Aviation Investigation Final Report

Location:	Albany, Texas	**Accident Number:**	CEN12FA164
Date & Time:	February 20, 2012, 19:36 Local	**Registration:**	N7147P
Aircraft:	Piper PA-24-250	**Aircraft Damage:**	Substantial
Defining Event:	Flight instrument malf/fail	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

After leveling at a cruise altitude of 9,500 feet mean sea level the pilot reported that he had lost instrument suction and his attitude indicator. Radar data showed that the airplane made a climbing right turn and then descended rapidly. Radar and radio contact were lost and the wreckage was found the next morning. Ground and airplane impact signatures showed evidence of a nearly vertical nose down collision with terrain. Other pilots in the area reported a reduction in visibility with blowing dust, which severely restricted visibility and resulted in the loss of a visible horizon. The manufacturer of the vacuum pump had issued a service letter 4 years earlier that indicated that the pump was beyond its mandatory replacement time and must be removed from service. A postaccident examination revealed that the vacuum pump had a preimpact failure that resulted in the loss of all vacuum driven flight instruments.

It is likely that the pilot inadvertently encountered instrument meteorological conditions (IMC) with reduced visibility and the lack of a visible horizon. The airplane's subsequent turning ground track and rapid, near-vertical descent are consistent with the pilot's loss of control of the airplane because of spatial disorientation following the loss of flight instrumentation while flying at night without a discernable horizon.

According to FAA Advisory Circular 60-4A "Pilot's Spatial Disorientation," "Surface references and the natural horizon may at times become obscured, although visibility may be above visual flight rule minimums. Lack of natural horizon or surface reference is common on over-water flights, at night, and especially at night in extremely sparsely populated areas or in low visibility conditions. A sloping cloud formation, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground lights can provide inaccurate visual information for aligning the aircraft correctly with the actual horizon. The disoriented pilot may place the aircraft in a dangerous attitude."

Probable Cause and Findings

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

The loss of flight instrumentation due to a failed vacuum pump while flying a night without a discernable horizon, which resulted in the pilot's spatial disorientation and an in-flight loss of control and impact with terrain. Contributing was the continued operation of the airplane with a recalled and unsafe vacuum pump.

Findings

Aircraft	Vacuum distribution system - Failure
Aircraft	Attitude gyro & indication - Failure
Aircraft	Directional gyro & indication - Failure
Personnel issues	Lack of action - Pilot
Aircraft	(general) - Not attained/maintained
Personnel issues	Vestibular function - Pilot
Personnel issues	Incorrect action selection - Owner/builder

Factual Information

History of Flight

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

HISTORY OF FLIGHT

On February 20, 2012, about 1936 central standard time, a Piper PA-24-250 single-engine airplane, N7147P, impacted terrain near Albany, Texas. The private pilot and passenger were fatally injured. The airplane was substantially damaged. The airplane was registered to Baga Air, Inc., and operated by a private individual under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Dark night visual meteorological conditions prevailed and no flight plan was filed. The flight departed Abilene Regional Airport (ABI), Abilene, Texas, at 1920, and was destined for the University of Oklahoma Westheimer Airport (OUN), Norman, Oklahoma.

The airplane had climbed to cruise altitude and was level at 9,500 feet mean sea level (msl). About three minutes later the pilot made a radio call that he needed to return to ABI because he had lost suction and his attitude indicator. The controller cleared the airplane to return to ABI. Radar data showed the airplane made a climbing turn to the right and the airplane then descended rapidly. Radar and radio contact was lost about 1936.

The wreckage was found the next morning. Ground and airplane impact signatures showed evidence of a nearly vertical nose down collision with terrain. The outboard section of the right wing and the right aileron were found about one mile southeast from the main wreckage.

PERSONNEL INFORMATION

The pilot, age 48, held a private pilot certificate with a rating for airplane single land which was initially issued on April 10, 2007. He was most recently issued a third class airman medical certificate, with limitations, on May 10, 2010.

The pilot's logbook showed entries beginning on June 7, 1994, with the last entry on February 1, 2012. An endorsement showed a flight review was completed on July 25, 2011, and a high-performance endorsement was entered on December 4, 2008. A review of the logbook showed that that pilot had logged 502.0 hours of total flight experience in single engine airplanes, with about 186 hours of flight experience in Piper PA-24 airplanes.

The pilot had logged 68.0 hours of night flight experience. During the previous 15 flights logged between ABI and OUN, 12 of the flights were logged as night flights.

The pilot had logged a total 3.6 hours of flight instruction in simulated instrument conditions. The logbook did not contain a listing of any instrument flights more recently than December 31, 2006.

AIRCRAFT INFORMATION

The four-seat, low-wing, retractable landing gear, single engine airplane, serial number (s/n) 24-2312, was manufactured in 1960. It was equipped with a 250-horsepower Lycoming model O-540-E4B5 engine, s/n L-20394-40A, which drove a Hartzell, model HC-C3YR-1RF, 3-blade metal alloy propeller, s/n DY-4365-A.

A review of the airframe logbooks and engine logbooks showed an entry dated July 4, 2011, which certified that an annual inspection had been completed at 4,800.1 total aircraft hours.

The most recent airframe logbook entry was made on December 15, 2011, at an aircraft total time of 4854.4 hours, when engine, s/n L-20394-40A, was installed on the accident airplane. At that time, the engine had accumulated 2794.8 hours, with 636.8 hours since its most recent overhaul.

Engine logbook entries showed that engine, s/n L-20394-40A had previously been installed on N33033, a Piper PA-32-260 airplane, until N33033 was damaged by a hurricane about October 19, 2005. The damaged airplane was later sold as scrap. Maintenance records for N33033 showed that an overhauled vacuum pump, Airborne part number 211CC, s/n 1706, which was overhauled on December 16, 1999, was installed on engine serial number L-20394-40A on January 21, 2000. There were no other airframe logbook entries or engine logbook entries for N33033 which mentioned a vacuum pump. Based on a review of the maintenance records for N33033 and the engine logbook entries, the total hours of operation of vacuum pump, s/n 1706, were estimated as about 636 hours, for the period from January 21, 2000 until October 19, 2005

At the time of the accident N7147P had been operated an additional 3.2 hours following the engine installation on December 15, 2011. This estimate was based on a review of the pilot's logbook which showed a flight of 1.4 hours on January 29, 2012, a flight of 1.5 hours on February 1, 2012, and an estimated 0.3 hours of operation during the accident flight on February 20, 2014.

At the time of the accident the airplane had an estimated aircraft total time of 4857.6 hours, and vacuum pump, s/n 1706, had been operated for more than 12 calendar years and an estimated total of about 639 hours since overhaul.

The accident airplane was also equipped with an S-TEC System 60 two axis autopilot with an optional electric pitch trim actuator, and a vacuum driven attitude gyro and vacuum driven directional gyro.

METEOROLOGICAL INFORMATION

At 1852, the automated weather observation station at ABI reported wind from 300 degrees at 12 knots, visibility 3 miles in haze and blowing dust, skies clear below 12,000 feet, temperature 14 degrees Celsius (C), dew point temperature -11 degrees C, altimeter 30.03 inches of Mercury.

Data from the United States Naval Observatory indicated that Sunset occurred at 1827, and Moonset occurred at 1734. At the time of the accident both the Sun and the Moon were more than 14 degrees below the horizon and provided no illumination.

A pilot report in the general area showed the reported cloud tops were as high as 12,000 feet msl with the dust tops to 12,000 feet msl.

A pilot operating his aircraft in the vicinity indicated that flight visibility was marginal at best, and indicated that the area was impacted with blowing dust with an estimated in-flight visibility of 1 to 3 miles. The pilot indicated that he could only faintly see ground lights, but at times could not distinguish between ground and sky.

A medical helicopter pilot operating in the area at the time of the accident reported that he was operating with his night vision goggles due to the dark nighttime conditions, and that even with the night vision goggles the dust and lack of surface lights restricted his view of any sense of horizon and made flying under visual meteorological conditions very difficult.

COMMUNICATIONS AND RADAR

Following is a timeline of selected communications between the pilot of N7147P and Federal Aviation Administration (FAA) Air Traffic Control (ATC). A summary of the FAA ATC radar contacts is included.

1920: the controller cleared N7147P cleared for takeoff from runway 35L at ABI

1921:31: N7147P reported he was at 2,600 feet and was climbing to 9,500 feet

1931:38: radar showed N7147P was at a transponder reported altitude of 9,500 feet

1933:49: radar showed N7147P was at a transponder reported altitude of 9,700 feet and began a slight change in flight track to the right.

1933:55: N7147P requested to return to Abilene

1934:04: N7149P reported "we've lost our suction and our attitude indicator"

1934:20: the controller responded and gave clearance to return to Abilene

1934:52: radar showed that N7147P's rate of right turn increased.

1935:10: radar showed that N7147P was at 9,300 feet and the remainder of the radar returns showed an erratic flight path

1935:30: radar showed N7147P was at a transponder reported altitude of 10,300 feet, and it then began descending

1935:38: the controller asked N7149P to verify that he was "VFR"

1935:43: N7147P reported "affirmative we are v f r but we are having trouble four seven …" (there was a change in the sense of urgency noted in the voice of the pilot and the end of the transmission was cut off)

1935:46: the controller responded giving the location of the nearest airport, however there were no further communications received from N7147P

1936:14: radar showed N7147P was at a transponder reported altitude of 5,300 feet

1936:23: the last radar return showed N7147P was at a transponder reported altitude of 3,600 feet

Radar contact was then lost.

WRECKAGE AND IMPACT INFORMATION

The main wreckage impacted on a rock exposed area in remote rolling terrain at an estimated elevation of 1,507 feet above mean sea level (msl). The impact crater and damage to the airframe was consistent with a nearly vertical impact angle. There was evidence of a fuel spill at the scene; however there was no postimpact fire.

The airframe was compressed from the engine aft to the empennage area with extensive fragmentation of many of the parts. The attitude of the airframe at the time of impact was also confirmed by an impact depression of the left wing and wingtip in the ground. Evidence of ground impact was noted on the stabilator balance tube displacing the balance weight aft on the tube and cutting one of the primary cables. All major components at the main wreckage showed evidence of impact crushing damage.

The left wing was fragmented and was found at the main crash site with the left flap and aileron. The leading edge displayed compression impact damage along the entire leading edge that penetrated aft to the trailing edge of the wing.

The position of the flap, as indicated by the wing trailing edge impression on the flap, was consistent with a retracted position. The aileron control and balance cables were both secure to the bellcrank, but the attach fitting was impact broken and the cables were pulled inboard. The balance cable was continuous to the right side and the control cable was continuous to the forward cockpit where it had been impact separated. The control wheel chain was broken and fragmented. The flap control cables were secure to the bellcrank, but the bellcrank was impact broken and the cables were pulled inboard.

The landing gear was observed in the retracted position.

The separated outboard section of the right wing, including the aileron, balance weight and bellcrank assembly, was found about one mile southeast from the main crash site. Examination of the separation surfaces showed a positive, or upward direction, overload separation with no evidence of preimpact corrosion or fatigue.

The right aileron was partially attached and the center mounted balance weight was in place. The control rod was separated. The aileron bellcrank was in place and both control cable attach points were broken off. The cable ends, with the bellcrank parts, were found with the inboard section of the wing.

The inboard section of the right wing was found with the main wreckage. The wing displayed impact compression damage from the leading edge aft to the flap area. The flap displayed impact damage from the upper wing skin which was consistent with a retracted flap position at the time of impact. The flap

control cables were secure to the bellcrank but the bellcrank was impact broken and the cables were pulled inboard.

The empennage section was found on top of the fuselage and displayed impact compression damage. There were impact signatures consistent with ground impact most notably to the right side vertical stabilizer which also separated the right side of the stabilator. The stabilator torque tube and horn assembly were in place and secure. The balance tube was secure but displayed impact damage to the front end and the balance weight had been displaced to the aft. The lower stabilator control cable had been impact separated from the attach fitting at the balance bar. The upper stabilator control cable was secure to the balance bar. Both stabilator cables were continuous to the forward cockpit area behind the instrument panels. The right side of the stabilator was not identified at the crash site.

The stabilator trim drum upper extension measured about 0.6 inches, which corresponds to a nose up setting of about 3 degrees of the available 13 degrees of nose up trim.

The fuselage was substantially compressed and fragmented. The engine had penetrated aft into the forward cabin area and most of the cockpit instruments had extensive impact damage.

The flap handle was broken and bent. The nose gear was in the retracted position. The landing gear emergency extension mechanism was broken and the electric drive motor gear separated. The emergency locator transmitter (ELT) was separated from the mount, fragmented and did not operate. The ELT switch was in the "ARM" position.

The engine was impact damaged and was fragmented. About 10 inches of the crankshaft remained secure to the propeller hub. The sump was fragmented and no data plate was recovered. The engine s/n observed on the top front portion of the case was L-20394-40A.

The propeller was mostly buried in the impact crater beneath the engine with one blade exposed. During wreckage retrieval the propeller was examined. Propeller blade A was secure in the hub and was bent aft from the root about 20 degrees with S bending along the full length of the blade. The leading edge had numerous substantial dents and gouges and the front of the blade displayed numerous chordwise scratches. Blade B was secure in the hub and bent aft from the root area about 10 to 15 degrees. The blade tip was separated about 10 inches from the tip and was found adjacent to the blade in the impact crater. The blade displayed substantial leading edge dents and gouges as well as chordwise scratches. Blade C was separated from the propeller hub at the blade root. The blade was bent aft and also showed twisting toward low pitch. The blade displayed leading edge dents and gouges as well as chordwise scratches.

A handheld GPS device, an engine driven vacuum pump, and two gyroscopic instruments were removed for laboratory examination. The on-scene examination of the remaining components from the airframe, engine, and propeller revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot by the Tarrant County Medical Examiner in Fort Worth, Texas. The cause of death was listed as "Massive blunt force trauma of body due to light aircraft crash (PILOT)".

Forensic toxicology was performed on specimens from the pilot by the Federal Aviation Administration (FAA), Aeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma.

The toxicology report stated: NO DRUGS detected in Liver.

FAA records showed the pilot's most recent Third-Class Limited Medical Certificate was issued on May 10, 2010, with a restriction: "must wear corrective lenses, possess glasses for near / intermediate vision". At that time the pilot reported that he was taking no medications.

TESTS AND RESEARCH

Handheld GPS Device:

A fragmented and impact damaged Garmin Aero handheld GPS device was removed from the wreckage and was examined at the NTSB vehicle recorder division in Washington, DC

The flash memory device was missing and no data was recovered.

Vacuum Pump:

The vacuum pump and drive spline assembly were removed from the wreckage and examined at the NTSB materials laboratory in Washington, DC. Within the vacuum pump drive spline assembly, the internal shear coupler, which connects the internal spline drive with the external spline drive, exhibited thermal damage such as melting. The thermal damage to the coupler material was consistent with continued engine rotation after the coupler fractured.

A fracture initiation location was found along an area where the reduced section of the inner coupler shaft meets a flange. Under magnification, some areas of flat fracture features were also noted, that were consistent with a fatigue fracture; however, missing material and the thermal damage to the existing shaft material, prevented a definitive determination of the failure mode.

Directional Gyro and Attitude Gyro:

Portions of the directional and attitude gyros were removed from the wreckage and examined at the NTSB materials laboratory in Washington, DC.

The directional gyro did not exhibit circumferential scoring. The inside of the gyro contained impressions on the case.

The attitude gyro exhibited circumferential scoring on both the case and gyro.

ADDITIONAL INFORMATION

According to FAA Advisory Circular 60-4A "Pilot's Spatial Disorientation," "Surface references and the natural horizon may at times become obscured, although visibility may be above visual flight rule minimums. Lack of natural horizon or surface reference is common on over-water flights, at night, and especially at night in extremely sparsely populated areas or in low visibility conditions. A sloping cloud formation, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric

patterns of ground lights can provide inaccurate visual information for aligning the aircraft correctly with the actual horizon. The disoriented pilot may place the aircraft in a dangerous attitude."

"… tests conducted with qualified instrument pilots indicated that it can take as long as 35 seconds to establish full control by instruments after a loss of visual reference of the earth's surface. AC 60-4A further states that surface references and the natural horizon may become obscured even though visibility may be above VFR minimums and that an inability to perceive the natural horizon or surface references is common during flights … at night, in sparsely populated areas, and in low-visibility conditions".

According to the FAA "Instrument Flying Handbook", FAA-H-8083-5B, "One possible cause of instrument failure is a loss of the suction or pressure source. This pressure or suction is supplied by a vacuum pump mechanically driven off the engine. Occasionally these pumps fail, leaving the pilot with inoperative attitude and heading indicators … that can fail progressively. As the gyroscopes slow down, they may wander, which, if connected to the autopilot … can cause incorrect movement or erroneous indications (which) the pilot may misinterpret … and transform a normally benign situation into a hazardous situation ... with the potential to lead the unsuspecting pilot into a dangerous unusual attitude that would require a partial panel recovery. It is important that pilots practice instrument flight without reference to the attitude and heading indicators in preparation for such a failure".

"An obscured horizon … a dark scene spread with ground lights and stars … can provide inaccurate visual information, or false horizon, for aligning the aircraft correctly with the actual horizon. The disoriented pilot may place the aircraft in a dangerous attitude".

"In moderate unusual attitudes, the pilot can normally reorient by establishing a level flight indication on the attitude indicator. However, the pilot should not depend on this instrument if … its upset limits may have been exceeded or it may have become inoperative due to mechanical malfunction ... As soon as the unusual attitude is detected, the recommended recovery procedures … should be initiated by reference to the ASI, altimeter, VSI, and turn coordinator".

According to the FAA "Airplane Flying Handbook", FAA-H-8083-3A, "The pilot should remember, that unless (instrument flying) tasks are practiced on a continuing and regular basis, skill erosion begins almost immediately. In a very short time, the pilot's assumed level of confidence will be much higher than the performance he or she will actually be able to demonstrate should the need arise".

"A VFR pilot is in IMC conditions anytime he or she is unable to maintain airplane attitude control by reference to the natural horizon, regardless of the circumstances or the prevailing weather conditions. (This situation) must be accepted by the pilot involved as a genuine emergency, requiring appropriate action".

Service Letter Number: 52A, issued on March 23, 2006, by the Nichols Airborne Division – Parker Hannifin Corporation, stated that Airborne air pumps with any model number beginning with 200 through 216 must not be operated beyond the mandatory replacement time of "500 aircraft hrs. or 6 years from date of manufacture, whichever comes first". The service letter continued with the following caution: "WARNING: Failure of the air pump will result in the loss of the pneumatically powered gyro flight instruments…"

Service Letter Number: 66, issued on January 21, 2007, by the Nichols Airborne Division – Parker Hannifin Corporation, stated that Airborne air pumps with any model number beginning with 200 through 216 must not be overhauled or repaired. The service letter continued with the following caution: "SAFETY WARNING: … FAILURE OF AN OVERHAULED OR RECONDITIONED PARKER/AIRBORNE PNEUMATIC COMPONENT ESPECIALLY WHILE FLYING IN INSTRUMENT METEOROLOGICAL INFORMATION (IMC) CAN LEAD TO SPATIAL DISORIENTATION OF THE PILOT AND SUBSEQUENT LOSS OF AIRCRAFT CONTROL RESULTING IN DEATH, BODILY INJURY OR PROPERTY DAMAGE. OVERHAULED OR RECONDITIONED PARKER/AIRBORNE PNEUMATIC COMPONENTS MUST NOT BE USED AND MUST BE REPLACED IMMEDIATELY... "

Service Letter Number: 72, issued on February 15, 2008, by the Nichols Airborne Division – Parker Hannifin Corporation, stated "All Parker/Airborne Engine Driven Air Pumps are beyond their Mandatory Replacement time and must be removed from service".

Pilot Information

Certificate:	Private	**Age:**	48
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	May 10, 2010
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	July 25, 2011
Flight Time:	(Estimated) 502 hours (Total, all aircraft), 186 hours (Total, this make and model)		

Passenger Information

Certificate:		**Age:**	31
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:			

Aircraft and Owner/Operator Information

Aircraft Make:	Piper	**Registration:**	N7147P
Model/Series:	PA-24-250	**Aircraft Category:**	Airplane
Year of Manufacture:	1960	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	24-2312
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	July 4, 2011 Annual	**Certified Max Gross Wt.:**	2900 lbs
Time Since Last Inspection:	57 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	4857 Hrs at time of accident	**Engine Manufacturer:**	LYCOMING
ELT:	C126 installed, not activated	**Engine Model/Series:**	0-540 SERIES
Registered Owner:	On file	**Rated Power:**	250 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	KABI,1791 ft msl	**Distance from Accident Site:**	30 Nautical Miles
Observation Time:	18:52 Local	**Direction from Accident Site:**	209°
Lowest Cloud Condition:	Clear	**Visibility**	3 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/ Unknown
Wind Direction:	300°	**Turbulence Severity Forecast/Actual:**	/ Moderate
Altimeter Setting:	30.03 inches Hg	**Temperature/Dew Point:**	14°C / -11°C
Precipitation and Obscuration:	N/A - Blowing - Widespread dust		
Departure Point:	Abilene, TX (ABI)	**Type of Flight Plan Filed:**	None
Destination:	Norman, OK (OUN)	**Type of Clearance:**	VFR flight following
Departure Time:	19:20 Local	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	32.808887,-99.323608(est)

Administrative Information

Investigator In Charge (IIC):	Latson, Thomas
Additional Participating Persons:	Reginald Vessels; FAA Lubbock FSDO; Lubbock, TX Arturo Castillo; FAA Lubbock FSDO; Lubbock, TX Michael C McClure; Piper Aircraft, Inc.; Vero Beach, FL
Original Publish Date:	June 2, 2014
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=82896