# Aviation Investigation Final Report

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| **Location:** | Chesapeake, Virginia | **Accident Number:** | ERA18FA150 |
| **Date & Time:** | May 22, 2018, 07:28 Local | **Registration:** | N6177W |
| **Aircraft:** | Piper PA28 | **Aircraft Damage:** | Destroyed |
| **Defining Event:** | Loss of control in flight | **Injuries:** | 1 Fatal |
| **Flight Conducted Under:** | Part 91: General aviation - Personal | | |

## Analysis

The commercial pilot completed a normal preflight inspection and engine run-up and received an instrument flight rules clearance from air traffic control to depart from the uncontrolled airport, where fog, low visibility, and clouds were present. Shortly after takeoff, the airplane entered the clouds and fog, climbed on the departure runway heading, and turned right, consistent with the clearance provided; however, the airplane continued the right turn, flying a 360° circle. During the circle, the airplane rapidly descended to about 60 ft above ground level (agl) then climbed to about 600 ft agl. The last radar data point showed the airplane at 356 ft agl, flying at 42 knots groundspeed. There were no communications received from the pilot during the flight. The wreckage was located in an open field about 1/4 mile from the last radar data point.

A postaccident examination of the airplane and the airplane's primary vacuum system did not reveal any anomalies consistent with a preimpact failure or malfunction. The airplane was equipped with a standby vacuum system and an electrically-powered attitude indicator, and the investigation found no anomalies with these components. Due to impact and fire damage, the investigation could not determine whether the standby vacuum system was activated by the pilot.

The restricted visibility, maneuvering, and workload associated with the initial post-takeoff phase of flight provided conditions conducive to the development of spatial disorientation, and the changes in the airplane's altitude, heading, and speed depicted on radar are consistent with the known effects of spatial disorientation. It is likely that the pilot experienced spatial disorientation during the climbing departure turn, which resulted in an exceedance of the airplane's critical angle of attack, an aerodynamic stall, and a subsequent 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 loss of airplane control due to spatial disorientation during the departure climb in instrument meteorological conditions.

## Findings

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| **Personnel issues** | Aircraft control - Pilot |
| **Personnel issues** | Spatial disorientation - Pilot |
| **Environmental issues** | Low ceiling - Contributed to outcome |
| **Environmental issues** | Low visibility - Contributed to outcome |
| **Environmental issues** | Fog - Contributed to outcome |

# Factual Information

## History of Flight

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| **Enroute-climb to cruise** | Loss of control in flight (Defining event) |
| **Enroute-climb to cruise** | Collision with terr/obj (non-CFIT) |
| **Post-impact** | Fire/smoke (post-impact) |

On May 22, 2018, at 0728 eastern daylight time, a Piper PA-28-140, N6177W, was destroyed when it impacted terrain shortly after takeoff from Chesapeake Regional Airport (CPK), Chesapeake, Virginia. The commercial pilot was fatally injured. The airplane was owned by the pilot who was operating it as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Day instrument meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan was filed for the flight, which departed about 0726 and was destined for Republic Airport (FRG), Farmingdale, New York.

The pilot's spouse reported that, for about 7 years, the pilot had commuted to FRG from CPK for work, and the accident flight was the flight to return to work. She reported that the night before the accident, the pilot called the fixed based operator at CPK to have the fuel tanks topped off. During the pilot's preflight inspection of the airplane on the morning of the accident, she observed the pilot walk around the airplane, sampled both fuel tanks, and remove the cover from the pitot probe on the left wing. She commented to the pilot that it was foggy, and the pilot stated to her that, "as long as I can see the runway, I'll be fine."

The pilot started the engine and taxied to the runway with the airplane lights operating. She reported that she heard the pilot perform an engine run-up and that the engine "sounded like a good running engine." Subsequently, she observed the airplane take off and shortly thereafter enter the clouds; about 2 to 3 minutes later, she heard an engine "revving noise." The pilot made no mention of any maintenance issues to her, nor was she aware of any recent maintenance performed on the airplane before the flight.

Review of air traffic control communications provided by the Federal Aviation Administration (FAA) revealed that, at 0704, while on the ground at CPK, the pilot requested an IFR clearance via telephone. He was issued instructions to fly a heading of 050° and maintain 3,000 ft after departure. The pilot called back at 0724, advising the controller that he was ready for takeoff. The controller issued him a clearance void time of 0729, and the pilot informed him he would be airborne within 3 minutes. There were no further communications received from the pilot.

Review of radar data provided by the FAA revealed that the airplane departed runway 23 at 0726:40, climbed to about 350 ft mean sea level (msl) on a southwest ground track and began a right turn at 0727:11. The airplane continued turning right and completed a 360° right turn, during which it rapidly descended to 75 ft msl (about 60 ft above the ground) then climbed to 600 ft msl. The last radar return, recorded at 0728:04, was about 1/4 mile from the accident site, and showed the airplane at 375 ft msl on a heading of 297° at 42 knots groundspeed.

## Pilot Information

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| **Certificate:** | Commercial | **Age:** | 57,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:** | No |
| **Instructor Rating(s):** | None | **Toxicology Performed:** | Yes |
| **Medical Certification:** | Class 2 Without waivers/limitations | **Last FAA Medical Exam:** | October 17, 2017 |
| **Occupational Pilot:** | No | **Last Flight Review or Equivalent:** | |
| **Flight Time:** | (Estimated) 2100 hours (Total, all aircraft) | | |

According to FAA airman records, the pilot held a commercial pilot certificate with ratings for airplane single- and multi-engine land and instrument airplane. He also held a remote pilot certificate for small unmanned aircraft system and a control tower operator certificate. The pilot was issued an FAA second-class medical certificate on October 17, 2017. At that time, the pilot reported civil flight experience that included 2,100 total hours and 160 hours in the preceding 6 months. The pilot's most recent logbook was not located and according to the pilot's wife, the pilot routinely carried the logbook with him in the airplane.

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | Piper | **Registration:** | N6177W |
| **Model/Series:** | PA28 140 | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | 1964 | **Amateur Built:** | |
| **Airworthiness Certificate:** | Normal; Utility | **Serial Number:** | 28-20194 |
| **Landing Gear Type:** | Tricycle | **Seats:** | 4 |
| **Date/Type of Last Inspection:** | January 12, 2018 Annual | **Certified Max Gross Wt.:** | 2150 lbs |
| **Time Since Last Inspection:** | | **Engines:** | 1 Reciprocating |
| **Airframe Total Time:** | 4322.4 Hrs as of last inspection | **Engine Manufacturer:** | LYCOMING |
| **ELT:** | Installed, activated, did not aid in locating accident | **Engine Model/Series:** | O-320-E2A |
| **Registered Owner:** | | **Rated Power:** | 160 Horsepower |
| **Operator:** | On file | **Operating Certificate(s) Held:** | None |

The accident airplane was a 4-seat, single-engine, low-wing airplane manufactured in 1964. It was powered by a Lycoming O-320-E2A engine. The most recent annual inspection was completed in

January 2018, which noted an airframe time of 4,322.4 hours, a tachometer time of 1,927 hours, and 2,329.4 hours since major engine overhaul. The tachometer was not located in the wreckage.

According to FAA airworthiness records, the airplane was equipped with a primary attitude indicator, which was powered by the engine driven-vacuum pump and mounted on the left side of the cockpit instrument panel. The airplane was also equipped with an electrically-powered attitude indicator mounted on the right side of the cockpit. The airworthiness records also showed that the airplane was equipped with a Precise Flight Standby Vacuum System Model V.

The standby vacuum system's manual stated in part:

The Standby Vacuum System connects easily to the aircraft powerplant intake manifold, electrical system and the instrument vacuum supply. In the event of an engine driven vacuum pump failure, The Precise Flight Standby Vacuum System allows the use of engine intake vacuum, in conjunction with a flight tested operating procedure, to supply vacuum to the primary aircraft instruments.

The standby vacuum system's manual further stated that, in the event of a loss of primary vacuum air pressure, the standby system could be manually activated by the pilot via a pull knob in the cockpit. The system also included a primary vacuum failure warning light mounted next to the primary attitude indicator. The airplane was equipped with a vacuum pressure gauge.

A copy of the airplane's maintenance records revealed that, on February 7, 2017, a discrepancy was noted with an inoperative dry-air vacuum pump. The record stated that a dry-air pump, part number 211CC, serial number 126363, was replaced with a new dry-air vacuum pump, RAP 215CC, serial number A62097, which was not the pump found in the wreckage. The maintenance records located contained no other entries or invoices regarding the installation of an Aero Accessories AA3215CC replacement vacuum pump.

According to the airplane's owner manual, the aerodynamic stall speed with flaps extended was 47 knots.

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Instrument (IMC) | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | CPK,18 ft msl | **Distance from Accident Site:** | 1 Nautical Miles |
| **Observation Time:** | 07:15 Local | **Direction from Accident Site:** | 50° |
| **Lowest Cloud Condition:** | 200 ft AGL | **Visibility** | 0.25 miles |
| **Lowest Ceiling:** | Overcast / 200 ft AGL | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 3 knots / | **Turbulence Type Forecast/Actual:** | None / None |
| **Wind Direction:** | 70° | **Turbulence Severity Forecast/Actual:** | N/A / N/A |
| **Altimeter Setting:** | 30.12 inches Hg | **Temperature/Dew Point:** | 19°C / 18°C |
| **Precipitation and Obscuration:** | Moderate - None - Fog | | |
| **Departure Point:** | CHESAPEAKE, VA (CPK ) | **Type of Flight Plan Filed:** | IFR |
| **Destination:** | FARMINGDALE, NY (FRG ) | **Type of Clearance:** | IFR |
| **Departure Time:** | 07:26 Local | **Type of Airspace:** | Class G |

The weather conditions reported at CPK at 0715 included visibility of 1/4 mile in fog, an overcast ceiling at 200 ft above ground level (agl), wind from 070° at 3 knots, temperature 19°C, and dew point 18°C. Additional review of the CPK weather observations reflected IFR conditions during the early morning, with low IFR conditions due to low overcast clouds and dense fog prevailing from 0355 through 1055, with gradual improvement to IFR and marginal visual flight rules conditions by 1155.

Review of the High-Resolution Rapid Refresh (HRRR) numerical model sounding for 0700 depicted a surface temperature of 20°C and a dew point of 19°C with a 98% relative humidity. The sounding indicated conditions favorable for fog. The lifted condensation level (LCL) and level of free convection (LFC) were at 169 ft agl, with expected overcast cloud tops to 3,600 ft and broken clouds with tops near 9,000 ft agl.

Review of the United States Naval Observatory's website showed sunrise at 0552. At the time of the accident, the sun was 17° above the horizon at an azimuth of 77°.

According to Leidos Flight Service, the pilot filed an IFR flight plan over the telephone, and during the call, he declined a weather briefing. Therefore, the specific weather products the pilot had reviewed regarding the flight could not be determined.

## Airport Information

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| **Airport:** | CHESAPEAKE RGNL CPK | **Runway Surface Type:** | Asphalt |
| **Airport Elevation:** | 18 ft msl | **Runway Surface Condition:** | Dry |
| **Runway Used:** | 23 | **IFR Approach:** | None |
| **Runway Length/Width:** | 5500 ft / 100 ft | **VFR Approach/Landing:** | None |

## Wreckage and Impact Information

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| **Crew Injuries:** | 1 Fatal | **Aircraft Damage:** | Destroyed |
| **Passenger Injuries:** | | **Aircraft Fire:** | On-ground |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 1 Fatal | **Latitude, Longitude:** | 36.657501,-76.336944 |

The airplane came to rest upright in a flat, open field, oriented on a magnetic heading of 325°, about 3/4 nautical mile southwest of CPK. The airplane sustained extensive impact damage and evidence of a postimpact fire. All major components of the airplane were accounted for at the accident site. Flight control continuity was established from all flight control surfaces to the cockpit area. The stabilator trim drum was measured and correlated to a slight nose-up trim setting.

The flap handle was found in the retracted position, and both inboard flap sections were in the retracted position. The main landing gear and nose gear separated from the airframe and were found in the wreckage. The fuel selector valve was impact-damaged and separated from the airframe. When disassembled and low-pressure air was applied, the outlet port was open to the right fuel tank. The fuel tank screen was clean and free of blockage.

The cockpit, instrument panel, and main cabin area, including the seats, were damaged during the impact and the postimpact fire. The throttle, mixture, and other cockpit control knobs were consumed by fire. The primary attitude indicator's vacuum gyro separated from its case and was found in the wreckage. An electrical attitude indicator gyro was found loose in an instrument casing that was fire and impact damaged.

The primary attitude indicator's gyro and housing and the gyro from the electrically-powered attitude indicator were sent to the NTSB's Material Laboratory in Washington, DC, for examination. Bench binocular examination of the cleaned outer surface of the gyro and the inner surface of the housing for the vacuum-powered attitude indicator revealed no evidence of circumferential gouge marks. The cleaned surface of the gyro for the electric attitude indicator revealed evidence of a circumferential gouge mark. [Refer to the Materials Laboratory Factual Report in the public docket for additional information.]

The engine remained attached to the firewall. The crankshaft was rotated by hand and valve train continuity was established. All cylinders remained attached to the crankshaft and thumb compression and suction was observed on all cylinders. Each spark plug displayed varying degrees of impact damage but exhibited normal operating and combustion signatures. The cylinders were inspected using a lighted borescope; the cylinder bore, piston faces, and valve heads displayed normal operating and combustion signatures. The standby vacuum system's shuttle valve remained attached to the engine mount. A pull cable was found near the shuttle valve separated from its attach point and exhibited signatures consistent with overload separation.

The carburetor was found separated from the engine and fractured. The throttle butterfly valve operated freely throughout its range of motion. The carburetor fuel inlet screen and oil screen were clean and free of debris. The fuel pump was impact and fire damaged. Both magnetos were found with the engine and could not be tested due to impact and thermal damage.

The propeller remained attached to the propeller flange. One blade was found above ground with an s-bend shape. The other blade was found under the engine and exhibited a mid-span 90° aft bend and blade polishing.

The vacuum pump remained attached to the accessory section of the engine and displayed impact and fire damage. The pump was missing one of two assembly screws that held the unit together. The single screw that was installed was finger-tight.

The dry-air vacuum pump was examined at Aero Accessories, Inc. The identification plate was not legible, but the pump had external and internal characteristics matching an Aero Accessories 3215CC dry-air vacuum pump. Examination of the pump's stator revealed that it was in an advanced state of wear. The vanes found within the stator were likely replacement vanes, as their wear was not consistent with that of the stator. Aero Accessories provides no approved method to replace the stator vanes. The examination revealed no internal damage to the pump's components and no evidence of pump failure.

Aero Accessories bench-tested an exemplar dry-air vacuum pump with one casing screw not installed. The manufacturer reported that the vacuum pump operated normally.

The airplane's standby vacuum system was examined. During the onsite examination, a pull cable was found near the shuttle valve separated from its attach point. The cable separation was consistent with overload. During a subsequent examination, pneumatic air was blown through the shuttle valve while it was submerged in water and air bubbles were observed exiting the entry and exit valve holes.

## Additional Information

Spatial Disorientation

The FAA Civil Aeromedical Institute's publication, "Introduction to Aviation Physiology," defines spatial disorientation as a loss of proper bearings or a state of mental confusion as to position, location, or movement relative to the position of the earth. Factors contributing to spatial disorientation include changes in acceleration, flight in instrument meteorological conditions (IMC), frequent transfer between visual meteorological conditions (VMC) and IMC, and unperceived changes in aircraft attitude.

The FAA's Airplane Flying Handbook (FAA-H-8083-3A) describes some hazards associated with flying when the ground or horizon are obscured. The handbook states, in part:

The vestibular sense (motion sensing by the inner ear) in particular tends to confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in the attitude of the airplane, 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.

### Medical and Pathological Information

An autopsy of the pilot was performed by the Department of Health, Office of the Chief Medical Examiner, Norfolk, Virginia, which stated the cause of death was multiple blunt trauma.

Toxicology testing performed at the FAA Forensic Sciences Laboratory was negative for volatiles and drugs.

## Preventing Similar Accidents

Reduced Visual References Require Vigilance

About two-thirds of general aviation accidents that occur in reduced visibility weather conditions are fatal. The accidents can involve pilot spatial disorientation or controlled flight into terrain. Even in visual weather conditions, flights at night over areas with limited ground lighting (which provides few visual ground references) can be challenging.

Preflight weather briefings are critical to safe flight. In-flight, weather information can also help pilots make decisions, as can in-cockpit weather equipment that can supplement official information. In-cockpit equipment requires an understanding of the features and limitations.

We often see pilots who decide to turn back after they have already encountered weather; that is too late. Pilot's shouldn't allow a situation to become dangerous before deciding to act. Additionally, air traffic controllers are there to help; be honest with them about your situation and ask for help.

Even when flying at night, visual weather conditions can also be challenging. Remote areas with limited ground lighting provide limited visual reference cues for pilots, which can be disorienting or render rising terrain visually imperceptible. Topographic references can help pilots become more familiar with the terrain. The use of instruments, if pilots are proficient, can also help pilots navigate these challenging areas.

See http://www.ntsb.gov/safety/safety-alerts/documents/SA_020.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

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| **Investigator In Charge (IIC):** | Gerhardt, Adam |
| **Additional Participating Persons:** | Amber D White; FAA/ FSDO; Richmond, VA<br>Robert Martellotti ; Piper Aircraft; Vero Beach, FL<br>David Harsanyi ; Lycoming Engines; Williamsport, PA |
| **Original Publish Date:** | November 6, 2019 |
| **Note:** | The NTSB traveled to the scene of this accident. |
| **Investigation Docket:** | https://data.ntsb.gov/Docket?ProjectID=97294 |