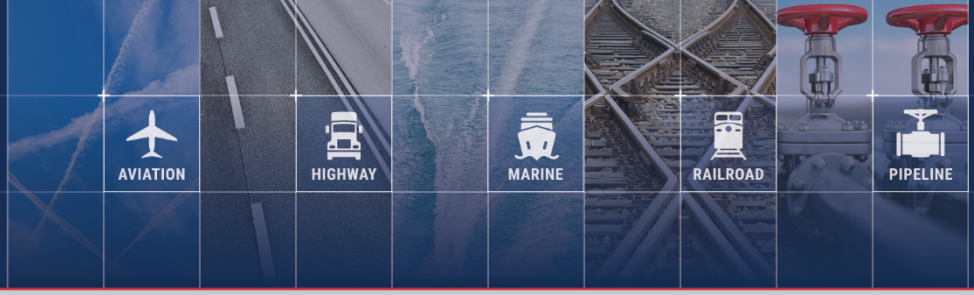

Aviation Investigation Final Report

Location:	Raphine, Virginia	**Accident Number:**	ERA09FA376
Date & Time:	July 5, 2009, 10:02 Local	**Registration:**	N578DC
Aircraft:	Pilatus PC-12/45	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	4 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

While in instrument meteorological conditions flying 800 feet above the airplane's service ceiling (30,000 feet), with no icing conditions reported, the pilot reported to the air traffic controller that he, "...lost [his] panel." With the autopilot most likely engaged, the airplane began a right roll about 36 seconds later. The airplane continued in a right roll that increased to 105 degrees, then rolled back to about 70 degrees, before the airplane entered a right descending turn. The airplane continued its descending turn until being lost from radar in the vicinity of the accident site. The airplane impacted in a nose-down attitude in an open field and was significantly fragmented.

Postaccident inspection of the flight control system, engine, and propeller revealed no evidence of preimpact failure or malfunction. The flaps and landing gear were retracted and all trim settings were within the normal operating range. Additionally, the airplane was within weight and balance limitations for the flight. The cause of the pilot-reported panel failure could not be determined; however, the possibility of a total electrical failure was eliminated since the pilot maintained radio contact with the air traffic controller.

Although the source of the instrumentation failure could not be determined, proper pilot corrective actions, identified in the pilot operating handbook, following the failure most likely would have restored flight information to the pilot's electronic flight display. Additionally, a standby attitude gyro, compass, and the co-pilot's electronic flight display units would be available for attitude reference information assuming they were operational.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's failure to maintain control of the airplane while in instrument meteorological conditions following a reported instrumentation failure for undetermined reasons.

Findings

Aircraft	Altitude - Capability exceeded
Personnel issues	(general) - Pilot
Aircraft	(general) - Failure

Factual Information

History of Flight

Enroute-climb to cruise	Flight instrument malf/fail
Maneuvering	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

Modifications were made to this report on 10/31/2011. Please see the public docket for this accident to see a list of changes.

HISTORY OF FLIGHT

On July 5, 2009, about 1002 eastern daylight time, a Pilatus PC12/45, N578DC, registered to Nicholas Elliott & Jordan LLC, impacted in a pasture near Raphine, Virginia, following an in-flight loss of control. Instrument meteorological conditions (IMC) prevailed at the altitude of the start of the in-flight loss of control and an instrument flight rules (IFR) flight plan was filed and activated for the 14 Code of Federal Regulations (CFR) Part 91 personal flight from Teterboro Airport (TEB), Teterboro, New Jersey, to Tampa Executive Airport (VDF), Tampa, Florida. The airplane was destroyed by impact and the certificated private pilot and three passengers were killed.

According to a chronological summary of communications, the pilot received his IFR clearance while on the ground at the departure airport. The certified copy of the voice transmission indicated the pilot was informed to expect flight level (FL) 260 ten minutes after departure. A transcription of communications indicated that the flight was cleared for takeoff about 0823, and after takeoff, air traffic control (ATC) communications were transferred to several ATC facilities while the flight proceeded towards the destination airport.

At approximately 0906, while in contact with the Washington Air Route Traffic Control Center (Washington ARTCC), the pilot advised the controller that he was at FL 260. While in communication with the same facility, he later requested clearance to climb to FL 280, followed by a request to climb to FL 300; both climb clearances were approved. The pilot climbed to FL 300 and at 0942, while continuing towards the destination airport, the pilot asked the controller if he was indicating any weather radar returns on the controller's scope. The controller informed the pilot that a line of radar returns 30 miles wide was located about 60 to 70 miles ahead of his position. The flight continued towards the destination and at approximately 0953, the pilot asked the controller if the ground based weather radar depicted a clear area of weather. The controller responded that ground based weather radar was depicting heavy weather ahead of the airplane's position using clock positions three and nine for reference. The pilot then requested to deviate 40 to 50 degrees to the right which was approved. The NTSB ATC Radar Study indicates the airplane deviated to the right and at

approximately 0954, ATC communications were transferred from the R52 sector to the R37 sector of the Washington ARTCC.

The transcription of communications further indicated that at approximately 0955, while in contact with the R37 sector controller of the Washington ARTCC, the pilot requested clearance to climb to FL320, which was approved. The NTSB ATC Radar Study indicated that from approximately 0953, to 1000, the airplane continued on a southwesterly heading and climbed to FL308. At 0959:47, while flying at FL308, the pilot informed the controller that he was turning back direct to JOINN intersection, which the controller acknowledged. The NTSB ATC Radar Study indicates the airplane turned left and at approximately 1000, ATC communications were transferred back to the R52 sector controller. At 1000:54, while at approximately FL312, the pilot advised the controller, "roger I'm ah gonna need a little dg heading I lost my panel I'm in the uh in the weather." The controller questioned the pilot about what he had lost and whether he needed a heading. The pilot did not clarify for the controller what panel he was referring to but responded that he needed a heading. The controller then questioned whether the pilot was clear of weather to his right and he replied he was. The controller provided a heading of 230 degrees, for radar vectors to the JOINN intersection.

The NTSB ATC Radar Study indicated that between approximately 1001, and 1001:38, the airplane proceeded in a southerly direction with altitude deviations noted. The transcription of communication indicated that at 1001:26, the pilot informed the controller, "and my altitude's gonna move a little bit."

The controller immediately advised the flight crew of an airliner (call sign Blue Streak 503) that was climbing below the accident airplane to stop their ascent, and to maintain FL290. The captain of Blue Streak 503 reported that while climbing through FL 260, he and his first officer heard the pilot of the accident airplane make a report that he had "lost a panel." At no point during the entire event did the crew of Blue Streak 503 receive an advisory or resolution advisory on their Traffic Alert and Collision Avoidance System (TCAS) display. The accident airplane's heading on their TCAS display appeared to curve around on their Multi Function Display. The weather conditions at FL 260 were solid IMC with no icing, and the on board weather radar depicted some green (light precipitation) in the area even though there was no rain on the windscreen. There was no convective activity depicted on their weather radar, and the ride conditions consisted of light chop. Shortly after the accident, Blue Streak descended to FL 240, on a heading of 180 degrees, and encountered VMC with an overcast layer below.

The controller then asked the accident pilot to advise him if he would be unable to maintain above FL300 due to traffic. The transcription of communications indicated the pilot did not reply and the controller then repeated the partial call sign of the airplane. The pilot responded at 1001:54, "I'm in a a descent" with the remainder of the comment unintelligible. There was no further recorded transmission from the accident pilot.

The NTSB ATC Radar Study indicated that between 1001:38, and 1002:29, the airplane was in a right descending turn. Between 1001:38, and 1002:06 (last radar return with altitude reported),

the airplane descended from FL 307, to FL 221, or a loss of 8,600 feet in 28 seconds, and between 1001:34, and 1002:29, the airplane completed a 360 degree right, descending turn. The accident site was located approximately 162 degrees and 0.81 nautical mile from the last radar return at 1002:38.

A person on the ground heard a sound that he associated with a jet type engine in distress. He went outside and looked up but was unable to see anything. He went back inside and again heard a similar sound, with a sound that he thought was an airplane climbing and then descending. The sound then went silent followed by a deep thud.

PERSONNEL INFORMATION

The pilot, age 56, held a private pilot certificate with rating(s) for airplane single and multi-engine land, and instrument airplane. The private pilot certificate with airplane single engine land rating was issued June 30, 1981, and the instrument rating was added to his private pilot certificate on February 18, 1988. The multi-engine land rating was added on July 15, 1988. He was last issued a third class medical certificate with no limitations on May 1, 2009.

Review of a pilot logbook that begins with an entry dated May 10, 1999, and a carry forward time of approximately 469 hours, to the last entry dated February 8, 2009, revealed he logged a total time of approximately 1,873 hours, of which approximately 1,050 were in turbine powered aircraft. His first logged flight in the accident make and model airplane occurred on August 29, 2001; he recorded accumulating approximately 715 hours in the accident make and model airplane. Of the 715 hours in the accident make and model airplane, approximately 711 were as pilot-in-command. His last logged instrument proficiency check performed by SimCom occurred on August 22, 2008, and his last logged instrument flight was on January 30, 2009. Recent instrument experience could not be determined based on entries in his pilot logbook, though he did fly to San Diego, California, in June 2009.

According to the Vice President & General Counsel for SimCom, Inc., the pilot received training at their Orlando facility in a PC-12 airplane in 2004, 2005, and 2006. He received training at their Scottsdale, Arizona, facility in a PC-12 airplane in August 2008. Additionally, from 1999 to 2004, he received training from SimCom in a Piper Meridian and Piper Mirage airplanes. There was no record that he received training there in 2007.

A review of the records associated with the training in August 2008, revealed four flights totaling 6.0 hours, conducted during the course of 2 days. The stick pusher system, Attitude and Heading Reference System (AHRS), Electronic Flight Instrument System (EFIS), and flight instruments review during the ground instruction each consisted of 18 minutes coverage. Failure of the AHRS and unusual attitude recovery were each covered during separate flights; the result for both was listed as satisfactory.

AIRCRAFT INFORMATION

The airplane was manufactured in June 2004 by Pilatus Aircraft Limited as model PC-12/45, and was designated serial number 570. It was powered by a Pratt & Whitney PT6A-67B 1,000 maximum continuous horsepower engine and equipped with a four-bladed Hartzell single acting, hydraulically controlled, constant speed propeller with feathering and reverse pitch capability. The airplane was configured in executive club seating consisting of 6 passenger seats, and equipped with a stall warning stick pusher system which utilizes angle of attack (AOA) vanes installed on the leading edges of both wings.

At the time of manufacture and at the time of the accident, flight and navigation instruments installed on the pilot's side of the instrument panel consisted of two independent 5-inch electronic flight instrumentation system display units (DU's) installed above each other in the center of the instrument panel, an airspeed indicator installed to the left of the upper DU, a remote magnetic indicator (RMI) installed to the left of the lower DU, an altimeter installed to the right of the upper DU, and a vertical speed indicator installed to the right of the lower DU. A standby attitude gyro was installed on the left side of the pilot's instrument panel, and is powered from the battery bus and emergency power system (EPS) bus. A course deviation indicator (CDI) was installed beneath the standby attitude gyro. With respect to the co-pilot's side of the instrumental panel, two DU's, one above the other, were installed in the center of the panel. The airplane was also equipped with two symbol generators, and two AHRS components installed beneath the cabin floor panel near Frame 25.

With respect to the DU's, they are the primary source for flight information. The upper DU is identified as an electronic attitude director indicator (EADI), and the lower DU is identified as an electronic horizontal situation indicator (EHSI). The EADI and EHSI are electronically identical; however, the EADI (upper) incorporates a slip-skid inclinometer. During normal operation, the upper DU (EADI) functions as an electronic attitude indicator, and the lower DU (EHSI) functions as an electronic horizontal situation indicator. Additionally in normal operation, the pilot and co-pilot DU's each are supplied data from its respective Attitude and Heading Reference System (AHRS) component.

The symbol generator is a remote mounted processor that receives information from flight systems and navigation data directly or through data converter adapters, and is a compartmented component. One compartment provides data to the EADI, while the other compartment provides data to the EHSI. Data such as aircraft attitude, heading, rate of turn, and respective valid flags are received from the AHRS and angle of attack information are received from the Stick Pusher Warning Unit. The information received at each symbol generator is processed and displayed graphically on its respective DU's. The symbol generator monitors the system for faults using continuous Built-In-Test (BIT) and if errors are detected, the errors are displayed on the DU's. The pilot's symbol generator is connected to the autopilot system.

The AHRS supplies pitch, roll, heading and turn rate information to the EADI, EHSI, and the RMI. The system maintains accurate indications in all aircraft attitudes. The magnetic sensing unit is installed in the right wing.

The pilot's EADI and EHSI serial number (S/N) at manufacture were 4689 and 4688, while the co-pilot's EADI and EHSI S/N at manufacture were 4690 and 4686. The maintenance records indicate that on May 12, 2005, at airplane total time 245.3 hours, the co-pilot's EADI and EHSI were swapped from top to bottom and vice versa. The maintenance records also reflect that on January 6, 2006, at airplane total time 323.2 hours, the co-pilot's lower DU (EHSI) was removed and an exchanged unit (S/N 4696) was installed. There was no further maintenance record entry pertaining to either the pilot's or co-pilot's DU's. Additionally, there was no record that either AHRS or symbol generator were removed and replaced since the airplane was manufactured.

At the time of manufacture, the Nos. 1 and 2 symbol generators were S/N 5343 and 5356, and the Nos. 1 and 2 Attitude Heading and Reference System units were S/N 1251 and 1228, respectively.

The last pitot static and altimeter testing in accordance with (IAW) 14 CFR Part 91.411, and the last transponder test IAW 14 CFR Part 91.413 were performed on June 19, 2008. The pilot's altimeter was tested to 35,000 feet.

Further review of the maintenance records revealed the airplane was last inspected in accordance with an annual inspection, using the manufacturer's maintenance manual, on June 22, 2009. At that time, the airplane had accumulated 723.7 hours of total time. No determination could be made as to how much time the airplane had been flown from the annual inspection to the time of the accident.

The airplane's maximum operating altitude and indicated airspeed specified in the Flight Manual are 30,000 feet mean sea level, and 236 knots respectively.

METEOROLOGICAL INFORMATION

According to the NTSB Meteorology Factual Report, the eastern central National Weather Service (NWS) Surface Analysis Chart for 1100 EDT (1500Z) on July 5, 2009, depicted a low pressure system with a central pressure of 1012-hectopascals (hPa) over northwestern North Carolina along a frontal wave, with a stationary front extending eastward from the low and then turning to a cold front over eastern North Carolina. A stationary front also extended southward from the low and then westward turning into a warm front across eastern Tennessee into Kentucky. The station models surrounding the accident site in Virginia depicted east to northeast wind of 5 knots, light to moderate rain, overcast sky, temperatures in the mid 60's (degrees Fahrenheit) with temperature-dew point spreads of 2 to 3 degrees F.

The NWS Weather Depiction Charts for 0900 (1300Z) and 1200 EDT (1600Z) depicted an area of instrument flight rule (IFR) conditions along and north of the frontal systems extending from southern Illinois, Indiana, and Ohio, through most of Kentucky, West Virginia, and Virginia by a shaded contour line. Surrounding that area was an area of marginal visual flight rules (MVFR)

conditions indicated by an unshaded contour. The closest visual flight rule (VFR) conditions were depicted over northeastern and eastern Virginia without a contour line. The accident site was located within the area of IFR conditions with the surrounding stations reporting visibility restrictions in light to
moderate rain with ceilings as low as 300 above ground level (agl).

The regional radar mosaic chart for 1100 EDT (1500Z), depicted a large area of echoes extending from Kentucky eastward across West Virginia, Virginia to the Maryland Atlantic coast. The maximum echoes reached 35 to 45 dBZ over central Virginia in the immediate vicinity of the accident site.

The closest weather reporting facility to the accident site was from Shenandoah Valley Regional Airport (SHD), Staunton, Virginia, located approximately 24 miles northeast of the accident site at an elevation of 1,201 feet. The airport was equipped with an Automated Weather Observation System (AWOS), and an observation at 1000, or approximately 2 minutes before the accident indicates the wind was calm, the visibility was 7 miles in light drizzle, scattered clouds existed at 2,800 feet, overcast clouds existed at 3,400 feet, the temperature and dew point were 18 and 16 degrees Celsius, respectively, and the altimeter setting was 30.00 inches of Mercury.

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Roanoke (KRNK), Virginia, site number 72318, located approximately 51 miles southwest of the accident site at an elevation of 2,126 feet. The 0800 EDT (1200Z) sounding wind profile on July 5, 2009, indicates the wind at 32,000 feet was from 280° at 47 knots, with a temperature of -35° C.

The Geostationary Operations Environmental Satellite number 12 (GOES-12) infrared band 4 image at 1002 EDT, or the time of the accident, depicts a general east-to-west band of enhanced clouds associated with cumulus congestus to nimbostratus type clouds extending over southern West Virginia into Virginia. The flight path of the airplane overlaid onto the image indicates the airplane deviating around some of the enhanced cloud tops as it flew west-southwest bound and deviated south. The radiative cloud top temperature over the accident site was observed at 235.90° Kelvin (K) or –37.26° C, which according to the KRNK sounding indicated cloud tops in the range of 32,000 feet. The maximum cloud tops along the flight path had a radiative temperature of 229.0 K or -44.16 C, which corresponded to cloud tops near 34,000 feet, indicating the flight was in instrument meteorological conditions at the time of the upset.

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was located at Roanoke (KFCX), approximately 62 miles southwest of the accident site. Based on the radar height calculations, the 3.98 degree elevation scan depicts the conditions encompassing the altitude from 28,430 to 34,620 feet. The KFCX WSR-88D composite reflectivity image completed at 1008, depicts the flight path over an area of echoes from 15 to 35 dBZ or Video Integrated Processor (VIP) Level 1 and Level 2 (very light to light to moderate) precipitation. Two areas of echoes of 40 to 45 dBZ or “heavy” intensity echoes were noted below the flight

path to the right and left of course. The KFCX WSR-88D echo tops product for 1008, depicts the maximum height of echoes of 18.5 dBZ to 31,000 feet, with echoes reaching between 20,000 and 25,000 feet along the flight track prior to the upset.

Pilot reports (PIREPs) were recorded over Virginia surrounding the time of the accident. Numerous aircraft throughout the period indicated light to moderate rime type icing from 13,000 through 27,000 feet. There was only one report of moderate turbulence above the accident airplanes cruising level, between 34,000 to 36,000 feet.

The Area Forecast (FA) valid for the accident area was issued at 0445 EDT on July 5, 2009, and was valid until 1700 EDT. It indicated broken to overcast skies with scattered embedded rain showers with clouds tops to 25,000 feet.

There were no Convective SIGMETs issued for Virginia surrounding the period.

The closest Terminal Aerodrome Forecast (TAF) to the accident site was from Lynchburg (KLYH). The forecast valid during the period expected Marginal Visual Flight Rules (MVFR) conditions in rain and mist with overcast skies throughout the period.

The Washington (KZDC) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) issued a Meteorological Impact Statement (MIS) at 0912 EDT, indicating marginal VFR conditions in rain showers and mist across Virginia with the potential occasional icing conditions between 12,000 and 26,000 feet. No significant turbulence was anticipated across the region.

COMMUNICATIONS

The pilot was in contact with the Washington ARTCC. There were no reported communication difficulties.

FLIGHT RECORDERS

The airplane was not equipped, nor was it required to be equipped, with a cockpit voice recorder (CVR) or flight data recorder (FDR). However, the airplane was equipped with components that record and retain non-volatile memory associated with flight. The components that have non-volatile memory, or retain data, consist of the engine condition monitoring system (ECMS) which stores data on a SD card, the AHRS units which store non-volatile memory on integrated circuits, the Integrated Hazard Awareness System (IHAS) which also store non-volatile memory on an integrated circuit, and the Caution Advisory Control Unit (CACU) which records all cautions and warnings that are triggered and displayed on the airplane’s Central Advisory and Warning System (CAWS) component. Details of component analysis are available in the NTSB public docket for this accident.

WRECKAGE AND IMPACT INFORMATION

The airplane crashed into a cow pasture; the accident site was located at 37 degrees 55.479 minutes North latitude and 079 degrees 13.042 minutes West longitude. Examination of the accident site revealed the airplane's heading at the initial impact was approximately 032 degrees magnetic, while the energy path of wreckage debris was oriented on a magnetic heading of 304 degrees. The smell of Jet A fuel was noted in the main impact crater. Three propeller blades and a section of one propeller blade were noted in the impact crater. The engine assembly was located about 7 feet below ground level. A slight postcrash fire to grass in pasture was noted. The airplane was nearly completely fragmented with the exception of the vertical stabilizer with attached rudder and rudder trim tab. Over-the-counter medication consisting of Advil Liqui Gels, Advil PM, and Salonpas Patches were found along the energy path; no determination was made as to whom the medication belonged to.

Major components from the airframe that could be readily identified were documented as to their position at the crash site. While fragmentation of the airplane precluded structural reconstruction, all primary flight control surfaces were located at the accident site. Both wings were fragmented; however, the inboard and outboard flap actuators for both wings were located and depicted a flaps retracted position. Also, by actuator extension measurements, both main landing gears were retracted. The left aileron trim tab actuator, rudder trim tab actuator, and horizontal stabilizer trim actuator were located at the accident site and were found to be positioned 1 degree trailing edge tab down (wing down), 2.5 degrees trailing edge tab left (tail left), and 0.9 degree stabilizer leading edge down (tail down), respectively. The aileron trim setting was within 1 degree of neutral, the rudder trim setting was 17 percent of the available nose-right trim which is within the normal trim range for cruise flight, and the pitch trim setting was 12 percent of the available nose-up trim, or within the green takeoff range.

The cockpit was fragmented. Instruments found at the accident site were recovered for further examination while at the site. Additionally, circuit boards associated with avionics were found loose at the accident site. Recovered avionics sustained crush damage. The cabin altimeter differential pressure gauge was located and found to be indicating 2.8 PSI differential, and the cabin altitude was indicating approximately 12,100 feet. All four DU's were located. An airspeed indicator in a fragmented section of instrument panel to the left of a DU (pilot's side) was located; the needles were separated. The faceplate of one vertical speed indicator (VSI) with a missing needle displayed white colored transfer in the middle of the 4,000 range, while the faceplate of another VSI, also missing the needle, exhibited white colored transfer at the 4,000 mark in the "Down" direction.

The empennage was also fragmented, and the horizontal and vertical stabilizers were separated. The vertical stabilizer separated at the rudder pulley bulkhead, and the leading edge was crushed aft to the rear spar. Postcrash fire damage was noted to the vertical stabilizer. Impact damage to the forward and rear spars of the vertical stabilizer was noted. The rudder remained attached to the vertical stabilizer at the bottom hinge, and was bent to the right, and the rudder trim tab remained attached to the rudder.

Examination of the separated horizontal stabilizer revealed it was fragmented. Impact damage was noted to the front and rear spars. The full span of the left and right elevator primary flight control surfaces were accounted for.

Examination of the aileron, elevator, and rudder flight control cables revealed no evidence of preimpact failure or malfunction. Tension overload was noted on the cables that were fractured.

Examination of the autopilot system control components revealed the yaw servo bridle cable was wrapped around the capstan, with the ball in the drum slot. The bridle cable clamps were intact. The roll servo bridle cables exhibited tension overload; the capstan was separated from the motor but the bridle cable ball was in the drum slot. The autopilot pitch capstan was separated from the motor, but the bridle cable remained connected to the primary flight control cable. The bridle cable ball was in the drum slot and 1.5 to 2.0 turns of bridle cable were noted around the drum.

The cargo door, passenger entry door, and the emergency exit window were located at the accident site. Examination of the cargo door revealed crushing, while the examination of the passenger entry door revealed it was fragmented. The emergency exit window was crushed and exhibited fire damage.

Examination of the stick pusher control cables revealed the elevator primary cable with attached stick pusher bridle cable clamps was fractured (tension overload) approximately 4 feet 10 inches from the forward clamp. The forward clamp was bent midspan, and the bridle cable was sheared at the clamp. The forward clamp had all securing hardware in place. Several wire strands of the forward clamp were broken just forward of the clamp. The bridle cable at the forward clamp extended 2.6 centimeters (cm) forward of the clamp. The aft clamp had all securing hardware installed. The bridle cable extended 3 cm past the clamp. The bridle cable was fractured (tension overload) 8.5 cm forward of the clamp. The primary cable was bent aft of the aft edge of the clamp. The bridle cable was bent up. The primary cable between the forward and aft bridle cable clamps was kinked. The primary elevator cable with stick pusher bridle cable was retained for further examination.

While the CAWS component contains lights that display annunciations recorded by the CACU, the lights are light emitting diode (LED) type; therefore, no useful information could be obtained.

The Caution Advisory Control Unit (CACU) records all cautions and warnings that are triggered and displayed in the aircraft and stores it in non-volatile memory. The circuit board for the CACU was located; however, the two chips were separated and not recovered. The circuit board in the area of the missing chips was bent and distorted.

Components consisting of the autopilot yaw, roll, and pitch servos, both AHRS, both symbol

generators, the stick pusher computer, the CACU, an SD card from the ECMS, airspeed indicator faceplate, IHAS, camera card, digital camera, cabin altimeter/differential pressure gauge, cabin rate of climb indicator, section of elevator primary control cable with bridle cable and clamps attached, and all four DU's were retained for further examination.

Examination of the engine revealed severe impact damage including disintegration of the reduction and accessory gearboxes. The propeller shaft was recovered separately. Heavy circumferential rubbing and machining were noted to the compressor rotor, compressor turbine vane ring, compressor turbine, 1st stage power turbine shroud, and to the 1st stage power turbine indicative of rotational operation of the engine during impact loads and external housing deformation. The reduction gearbox propeller shaft coupling webs were fractured in torsion due to impact loads. A detailed examination report with accompanying pictures is contained in the public docket for this accident.

Examination of the propeller revealed three of the four propeller blades were liberated from the propeller hub, while the fourth blade had a section of propeller hub attached. The piston/cylinder assembly was separated from the propeller hub. Numerous missing parts were not recovered including components consisting of the beta mechanism, blade counterweights, blade pitch change brackets, three of the four blade preload plates, blade bearings, and spinner assembly. The mounting flange portion of the propeller hub remained attached to the propeller shaft. Examination of the No. 4 blade preload plate revealed impact marks but no determination could be made as to propeller blade angle at impact. Examination of the four propeller blades revealed that one blade exhibited a slight aft bend and also was bent forward slightly at mid blade. The leading edge was twisted towards low pitch. The second blade was bent aft approximately 70 degrees, exhibited multiple wavy bends, and the outer 1/3 of the blade was separated. The trailing edge of the blade was extensively deformed. The third blade was bent aft approximately 45 degrees at 1/4 radius and the leading edge was twisted towards low pitch. Extensive trailing edge deformation and tearing was noted with rotational scoring noted on the non-cambered side of the blade. The fourth blade was bent forward approximately 30 degrees with a large radius bend, and rotational scoring was noted on the cambered side of the blade. The examination determined that the propellers blades were not feathered at the moment of impact. A detailed examination report with accompanying pictures is contained in the public docket for this accident.

Examination of the symbol generators, DU's, yaw servo, and servo capstains for roll and pitch was performed. The examination of the two symbol generators revealed heavy impact damage which precluded operational testing at the unit level. Complete disassembly inspection of both symbol generators was performed. The inspections revealed no burnt or heat signatures to any of the observed components or circuit boards. Fuses of the ADI low voltage power supply circuit board for both symbol generators tested satisfactory electrically. Dark discoloration on components adjacent to electrolytic capacitors was noted for both symbol generators. The discolored material associated with one symbol generator was specifically analyzed and revealed all tested materials were consistent with materials found on and in the components of printed circuit boards. Attempt to recover information from the configuration module of S/N

5356 was unsuccessful.

Examination of the DU's revealed heavy impact damage which precluded operational testing at the unit or subassembly level. Complete disassembly inspection of the DU's was performed. No arching or burn signatures were noted on any of the high or low voltage supplies. Examination of the yaw servo and yaw servo mount revealed impact and fire damage. The middle ball on the bridal cable was properly captured on capstain, which was stuck and could not be moved. Disassembly of the clutch revealed witness marks on the crowns of the clutch teeth consistent with the clutch being in the disengaged position at impact. Examination of the roll servo capstain revealed impact damage. The middle ball of the bridal cable was properly captured on the capstain. The carbon graphite clutch disks were broken in many pieces. Examination of the pitch servo capstain revealed impact and heat damage. The middle ball on the bridal cable was properly captured on capstain. The carbon graphite clutch disks were broken in many pieces. Detailed examination reports with accompanying pictures are contained in the public docket for this accident.

Examination of the Honeywell Integrated Hazard Awareness System (IHAS) component revealed impact damage which separated the flash memory chips; therefore, no data was recovered. A detailed examination report with accompanying pictures is contained in the public docket for this accident.

Examination of the elevator primary control cable with attached bridal cable clamps and bridal cable, airspeed indicator faceplate, cabin altimeter/differential pressure gauge, and rate of climb indicator was conducted. The inspection of the primary elevator cable with attached bridle cable clamps revealed a kink in the cable that precluded accurate measurement of the distance between the bridal cable clamps. Inspection of the bridal cable clamps using a stereo microscope revealed no evidence of slippage of either clamp on the cable. Tension was applied to the primary cable to remove the kinks and the measurement between the clamps measured 579.4mm (specification is 586.4 to 591.6mm). Inspection of the airspeed indicator faceplate revealed an impression of two needles. The wider needle associated with the red/white needle made an impression at 310 knots, while the thinner needle associated with indicated airspeed indicated 350 knots. The inspection of the faceplate of the cabin altimeter/differential pressure gauge revealed one faint witness mark corresponding with the altimeter needle. The witness mark was noted at 2,000 feet. Inspection of the faceplate of the cabin rate of climb gauge revealed no evidence of any witness mark. A detailed examination report with accompanying pictures is contained in the public docket for this accident.

Examination of the AHRS units was performed. Impact damage to both precluded operational testing at the unit level. By design, each unit has two EEPROMS identified as U3 and U4 which in part, record and retain non-volatile memory that contains BIT history information. The BIT history information contains data including an error log and other information pertaining to the health of each unit. The U3 EEPROM from unit S/N 1228 was found separated from the circuit board and pressed into a ribbon cable. The U4 EEPROM from unit S/N 1228 was also found separated from the circuit board and pressed into a ribbon cable. Only a portion of the U4

EEPROM remains. Data from the U3 and U4 EEPROMS could not be downloaded due to fragmentation of both. Complete disassembly inspection of the AHRS revealed no evidence of abnormal color/discoloration on any observed components. The U3 EEPROM from unit S/N 1251 was found separated from the circuit board and pressed into a ribbon cable. The U4 EEPROM was also found separated from the circuit board and a portion of it was pressed into a ribbon cable. Data from the U3 and U4 EEPROMS from both units could not be downloaded due to fragmentation of both. Complete disassembly inspection of the AHRS revealed no evidence of abnormal color or discoloration on any observed components. A detailed examination report with accompanying pictures is contained in the public docket for this accident.

MEDICAL AND PATHOLOGICAL INFORMATION

Postmortem examinations of the pilot and passengers were performed by the Office of the Chief Medical Examiner, Roanoke, Virginia.
Forensic toxicology was not performed on specimens of the pilot or passengers.

TESTS AND RESEARCH

The pilot flew the airplane to TEB, and arrived there on June 30th. After arrival, he requested the fuel tanks be topped off with Jet A with anti-ice additive. The airplane was fueled on July 4th, but was invoiced on the accident date. A total of 231.0 gallons of Jet A with anti-ice additive (Prist) were added. Personnel of the facility that fueled the airplane reported to FAA that the pilot called their facility on the day of the accident about 0400, and, “asked for a 7am pull-up.”

Personnel of a fixed base operator (FBO) at the departure airport reported by name the person who was seated in the co-pilot’s seat before the flight taxied out. No determination could be made as to the seating locations of the remaining 2 passengers at the time of the accident.

Review of the Aircraft Weight and Balance and Equipment List Revision sheets located in the wreckage revealed the latest was dated June 23, 2008. The airplane’s empty weight, empty weight moment, and empty weight center of gravity (CG) were listed as 6,422.44 pounds, 1478128.15, and 230.15 inches aft of datum respectively.

Weight and balance calculations were performed postaccident using the airplane’s empty weight (6,422.44 pounds), the weight of the pilot (202 pounds) per his last medical application dated April 29, 2009, and a doctor visit of October 3, 2008. The weight of the passenger seated in the co-pilot’s seat (118 pounds) was estimated by her father, and the weight of the pilot’s wife (112 pounds) was based on her son’s estimate. The weight of the remaining passenger (110 to 120 pounds) was based on his U.S. sponsor. By a witness account, 5 bags were loaded into the aft baggage compartment. No determination could be made as to whether any other baggage was loaded into any other part of the airplane. Since the weight of the luggage (5 bags) loaded into the aft baggage compartment was not known and could not be accurately

determined, calculations were performed using total luggage weights of 40, 60 and 80 pounds. The weight and balance calculations also included the full usable fuel weight, and allowed for 26 pounds of fuel for engine start and taxi. Additionally, the calculations included 590 pounds fuel consumption for the 34 minutes time to climb and 63 minutes of cruise flight. The airplane was calculated to be within weight and balance limits for all estimated baggage weights at the time of the accident.

Engineer's and accident investigation personnel from the airplane manufacturer performed a review of the airplane's flight instrument systems in order to develop a systematic approach to the investigation and to understand what flight instrument(s) the pilot may have alluded to when he told ATC that he "…lost my panel." While the pilot did not clarify what panel he was referring to when asked by the controller, the review focused on the pilot's primary flight instruments and components that provide data to them. In the review, failure of the co-pilot's flight instruments was not evaluated, nor was the use of the secondary flight instruments located on the pilot's instrument panel. In addition, an electrical failure was not evaluated because the pilot communicated with ATC after he advised that he had, "…lost my panel", and also transponder beacon returns was noted during the descent. For the review, it was also assumed that the autopilot was engaged at the time he advised the controller that he had, "… lost my panel." In all scenarios, secondary or standby flight instruments were available for reference.

One scenario involving failure of the No. 1 (pilot's) AHRS would result in disconnection of the autopilot with resulting short duration audio annunciation and visual annunciation, flags on the pilot's EADI and EHSI, and flags on the pilot's and co-pilot's RMI. In this scenario, a corrective action would be for the pilot to select AHRS 2, which will immediately allow the EADI and EHSI to provide useful data. The autopilot would be able to be engaged after the AHRS change.

A second scenario involves failure of the pilot's EADI DU. In this scenario, the autopilot remains engaged but there is a momentary loss of primary attitude information. The EHSI is still available. The corrective action for this scenario is for the pilot to select composite mode (CMPST) which will disengage the autopilot with resulting short duration audio annunciation and visual annunciation. The lower DU will then provide attitude and heading information. The autopilot is allowed to be re-engaged.

A third scenario involves failure of the pilot's EHSI DU. In this scenario, the autopilot remains engaged but there is a momentary loss of primary heading information. The EADI is still available providing attitude information. The corrective action for this scenario is for the pilot to select composite mode (CMPST) which will disengage the autopilot with resulting short duration audio annunciation and visual annunciation. The upper DU will then provide attitude and heading information.

A fourth scenario involves failure of the symbol generator resulting in failure of the pilot's EADI. The EHSI is still available, and the autopilot disengages after 5 seconds with a visual annunciation and a short duration audio warning. Corrective action consists of the pilot

engaging the composite switch resulting in attitude and heading information being available on the lower DU.

A fifth scenario involves failure of the symbol generator resulting in failure of the pilot's EHSI. The EADI is still available, and the autopilot disengages after 5 seconds with a visual annunciation and a short duration audio warning. Corrective action consists of the pilot engaging the composite switch resulting in attitude and heading information being available on the upper DU.

Personnel from Honeywell stated that pertaining to symbol generators, the Failure Modes and Effects Analysis conducted as a requirement for certification indicate there is no single point failure possible that will cause the loss of both the EADI and EHSI displays.

An individual who flew the accident airplane on June 22, and June 23, 2009, reported having a discussion with the pilot several days before his first flight on June 22nd. During that conversation, the pilot asked the individual to reposition the airplane following completion of the annual inspection, and was informed that the Uplink Weather was not working properly. It was agreed by both that the individual would test fly the airplane on June 22nd, before repositioning it to verify the Uplink Weather was fixed and the airplane and systems were functioning properly following completion of the annual inspection. The individual reported that prior to the flight on the 22nd, the crew chief informed him that the hydraulic motor/power pack was cycling often in-flight. This discrepancy was corrected during the annual inspection by replacement of the hydraulic accumulator. The individual flew the airplane for approximately 1 hour that day and tested the pressurization system, Uplink Weather, and the hydraulic pump. He also confirmed that all four DU's, standby gyro flight instrument, and autopilot were functioning properly. No squawks or discrepancies were noted during the flight.

The individual who flew the airplane on June 23rd, from Atlanta, Georgia, to Tampa, Florida, reported the flight duration was approximately 1 hour 30 minutes. During the flight he operated the autopilot in various modes, operated the onboard weather radar and Uplink Weather to remain clear of thunderstorms. He reported all systems were operational with no discrepancies. At the completion of the flight while being driven to a commercial airport in Tampa, the accident pilot's assistant relayed to him details pertaining to a "pressurization problem" during a flight by the accident pilot from Texas to Florida. She relayed that after leaving the cockpit, the pilot made a rapid descent from "altitude" to 10,000 feet. The pilot reportedly reset something and climbed back to altitude and continued the flight. The individual further reported there was no mention of the pressurization problem to him or to any of the maintenance personnel associated with his facility.

Review of the aircraft maintenance records revealed an entry dated June 22, 2009, associated with an annual inspection. The entry indicates in part removal and replacement of the hydraulic accumulator. There was no record of any maintenance performed to any components of the pressurization system.

A sound spectrum study performed by the NTSB used digitized auto recordings from the FAA air traffic control facility last in contact with the accident pilot. The study was performed in an effort to determine the pilot's speech patterns prior to, and at the in-flight loss of control. A total of eight voiced segments between 0954:14 and 1001:57 were analyzed. The study indicated several major differences were noted between the mean set of the first seven voice segments and the last recorded voice transmission from the pilot. The first difference consists of an increase in pitch, the second difference was a dramatic increase in the spread in computed format frequency at the end of the last transmission from the pilot, while the final difference was a decrease with time in the format spacing from the first transmission to the last. A detailed examination report is contained in the public docket for this accident.

The NTSB prepared performance plots of the last portion of the accident flight. A simulation was developed in which the flight controls and engine power were manipulated to approximate the flight path of the airplane as recorded by radar data. The simulation included lift and drag data, an estimated airplane weight at the time of the accident using the middle of the baggage weights, and winds aloft data provided in the NTSB Meteorology Factual Report. The simulation attempted to duplicate the flight path between 1000:23, and 1002:06, but was primarily focused on the portion of the flight transition from controlled to uncontrolled flight. Because the actual flight path was hard to discern during the descent from approximately 22,100 feet pressure altitude to the crash site elevation (1,760 feet), no simulation or performance data was performed. The simulation indicates that the angle of attack prior to the transition from level flight to the descent was not beyond 5.5 degrees (the airplane manufacturer indicates the stall angle of attack is 13.2 degrees). A right descending turn beginning about 1001:26, or about 32 seconds after the pilot reported to the controller about losing his panel was reflected in the simulation. The right roll continued steadily to about 105 degrees, before returning to about 70 degrees at the end of the simulation. During the right descending turn, the pitch angle decreased steadily reaching about minus 68 degrees at the end of the simulation. The simulation load factor was noted to be near 1.0 until the airplane rolled beyond 55 degrees and the pitch angle decreased through minus 10 degrees. A detailed examination report is contained in the public docket for this accident.

Review of the emergency procedures section of the Pilot Operating Handbook/Airplane Flight Manual (POH) related to AHRS failure revealed checklist item(s) for completion if equipped with a single or dual AHRS. Since the airplane was equipped with dual AHRS, the checklist indicates to select AHRS 2 in the event of AHRS 1 failure. The checklist for single AHRS failure does not provide information beneath that section identifying that the autopilot will disengage with accompanying audio and visual warnings with failure of the No. 1 AHRS (normal selection for the pilot's primary flight instruments), but can be re-engaged after selecting AHRS 2. Further review of the POH related to an electronic flight display unit failure indicated by a blank screen specifies the corrective action is to select the EFIS CMPST switch to the CMPST position. A note beneath that section indicates that switching to CMPST with the autopilot engaged will cause the autopilot to disengage.

Personnel of SimCom, Inc., reported that the symbol generator and the effects of their failure is

discussed during the ground school, and during training in the fixed flight training device (FTD). They do not have the capability of failing the symbol generator as an isolated component; however, in the FTD, they illustrate failure of the symbol generator by failing a display unit. With respect to simulated failure of an electronic display unit in the FTD, the autopilot does not automatically disconnect when an instructor simulates failure of an electronic display unit. In that instance, the student is taught to select the composite switch which does result in autopilot disconnection.

Pilot Information

Certificate:	Private	**Age:**	56,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	May 1, 2009
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	August 22, 2008
Flight Time:	1873 hours (Total, all aircraft), 715 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Pilatus	**Registration:**	N578DC
Model/Series:	PC-12/45	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	570
Landing Gear Type:	Retractable - Tricycle	**Seats:**	8
Date/Type of Last Inspection:	June 22, 2009 Annual	**Certified Max Gross Wt.:**	9921 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:	724 Hrs as of last inspection	**Engine Manufacturer:**	Pratt & Whitney
ELT:	Installed, not activated	**Engine Model/Series:**	PT6A-67B
Registered Owner:	On file	**Rated Power:**	1000 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	SHD,1201 ft msl	**Distance from Accident Site:**	26 Nautical Miles
Observation Time:	10:00 Local	**Direction from Accident Site:**	45°
Lowest Cloud Condition:	Scattered / 2800 ft AGL	**Visibility**	7 miles
Lowest Ceiling:	Overcast / 3400 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	18°C / 16°C
Precipitation and Obscuration:	Light - None - Drizzle		
Departure Point:	Teterboro, NJ (TEB)	**Type of Flight Plan Filed:**	IFR
Destination:	Tampa, FL (VDF)	**Type of Clearance:**	IFR
Departure Time:	08:23 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Fatal	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	
Total Injuries:	4 Fatal	**Latitude, Longitude:**	37.924446,-79.217224

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Bob Hendrickson; FAA/AVP-100; Washington, DC Andreas Betzoll; PilatusAircraft Ltd.; Stans Thomas Berthe; Pratt & Whitney; Montreal Thomas McCreary; Hartzell Propeller, Inc.; Piqua, OH Bill Gill; Honeywell; Olathe, KS
Original Publish Date:	November 3, 2011
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=74189

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.