Total Time:	1269.5 Hrs as of last inspection	Engine Manufacturer:	Continental Motors
ELT:	Installed, not activated	Engine Model/Series:	IO-550-N7B
Registered Owner:	On file	Rated Power:	310 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

General

The altitude indicating system and transponder, which were most recently tested in accordance with the requirements of 14 *CFR* Sections 91.411 and 91.413, "Altimeter system and altitude reporting equipment tests and inspections" and "ATC transponder tests and inspections," respectively, on September 26, 2017.

The airplane was not equipped with an anti-icing or deicing system, thus it was not equipped for flight in icing conditions.

The pilot had the ForeFlight application on a mobile device, which provided instrument approach plates; paper approach plates were found at the accident site.

The cockpit instrumentation included an airspeed indicator, attitude indicator, altimeter and a turn coordinator, vertical speed indicator, Garmin mechanical course deviation indicator, and Sandel SN3308 electronic horizontal situation indicator. The airplane was also equipped with an S-TEC 55X autopilot, a Garmin GTX345 transponder, dual Garmin GNS 430 units, and an ARNAV ICDS-2000 multifunction display (MFD) with an engine monitoring module (EMM-35) that displayed engine data. The ARNAV unit displayed, in part, navigational waypoints, course line, and ground speed and had a separate database, which displayed terrain elevations based on position. The Garmin GNS 430 was approved for IFR operations; however, the ARNAV MFD was for reference only and was not certified for flight in IMC.

Cirrus Airframe Parachute System (CAPS)

The airplane was equipped with a Ballistic Recovery Systems ballistic recovery parachute system. According to Cirrus, the CAPS will lower the airplane's entire airframe to the ground when all

alternatives to land the airplane have been exhausted. The CAPS consisted of a parachute, a solid-propellant rocket to deploy the parachute, a rocket activation handle, and a Kevlar harness embedded within the fuselage structure. The pilot could activate the system by pulling on a T-handle mounted on the cockpit ceiling above the pilot's right shoulder, which in turn activated the firing pin mechanism that then ignited the solid-propellant rocket in the parachute enclosure.

In the airplane's Pilot's Operating Handbook "Normal Procedures, Preflight Walk-Around" checklist, item 1 states, "CAPS Handle...Pin Removed." In the "Before Starting Engine" checklist, item 4 states, "Verify CAPS handle safety pin is removed." In the "Before Takeoff" checklist, item 2 states, "CAPS Handle... Verify Pin Removed."

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	Condition of Light:	Day
Observation Facility, Elevation:	KAOO,1469 ft msl	Distance from Accident Site:	9 Nautical Miles
Observation Time:	08:39 Local	Direction from Accident Site:	213°
Lowest Cloud Condition:		Visibility	2 miles
Lowest Ceiling:	Broken / 500 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	7 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	10°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.7 inches Hg	Temperature/Dew Point:	6°C / 4°C
Precipitation and Obscuration:	Moderate - None - Mist		
Departure Point:	LANCASTER, PA (LNS)	Type of Flight Plan Filed:	IFR
Destination:	SOUTH BEND, IN (SBN)	Type of Clearance:	IFR
Departure Time:	07:34 Local	Type of Airspace:	Class E

The pilot received a weather briefing the night before the accident flight at 2127 and filed an IFR flight plan via the Foreflight mobile application with a planned flight route of LNS-EWC-NORNA-SBN at 6,000 ft msl. The pilot entered the same route into the application two times before he filed the flight plan, which is consistent with his comparing the winds aloft at two different flight altitudes.

The ForeFlight weather briefing contained the standard weather information valid for a departure time of 0645 on April 19, but some of the weather forecast products did not provide forecast information of the weather conditions at the time of departure because the weather briefing was requested 10 hours before the flight. The graphical forecast products from the weather briefing predicted cloud cover as low as 2,000 ft msl along the flight route, and the surface forecast predicted marginal visual flight rules conditions with likely snow shower activity. The AOO and JST TAFs called for IFR and low IFR conditions between 0200 and 1000 on April 19. The AIRMET received during the weather briefing was only valid until 0500 on April 19, which was before the intended departure time. At the time of the accident, there was an active AIRMET for moderate icing, IFR/mountain obscuration, and low-level turbulence. An updated AIRMET advisory from as late as 0452 on April 19 was recorded via the flight plan identification number, but it could not be determined if the pilot checked the updated AIRMET information before the flight. No records were found indicating whether the pilot retrieved any other

weather information before or during the flight.

Icing Potential

Current icing potential (CIP) and forecast icing potential (FIP) products are intended to be supplemental to other icing advisories, such as AIRMETs and SIGMETs. The FIP products indicated a 50 to 70% probability of icing at trace-to-moderate levels above the accident site from 4,000 to 6,000 ft msl at 0900. The FIP indicated a 40 to 50% probability of supercooled large droplet (SLD) over the accident area around the accident time at 6,000 ft msl. The CIP product indicated a 60 to 85% probability of icing at light-to-moderate levels above the accident site from 4,000 to 6,000 ft msl at 0900. The CIP also indicated a 10 to 40% probability of SLD near the accident site at 0900 between 4,000 and 6,000 ft msl and a 0 to 40% probability of SLD near the accident site at 0800 between 4,000 and 6,000 ft msl. The CIP/FIP information would have been available to the pilot before the accident flight departed.

The National Weather Service Aviation Weather Center that issues the CIP and FIP advises, "NOTE: CIP/FIP is intended for flight planning purposes and should always be used in combination with icing information from all available sources including AIRMETs, SIGMETs, and PIREPs. CIP/FIP aid flight planning and situational awareness through graphical depiction of current and forecast icing conditions across an area or along a route of flight. NOTE: Pilots of aircraft that are not certified for flight into known or forecast icing conditions should be especially cautious of areas displaying any type of icing severity, regardless of the probability indicated on CIP graphics."

Satellite Data

Figure 3 shows the compiled Geostationary Operational Environmental Satellite 16 (GOES-16) infrared and visible data and the pilot's communication with ATC at the time he requested to divert with the direction of travel indicated with a red arrow. This imagery indicated that the airplane was in areas of abundant cloud cover with cloud top temperatures between -5° and -15°C throughout the flight. The airplane turned back toward the east before reaching an area of cloud top temperatures between -15° and -25°C . The cloud-top heights above the accident site at around the time of the accident were about 10,400 ft msl. The IMC and icing conditions would have ended above the cloud layer.

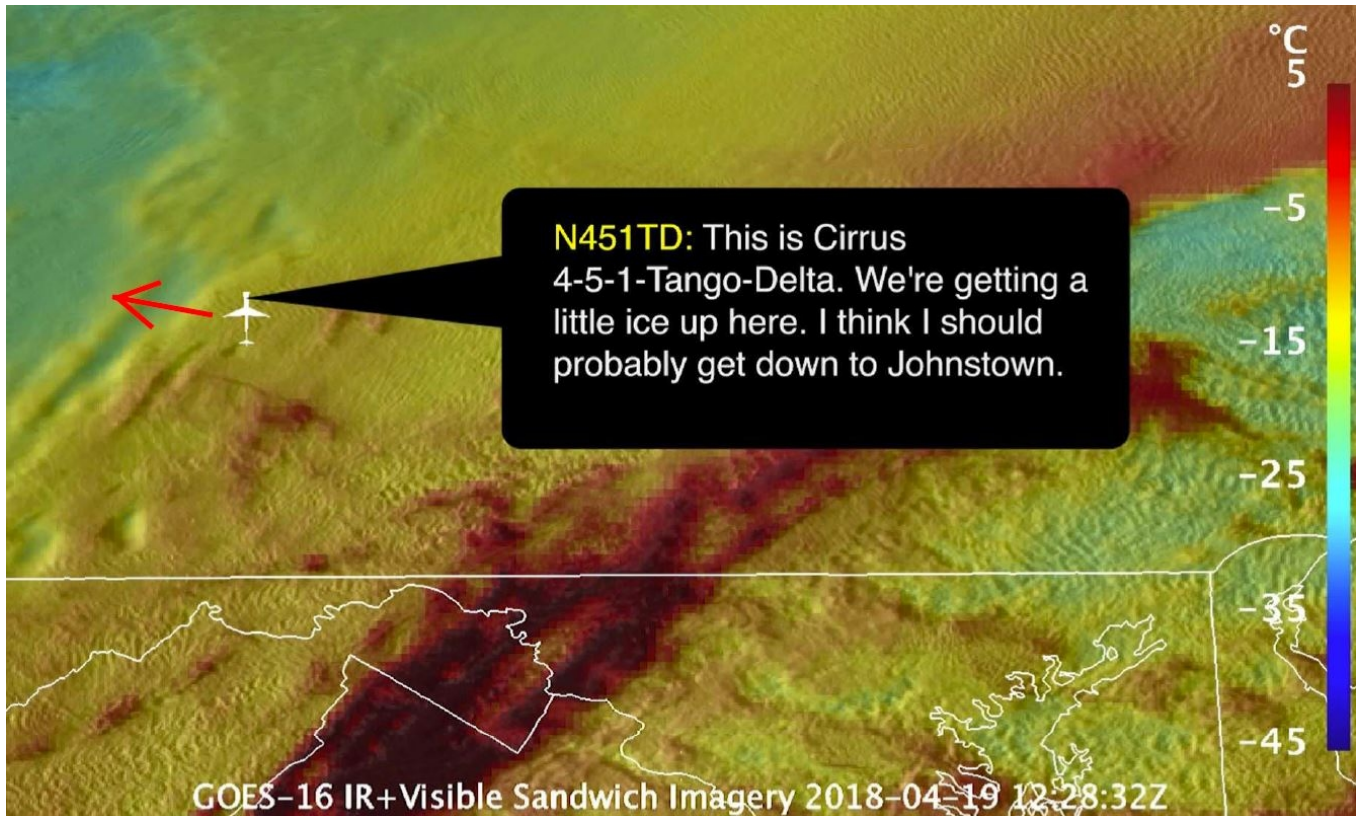


Figure 3. GOES-16 satellite imagery with the airplane's position when the pilot diverted

Airport Information

Airport:	ALTOONA-BLAIR COUNTY AOO	Runway Surface Type:	Asphalt
Airport Elevation:	1503 ft msl	Runway Surface Condition:	Unknown
Runway Used:	21	IFR Approach:	ILS
Runway Length/Width:	5465 ft / 100 ft	VFR Approach/Landing:	None

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:	40.422779,-78.211669(est)

The airplane impacted a field behind a residential property 9.5 miles northeast of AOO (see figure 4, which shows the initial impact point and the airplane wreckage). The wreckage debris path was about 200 ft long, on a magnetic heading of 150°, and at an elevation 1,025 ft msl.



Figure 4. Initial impact point and airplane wreckage

Ground scars at the accident site and damage to the airplane were consistent with the airplane impacting terrain in a steep, nose-low, wings-level attitude. The left wing inspection panels and the pitot tube were found in the horizontal ground scar, which can be seen on the lower left side of figure 4. The ground scars surrounding the center impact crater were consistent with the shape of the wing leading edges and the tricycle landing gear. The engine, firewall, and all three propeller blades were found in the center impact crater, which was about 3 ft deep. A postimpact fire consumed most of the wreckage, but all major airplane structural components were located within the debris field.

The engine mounts and nose landing gear brace remained attached to the engine with the firewall. The throttle, mixture, and propeller control cables remained attached to their respective control levers. The front portion of the oil sump was flattened against the bottom side of the engine, and the aft portion of the oil sump was impact-damaged and displaced aft, exposing the bottom crankcase halves.

The three-bladed, constant-speed propeller remained attached to the crankshaft, but two of the blades were separated just outboard of the shank. The third blade remained attached to the hub and was bent aft around the engine's left side and twisted toward low pitch; the outboard tip was impact-separated from the blade. The leading edge of one of the separated blades exhibited deep gouges. The propeller spinner was crushed aft around the propeller hub.

Both the directional and turn coordinator gyros exhibited rotational scoring and signs of rotation at impact.

The ARNAV ICDS-2000 and EMM-35 were destroyed by fire, and data extraction was not possible.

The CAPS activation handle remained in its holder with the safety pin installed as shown in figure 5. The CAPS was found deployed, and the CAPS solid rocket propellant was expended. The parachute was found deployed, and it extended along the debris path. Portions of the CAPS that remained within the main wreckage were consumed by fire. All evidence revealed that the CAPS was not activated in flight but rather that it deployed due to impact forces and thermal exposure.



Figure 5. Safety pin installed in the CAPS activation handle

Although the postaccident examination was limited due to postimpact fire damage, examinations of the airframe and engine did not reveal evidence of any preaccident mechanical malfunctions or anomalies that would have precluded normal operation.

Medical and Pathological Information

Mount Nittany Medical Center, State College, Pennsylvania, conducted an autopsy of the pilot. The autopsy report concluded that the cause of death was "blunt force trauma." The examination was limited due to the extent of damage to the pilot's body as a result of the accident. However, the autopsy was able to determine that the pilot had mild-to-moderate atherosclerotic coronary artery disease with 50% stenosis of the left coronary artery and 30% stenosis of the left circumflex coronary artery. The

examination of the remaining available cardiac tissue was unremarkable.

Toxicology testing performed by the laboratory at FAA Forensic Sciences identified the following: 10 mg/dL ethanol in liver tissue but no ethanol in the muscle tissue, diphenhydramine in liver and muscle tissue, amlodipine in kidney tissue, atenolol in kidney and heart tissue, 0.039 µg/mL 7-amino-clonazepam in kidney tissue, and 0.026 µg/mL 7-amino-clonazepam in lung tissue.

Ethanol is an intoxicant, which, after absorption, is uniformly distributed throughout all tissue and body fluids. It may also be produced in postmortem tissue by microbial action.

Diphenhydramine is a sedating antihistamine used to treat allergy symptoms and as a sleep aid. It is available over the counter under the names Benadryl and Unisom. In a driving simulator study, a single 50 mg dose of diphenhydramine impaired driving ability more than a blood alcohol concentration of 0.100%. Diphenhydramine carries the following U.S. Food and Drug Administration (FDA) warning: "may impair mental and/or physical ability required for the performance of potentially hazardous tasks (e.g., driving, operating heavy machinery)." Compared to other antihistamines, diphenhydramine causes marked sedation, which is the rationale for its use as a sleep aid. Altered mood and impaired cognitive and psychomotor performance may also be observed.

Amlodipine and atenolol are nonimpairing blood pressure medications, and the pilot had reported them to the FAA. According to records obtained from the pilot's primary care physician, at the time of the accident, the pilot had been prescribed both atenolol and amlodipine to control his hypertension.

Clonazepam, the parent drug that is metabolized into 7-amino-clonazepam (an inactive metabolite) is a sedating benzodiazepine used to treat panic and anxiety disorders and certain kinds of seizures. Clonazepam carries the following FDA warning: "Since clonazepam produces central nervous system (CNS) depression, patients receiving this drug should be cautioned against engaging in hazardous occupations requiring mental alertness, such as operating machinery or driving a motor vehicle. They should also be warned about the concomitant use of alcohol or other CNS-depressant drugs during clonazepam therapy." No records were found regarding a prescription for clonazepam or any disorder that would have required its use.

Additional Information

Preflight Action

14 *CFR* Section 91.103, "Preflight action," states, in part, the following:

Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. This information must include -

(a) For a flight under IFR or a flight not in the vicinity of an airport, weather reports and forecasts...

Operating in Icing Conditions

14 CFR Section 91.527, "Operating in Icing Conditions," states, in part, the following:

(b) No pilot may fly under IFR into known or forecast light or moderate icing conditions, or under VFR into known light or moderate icing conditions, unless –

(1) The aircraft has functioning deicing or anti-icing equipment protecting each rotor blade, propeller, windshield, wing, stabilizing or control surface, and each airspeed, altimeter, rate of climb, or flight attitude instrument system;

(2) The airplane has ice protection provisions that meet section 34 of Special Federal Aviation Regulation No. 23; or

(3) The airplane meets transport category airplane type certification provisions, including the requirements for certification for flight in icing conditions.

(c) Except for an airplane that has ice protection provisions that meet the requirements in section 34 of Special Federal Aviation Regulation No. 23, or those for transport category airplane type certification, no pilot may fly an airplane into known or forecast severe icing conditions.

(d) If current weather reports and briefing information relied upon by the pilot in command indicate that the forecast icing conditions that would otherwise prohibit the flight will not be encountered during the flight because of changed weather conditions since the forecast, the restrictions in paragraphs (b) and (c) of this section based on forecast conditions do not apply.

Spatial Disorientation

The FAA publication, "Medical Facts for Pilots (AM-400-03/1)," discusses the vestibular aspects of spatial orientation and states in part, the following:

The inner ear contains the vestibular system, which is also known as the organ of equilibrium...the vestibular system contains two...semicircular canals, which detect changes in angular acceleration, and the otolith organs..., which detect changes in linear acceleration and gravity. Both the semicircular canals and the otolith organs provide information to the brain regarding our body's position and movement. A connection between the vestibular system and the eyes helps to maintain balance and keep the eyes focused on an object while the head is moving or while the body is rotating...The semicircular canals are three half-circular, interconnected tubes located inside each ear that are the equivalent of three gyroscopes located in three planes perpendicular...to each other. Each plane corresponds to the rolling, pitching, or yawing motions of an aircraft....Illusions involving the semicircular canals of the vestibular system occur primarily under conditions of unreliable or unavailable external visual references and result in false sensations of rotation.

These illusions include the graveyard spiral, about which, the publication states, in part, the following:

The graveyard spiral...is associated with a return to level flight following an intentional or unintentional prolonged bank turn. For example, a pilot who enters a banking turn to the left will initially have a sensation of a turn in the same direction. If the left turn continues (~20 seconds or more), the pilot will experience the sensation that the airplane is no longer turning to the left. At this point, if the pilot attempts to level the wings this action will produce a sensation that the airplane is turning and banking in the opposite direction (to the right). If the pilot believes the illusion of a right turn (which can be very compelling), he/she will reenter the original left turn in an attempt to counteract the sensation of a right turn. Unfortunately, while this is happening, the airplane is still turning to the left and losing altitude. Pulling the control yoke/stick and applying power while turning would not be a good idea—because it would only make the left turn tighter. If the pilot fails to recognize the illusion and does not level the wings, the airplane will continue turning left and losing altitude until it impacts the ground.

Figure 6 is a graphic from the FAA's Pilot's Handbook of Aeronautical Knowledge showing a graveyard spin and a graveyard spiral.

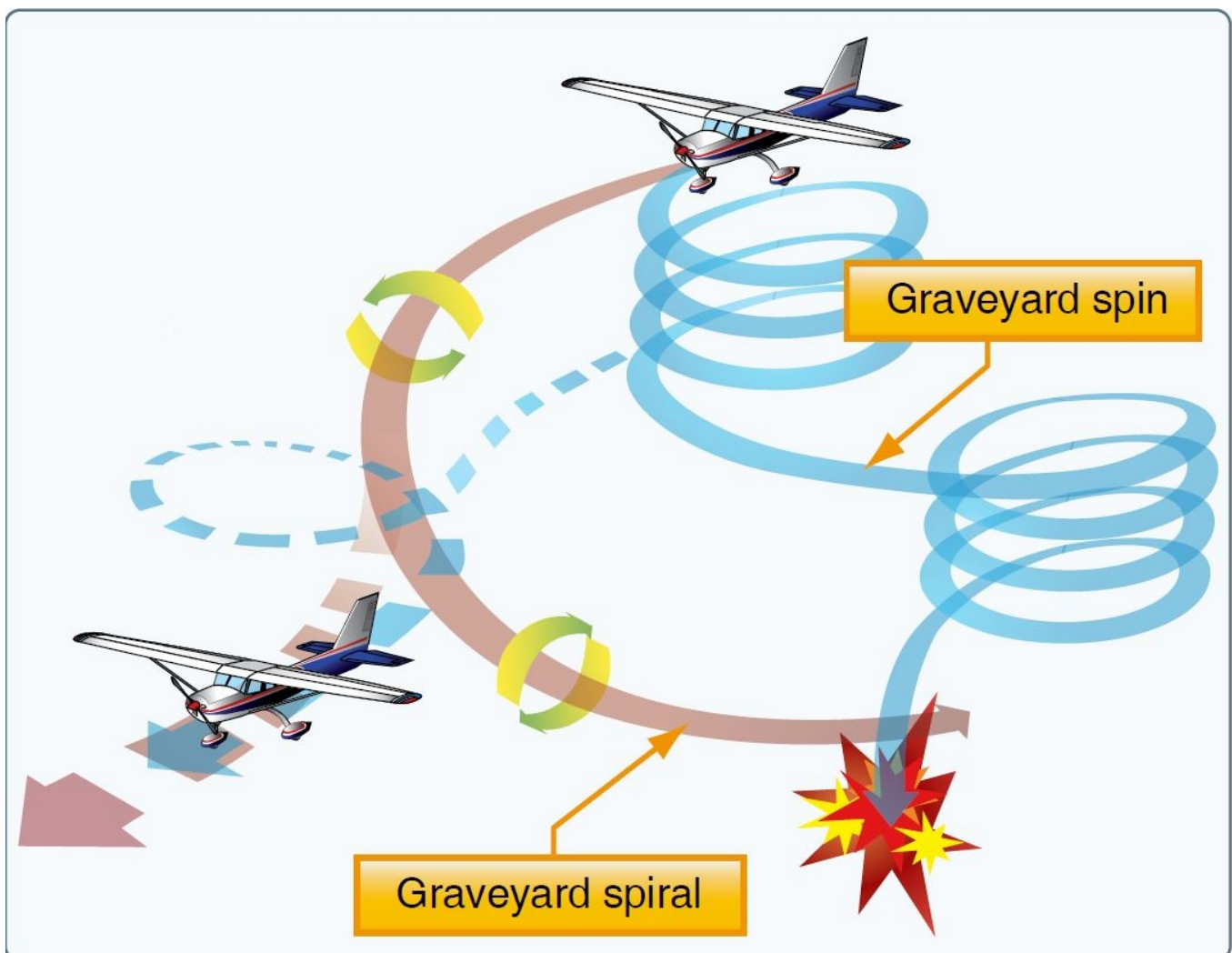


Figure 6. Graphic depicting a graveyard spin and graveyard spiral

Administrative Information

Investigator In Charge (IIC):	Lindberg, Joshua
Additional Participating Persons:	Michael Shannon; Federal Aviation Administration; Allegheny, PA Nicole Charnon; Continental Motors; Mobile, AL Brad Miller; Cirrus Aircraft; Duluth, MN
Original Publish Date:	November 6, 2019
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=97066

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).