Aviation Investigation Final Report

Location:	Rachel, Texas	**Accident Number:**	FTW04FA235
Date & Time:	September 9, 2004, 06:14 Local	**Registration:**	N6209J
Aircraft:	Piper PA-32R-300	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	1 Fatal
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

A single-engine airplane, operating in dark night instrument meteorological conditions as a Part 135 mail cargo flight, impacted terrain after an in-flight break up. Several minutes before the impact, the pilot reported to air traffic control that he had lost his vacuum pump. An on-site examination of the wreckage revealed that the vacuum pump the drive was separated from the engine and the flex coupling displayed a torsion-type separation with coupling wear consistent with engine operation after the separation. Disassembly of the model 211CC vacuum pump revealed the following. A number was assigned to each of the rotor segments and the corresponding vanes were marked and removed from their respective slots. Five of the six vanes were intact, and vane #4 was broken. Four pieces were reassembled to recreate approximately 80 percent of vane #4. Three of the four pieces were found in the mounting flange, and one piece was found in the back flange. The rotor segments were marked such that vane slot #4 is between segment 4 and segment 5. Upon examination of the walls of vane slot 4, a groove approximately .450 inches by .120 inches by .020 inches deep was found on both sides of the vane slot. These grooves corresponded in dimension and position to the portion of the vane that was missing. Three carbon pieces were found, which exhibited extensive wear, which, in two cases, were smooth and round like a "BB." The rear fracture surface of vane #4 exhibited a smooth, polished, spherical wear mark corresponding with the carbon pieces found. The pump housing had severe wear such that there were washboard marks around its entire circumference. At the bottom of the bore, a burr was found on the edge of one of the back flange discharge ports. Corresponding rotational marks were found on the pump's rotor. According to Parker Hannifin, the rule of thumb for vane wear versus service life is: .025-inches of wear for every 100 hours of operation. Using Parker's original new vane length of .845 inches, the estimated time of operation of the vanes of the accident pump was approximately 1,380 hours. According to Parker the vacuum pump had been overhauled. Parker's service letters require replacement of model 211CC vacuum pumps after 500 hours of operation or 6 years from the date of manufacture, which ever occurs first. Examination of the directional gyro revealed that the housing was intact and the gyro was free

to move. No rotational marks were found on the gyro or inside the housing. The turn coordinator gyro was examined and no rotational scoring was found when removed from the housing. A small portion of the housing was fractured and missing. The attitude indicator gyro was free to move within its housing and the housing was intact. No rotational scoring was noted when the gyro was removed from the housing. The filament of the vacuum enunciator bulb # PL33[0] exhibited stretching.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The total failure of the vacuum pump that resulted in an inoperative attitude gyro and spatial disorientation and a subsequent loss of aircraft control by the pilot. Factors were; the prevailing instrument meteorological conditions, and the dark night light condition.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: DESCENT

Findings
1. (C) VACUUM SYSTEM - FAILURE
2. (C) FLIGHT/NAV INSTRUMENTS,ATTITUDE GYRO - NOT OPERATING
3. (C) AIRCRAFT CONTROL - NOT MAINTAINED - PILOT IN COMMAND
4. (C) SPATIAL DISORIENTATION - PILOT IN COMMAND
5. (F) WEATHER CONDITION - CLOUDS
6. (F) LIGHT CONDITION - DARK NIGHT

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
7. DESIGN STRESS LIMITS OF AIRCRAFT - EXCEEDED

Factual Information

HISTORY OF FLIGHT:

On September 9, 2004, approximately 0614 central daylight time, a Piper PA-32R-300, N6209J, owned by a private individual and operated by San Antonio Piper, Inc., of San Antonio, Texas, was destroyed when it impacted the ground following an in-flight break up near Rachel, Texas. The commercial pilot was fatally injured. Dark night instrument meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed for the cargo flight being conducted under the provisions of Title 14 Code of Federal Regulations Part 135. The flight originated from Stinson Municipal Airport (SSF), near San Antonio, Texas, at 0510 and was destined for Mc Allen Miller International Airport (MFE) near McAllen, Texas.

According to radar data that was provided by Houston Air Route Traffic Control Center (ARTCC), the airplane initially climbed to an en route cruising altitude of 9,000 feet mean sea level (msl) after departing from San Antonio. According to air traffic control (ATC) information provided by the FAA, the pilot requested to descend to 7,000 feet msl, at 0537. At 0556, the pilot reported that he "lost the vacuum pump," and at 0559, he requested to descend to 5,000 feet. Radar data depicted the airplane passing through 6,600 feet at 0606.

At 0613, the pilot requested to divert to Brooks County Airport (prior to the request, radar depicted the airplane in a right turn from a heading of 180 degrees toward 130 degrees). The diversion to Brooks County was cleared by air traffic control and a controller asked the pilot if he needed a telephone number to cancel his flight plan once he landed. At 0613:45, the pilot radioed that he did not need a telephone number to cancel his flight plan. At 0613:59, radar depicted the airplane passing through 4,600 feet. The next radar sweep (12 seconds later) depicted the airplane passing through 4,100 feet. The last position of the airplane prior to the loss of contact was approximately 10 miles southwest of Brooks County on a heading of 014 degrees.

PERSONNEL INFORMATION:

The pilot held a valid Federal Aviation Administration (FAA) commercial pilot certificate with ratings for single-engine land, multi-engine land, and instrument airplane. He also held a flight instructor certificate with airplane single-engine land rating and an advanced ground instructor certificate. His most recent first- class medical certificate was issued on February 4, 2004. A review of the pilot's logbook revealed he had accumulated 2,290 hours of flight time as of April 20, 2004. The flight time logs showed 182.7 hours of actual instrument flight time and 65 hours of simulated instrument time. The operator reported that the pilot had flown approximately 30 hours in the accident model airplane (PA32R-300) and 200 hours in PA-32 series aircraft (Cherokee and Lance) in the last 90 days.

AIRCRAFT INFORMATION:

The 1976-model Piper PA-32R-300, serial number 32R-7680332, was powered by a 250-horsepower Lycoming I0540-K1G5D engine, serial number L-24893-48-A, which was overhauled at Lycoming on November 5, 2001, at 1,822.0 hours of tachometer time. The engine was then installed on the above aircraft on February 7, 2002, at a tachometer time of 6,380.45. The tachometer was reset to "0" at 7,560.28 on August 11, 2003.

Entries in the aircraft's maintenance records showed that the last annual inspection was completed on October 1, 2003, tachometer time of 73.3 (total time of 8,411.4). The last 100-hour inspection was completed on August 2, 2004, at a tachometer time of 761.7 hours, and the last 50-hour inspection was completed on August 25, 2004, at a tachometer time of 817.5. Static system and transponder tests were performed on January 27, February 11, and February 27 of 2004.

Aircraft and engine maintenance logbooks revealed that the following items were removed and replaced between October 1, 2003, and the date of the accident:

DATE	ITEM	TACH TIME
October 16, 2003	Power Pack	111.0
	Turn Coordinator	
	Directional Gyro	
December 7, 2003	Aircraft Battery	223.4
January 8, 2004	Turn Coordinator	282.6
January 27, 2004	Airspeed Indicator	324.9
February 11, 2004	Airspeed Indicator	361.8
April 12, 2004	Aircraft Battery	499.8
May 7, 2004	Vacuum Pump	563.9
May 27, 2004	Propeller Governor	611.9
June 18, 2004	Propeller Governor	664.0

Flight log entries showed that the tachometer time at the time of departure from SSF was 850.0 hours, and the Hobbs time was 8461.0 hours. Hobbs time at the time of the accident was 8,462.1. The tachometer time computed from the Hobbs time at the time of the accident was 851.1 hours.

METEOROLOGICAL INFORMATION:

At 0605, the automated weather observing system at Brooks County Airport (BKS), near Falfurrias, Texas, located approximately 10 miles northeast from the site of the accident, reported wind from 320 degrees at 5 knots, 10 statute miles visibility, broken clouds at 4,400 feet, overcast clouds at 5,000 feet, temperature 71 degrees Fahrenheit, dew point 64 degrees Fahrenheit, and a barometric pressure setting of 29.94 inches of Mercury.

A satellite image taken at 0615 indicated a low-level layer of overcast to broken cloud layer extending from the coast inland to approximately 20 miles west of Falfurrias and extended northward to McMullen, Texas. The radiative cloud top temperature over Falfurrias was approximately 6.2 degrees Celsius, which according to the Corpus Christi, Texas sounding, indicated cloud tops near 8,600 feet msl.

The beginning of civil twilight on the morning of the accident was at 0652, and sunrise was at 0715. The phase of the moon on the morning of the accident was a waning crescent with 22% of the moon's visible disk illuminated. Moonset was at 1612 on the preceding day, and moonrise was at 0229 on the morning of the accident.

WRECKAGE AND IMPACT INFORMATION:

The main wreckage of the aircraft, which consisted of the engine, propeller assembly, main fuselage, and right wing, was found on ranchland in close proximity to a natural gas processing center, GPS coordinates, latitude 26 degrees 57.56 minutes North, longitude 98 degrees 15.03 minutes West. Remaining components of the aircraft were scattered within a 1/4 mile distance from the main wreckage over brush and desert-like terrain in a general southeast direction.

Engine and propeller assemblies were found embedded into the ground approximately 12-18 inches. The engine remained attached to the firewall and airframe and the propeller and spinner was attached to the crankshaft flange. One propeller blade was buried, and when exposed, exhibited severe twisting and bending. The other blade remained relatively straight, and both both blades exhibited leading edge polishing and chord-wise scoring. The vacuum pump was found partially detached from the engine and was recovered for further examination. (See Tests and Research for more details.)

Found laying on its left side, the fuselage was found crushed along its length and was split down the left portion of the cabin ceiling. The fuel selector was destroyed and the fuel valve was positioned in the "OFF" position. The instrument indications that were visible in the cockpit are as follows: Gyro suction indicated +4, magnetos were in the "BOTH" position, the altimeter indicated 300 feet, and the directional gyro indicated 302 degrees. The fuel selector valve was in the "OFF" position. The mode C transponder displayed "4522" in the "ALT" position. Navigation radio number one was set to 109.0, and navigation radio number two was set to 111.4. A large amount of mail cargo was found compacted in the tail cone section of the main wreckage.

The right wing was detached from its respective mounts and was bent rearward and parallel to the fuselage. The aileron was secure at all hinges points and the flap remained attached by the inboard hinge. The fuel cap was in place and secure. The fuel tanks were breached and no fuel was noted. The aileron control cable exhibited "broomstraw" separation at the wing root.

The condition and position of the following components are described in the order of their location throughout the wreckage path, extending in a southeast direction from the main wreckage to pieces of stabiltator skin, which were located furthest from the main wreckage:

The forward section of the left wing root was located at coordinates 26 degrees 57.50 minutes North,98 degrees 14.90 minutes West, approximately 900 feet southeast of the main wreckage. The left wing, with aileron and flap intact, was located at 26 degrees 57.48 minutes North,98 degrees 14.88 minutes West, approximately 950 feet southeast of the main wreckage. The wing came to rest in an upright position and exhibited compression wrinkling parallel along the span. The left wing flap was in the zero degree position, and the landing gear was extended and bent aft under the wing.

Most of the vertical stabilizer, excluding the rudder, was located at 26 degrees 57.49 minutes North, 98 degrees 14.83 minutes West, approximately 1,150 feet southeast of the main wreckage. It was bent to the left near mid-height. The rudder bellcrank remained attached to the rear fuselage bulkhead and was jammed past the right side rudder stop. Both rudder cables were secure to the bellcrank. The left side rudder cable was separated near the mid-fuselage. The cable exhibited "broomstaw" separation, consistent with overload. The right side rudder cable was intact and secure.

The trim tabs of the stabilator, with partial stabilator skin, were located at 26 degrees 57.43 minutes North, 98 degrees 14.83 minutes West. The bottom stabilator cable was separated near mid-fuselage and exhibited "broomstraw" separation. The top stabilator cable was intact and secure. The stabilator trim drum showed an inner shaft extension of two threads upper extension, which is consistent with a setting of approximately two degrees nose-down trim.

SURVIVAL ASPECTS:

The airplane, normally configured fro six occupants, had a pilot (left) and co-pilot (right) seat installed. The four rear cabin seats had been removed to accommodate cargo, and a cargo net was installed. Both seats were equipped with seatbelts and shoulder harnesses. The pilot was wearing a seatbelt, but not a shoulder harness at the time of the accident. Both seat backs were flattened and twisted to the left, and both seats were displaced from their respective seat tracks.

MEDICAL AND PATHOLOGICAL INFORMATION:

An autopsy was performed by the Corpus Christi Medical Examiner on September 10, 2004. The pilot's cause of death was determined to be multiple blunt force injuries. The FAA's Civil Aeromedical Institute's (CAMI) Forensic and Accident Research Center examined the specimens taken by the medical examiner. The toxicological tests were negative for carbon monoxide, cyanide, and alcohol.

TESTS AND RESEARCH:

The wreckage was recovered to Air Salvage of Dallas, Lancaster, Texas, on September 11, 2004, for further examination. Examination of the engine and propeller assembly did not reveal any pre-impact anomalies.

On October 13, 2004, the vacuum pump, serial number 18052, part number 211CC, which displayed an overhauled placard from Prairie Aviation Supply, Inc., of Grand Prairie, Texas, was disassembled by the investigation team, which included a representative from Parker-Hannifin, the unit's original manufacturer. Before disassembly, the drive was found separated from the engine and the flex coupling displayed a torsional-type separation with coupling wear consistent with engine operation after the separation.

The representative assigned a number to each of the rotor segments and marked the corresponding vanes removed from their respective slots. Five of the six vanes were intact and were of the following dimensions; however, vane #4 was broken:

Vane	Height (in.)		Length (in.)	Thickness (in.)
1	1.302	.497	.122	
2	1.305	.509	.122	
3	1.304	.501	.122	
4	X	X	X	
5	1.299	.520	.122	
6	1.300	.519	.122	

According to Parker Hannifin, the rule of thumb for the vane wear versus service life is: .025-inches of wear for every 100 hours of operation. Using Parker's original new vane length of .845 inches, the estimated time of operation of the vanes of the accident pump was approximately 1,380 hours. The vacuum regulator, part number 2H5-19, date code 3B, was manufactured in March of 1976. The air filter assembly, part number 1J7-1, element part number D9-18-1, date code 12AT, was manufactured in December of 2000.

Four pieces were reassembled to recreate approximately 80 percent of vane #4. Three of the four pieces were found in the mounting flange, and one piece was found in the back flange. The rotor segments were marked such that vane slot #4 is between segment 4 and segment 5. Upon examination of the walls of vane slot 4, a groove approximately .450 inches by .120 inches by .020 inches deep was found on both sides of the vane slot. These grooves corresponded in dimension and position to the portion of the vane that was missing. Three carbon pieces were found, which exhibited extensive wear, which, in two cases, were smooth and round like a BB. The rear fracture surface of vane #4 exhibited a smooth, polished, spherical wear mark corresponding with the carbon pieces found.

The pump housing had severe wear such that there were washboard marks around its full circumference. At the bottom of the bore, a burr was found on the edge of one of the back flange discharge ports. Corresponding rotational marks were found on the pump's rotor.

Examination of the directional gyro revealed that the housing was intact and the gyro was free to move. No rotational marks were found on the gyro or inside the housing. The turn coordinator gyro was examined and no rotational scoring was found when removed from the housing. A small portion of the housing was fractured and missing. The attitude indicator gyro was free to move within its housing and the housing was intact. No rotational scoring was noted when the gyro was removed from the housing.

The filament of the alternator enunciator bulb # GE330 did not exhibit any stretching, which indicated that the bulb was not illuminated at the time of impact. The filament of the vacuum enunciator bulb # PL33[0] exhibited stretching, which was consistent with the bulb being illuminated at the time of impact. The filament of the oil pressure enunciator bulb # PL330 exhibited slight stretching, which was consistent with the bulb being illuminated at the time of impact.

On April 1, 2005, the engine was examined. The engine was partially rotated by hand, using the propeller. The vacuum pump drive was observed rotating at the back of the engine. Crankshaft and valve train continuity was established, and no anomalies were discovered that would have precluded the engine from making power prior to impact.

ADDITIONAL INFORMATION:

According to Parker the vacuum pump had been overhauled. Parker's service letters require replacement of model 211CC vacuum pumps after 500 hours of operation or 6 years from the date of manufacture, which ever occurs first.

Starting in December 1986, Parker Hannifin Corporation, the manufacturer of the vacuum pump, began publishing periodic safety mailings, which urged pilots and operators to install a back-up pneumatic power source for the air driven gyros or a back-up electric attitude gyro instrument in their airplanes; however, the accident airplane was not equipped with either of these systems. Additionally, the safety mailings urged pilots to understand how the gyro instruments operate, recognize when gyro instruments fail, maintain partial panel proficiency, and obtain pilot safety training in spatial disorientation.

According to the FAA Advisory Circular (AC) 61-21A, "The flight attitude of an airplane is generally determined by reference to the natural horizon. When the natural horizon is obscured, attitude can sometimes be maintained by reference to the surface below. If neither horizon nor surface references exist, the airplane's attitude must be determined by artificial means - an attitude indicator or other flight instruments. Sight, supported by other senses such as the inner ear and muscle sense, is used to maintain spatial orientation."

"However, during periods of low visibility, the supporting senses sometimes conflict with what is seen. When this happens, a pilot is particularly vulnerable to spatial disorientation. Spatial disorientation to a pilot means simply the inability to tell "which way is up."

The FAA AC 61-27C (Section II, "Instrument Flying: Coping with Illusions in Flight") states that spatial disorientation cannot be completely prevented, but it be ignored or sufficiently suppressed by pilots' developing an "absolute" reliance upon what the flight instruments are reporting about the attitude of their aircraft.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	33,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Front
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	February 4, 2004
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 9, 2003
Flight Time:	2290 hours (Total, all aircraft), 2180 hours (Pilot In Command, all aircraft), 195 hours (Last 90 days, all aircraft), 56 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Piper	**Registration:**	N6209J
Model/Series:	PA-32R-300	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	32R-7680332
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	August 2, 2004 100 hour	**Certified Max Gross Wt.:**	3600 lbs
Time Since Last Inspection:	89.4 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	8411.38 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	IO-540-K1G5D
Registered Owner:	San Antonio Piper Inc.	**Rated Power:**	300 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	BKS,112 ft msl	**Distance from Accident Site:**	8 Nautical Miles
Observation Time:	06:25 Local	**Direction from Accident Site:**	45°
Lowest Cloud Condition:	Thin Overcast / 4200 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Overcast / 4200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots / 0 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	330°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	22°C / 18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	San Antonio, TX (SSF)	**Type of Flight Plan Filed:**	IFR
Destination:	Mc Allen, TX (MFE)	**Type of Clearance:**	IFR
Departure Time:	05:10 Local	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	26.965555,-98.250831

Administrative Information

Investigator In Charge (IIC):	Lemishko, Alexander
Additional Participating Persons:	Edward J Trayhan; San Antonio, Texas FSDO; San Antonio, TX Michael McClure; Piper Aircraft; Dallas, TX John Butler; Lycoming Engines; Dallas, TX
Original Publish Date:	July 7, 2005
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=60086