National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI05LA045	Aircraft Registration Number: N922RG
Occurrence Date: 12/14/2004	Most Critical Injury: None
Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
South Bend	IN	46637	1330	EST	

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility: 3	Direction From Airport:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
Pilatus	PC-12/45	Airplane

Sightseeing Flight: No

Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

HISTORY OF FLIGHT

On December 14, 2004, about 1330 eastern standard time, a Pilatus PC-12/45, N922RG, operated by Greenhill Aviation Co. and piloted by an airline transport pilot, was substantially damaged during a forced landing following a loss of engine power near South Bend, Indiana. The corporate flight was being operated under 14 CFR Part 91 on an instrument flight rules (IFR) flight plan. The flight was reportedly in instrument meteorological conditions (IMC) at the time of the loss of engine power, however, visual meteorological conditions (VMC) prevailed at the accident site. The pilot and four passengers reported no injuries. The flight departed South Bend Regional Airport (SBN), South Bend, Indiana about 1315. The flight's intended destination was Westchester County Airport (HPN), White Plains, New York.

The pilot stated that approximately 10 minutes after departing SBN, while climbing through 6,000 feet mean sea level (msl), the engine "abruptly and smoothly rolled back." He noted that smoke and flames were subsequently seen from both exhaust stacks. He reported that movement of the power control lever had no effect. He stated that use of the emergency manual override (MOR) system did not restore engine power. He then secured the engine.

The pilot noted that he declared an emergency with South Bend approach control and requested radar vectors to the nearest airport. The air traffic controller informed him that SBN was the nearest airport and provided a heading. He reported that he configured the airplane at best glide airspeed and remained in IMC until descending through 3,000 feet msl. Upon exiting the clouds, the pilot obtained visual contact with the airport, however, the aircraft's altitude was not sufficient to reach it. According to the pilot, the flight was over the city of South Bend at that time and he ultimately elected to set-up for a landing on a roadway. He noted that traffic cleared at the last minute and he executed a landing on the road. During the rollout the right wing struck two utility poles before the airplane came to a stop.

PERSONNEL INFORMATION

The pilot-in-command held an airline transport pilot certificate with single-engine land and sea airplane, and multi-engine land and sea airplane ratings. He was issued a first-class medical certificate with no limitations in March 2004. The pilot reported a total flight time of 2,879 hours, with 30 hours in a Pilatus PC-12/45. He noted 50 flight hours during the past 30 days, with 30 hours in the PC-12/45.

AIRCRAFT INFORMATION

The accident airplane was a 2001 Pilatus PC-12/45, serial number 409. The aircraft was a single-engine, pressurized airplane, configured with six passenger seats and two flight crew (pilot) seats. The PC-12/45 was certified to operate at a maximum altitude of 30,000 feet, and had a maximum cruise speed of 270 knots.

National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB ID: CHI05LA045

Occurrence Date: 12/14/2004

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Narrative (Continued)

A Pratt & Whitney PT6A-67B turbo-shaft engine, serial number PCE-PR0271, capable of producing 1,200 horsepower, powered the accident airplane.

According to the operator, the engine and airframe had accumulated 599 hours total time. The most recent inspection was completed on July 8, 2004, at 514 hours.

METEOROLOGICAL CONDITIONS
The South Bend Regional Airport (SBN) Automated Surface Observing System (ASOS), at 1254, recorded: calm winds; 9 statute miles visibility; 2,400 feet above ground level (agl) scattered, 3,000 feet agl overcast; temperature and dew point -4 and -7 degrees Celsius, respectively; altimeter setting was 30.48 inches of mercury.

At 1354, the SBN ASOS recorded: calm winds; 7 statute miles visibility in light snow; 3,400 feet agl overcast; temperature and dew point -4 and -7 degrees Celsius, respectively; altimeter setting was 30.47 inches of mercury.

WRECKAGE AND IMPACT INFORMATION
The airplane landed on U.S. Route 933, approximately 3 miles east of SBN. The aircraft came to a stop on the roadway. A section of the right wing from the end of the flap outboard was completely separated and located at the side of the road. An additional area of impact damage was located on the leading edge of the right wing about mid-span. The wing skin was crushed aft exposing the spar and sub-structure. The width of the crushed area was approximately the same as the diameter of a static wire support pole along the side of the roadway.

Two utility poles were damaged. One was knocked down and the other had impact marks consistent with the height and thickness of the wing. The outboard section of the right wing was lying against the intact pole.

TESTS AND RESEARCH
Engine operating parameters were recorded on-board the aircraft during normal operations. Recorded parameters included the interstage turbine temperature (ITT) and fuel flow (FF). Data from the accident flight was downloaded and reviewed. Prior to the rollback, the ITT was stabilized approximately 600 degrees Celsius and the fuel flow maintained about 550 pounds per hour (lbs/hr). Beginning at 1322:24 (HHMM:SS), the ITT and FF decreased from 589 degrees Celsius and 521 lbs/hr, respectively, to 420 degrees Celsius and 79 lbs/hr. The ITT and FF then began to increase, reaching 1,028 degrees Celsius and 432 lbs/hr respectively, about 1322:53. The ITT maintained approximately 900 degrees Celsius, until it peaked again 60 seconds later at 1,283 degrees Celsius. A plot of the data is included in the docket material associated with this accident file.

The pilot's operating handbook (POH) documented limitations related to engine operation. The POH denoted maximum ITT limits as follows: During starting for no more than 5 seconds, 1,000 degrees Celsius; transient for no more than 20 seconds, 870 degrees Celsius; takeoff for no more than 5 minutes, 800 degrees Celsius; and maximum continuous, 760 degrees Celsius.

The engine assembly was removed for examination. A teardown was conducted at Pratt & Whitney Canada facilities under supervision of the Transportation Safety Board of Canada.

Teardown inspection of the engine revealed that the first and second stage power turbine blades were fractured. The first stage blades were fractured approximately mid-span. Approximately one-half of the second stage blades were separated from the blade disc. The compressor blades exhibited damage at the tips, with portions of the blades missing. Noted damage was consistent with exposure to elevated temperatures.

Examination and testing of the fuel control unit (FCU) revealed a leak in the compressor discharge pressure (CDP) sensor assembly bellows. The leak was located in a pit on the outer ply of the

Narrative (Continued)

bellows. Additional pitting was observed near the leak site and on adjacent convolutions. There was no evidence of intergranular attack into the bellows material. There was no mechanical damage to the bellows.

The CDP sensor consisted of the double-walled, hydro-formed bellows assembly fabricated from beryllium copper. Changes in CDP caused the bellows to expand or contract, which subsequently controlled a fuel valve. A leak in the bellows prevented the assembly from properly responding to pressure variations and resulted in the FCU providing minimum fuel flow to the engine regardless of throttle setting. The resulting power output of the engine at minimum fuel flow was insufficient to maintain level flight.

ADDITIONAL INFORMATION

Pratt & Whitney Canada, the manufacturer of the engine, issued Service Information Letter PT6A-128 in September 2004, regarding a prior in-flight engine power roll back on a PC-12 aircraft. The cause of the loss of engine power was attributed to a "loss of Fuel Control Unit (FCU) authority caused by leakage of the FCU bellows." The service letter noted that the leak was due to a perforation of the bellows at an inclusion in the material. The letter noted four previous events with similar malfunctions. Two of the events occurred in-flight, however, in those instances power was successfully recovered by using the MOR system.

Pilatus Aircraft Ltd., the manufacturer of the airframe, issued service letter no. 81 in conjunction with the Pratt & Whitney letter. In addition to informing operators of the engine power roll back event, Pilatus issued a revision to the pilot's operating manual regarding use of the MOR. The revision combined previous emergency procedures into one Engine Partial Power Loss in Flight procedure.

Pratt & Whitney Canada issued Service Information Letter PT6A-131 in January 2005. The letter informed operators of the occurrence of the engine power roll back involved in this accident. It also reminded pilots of the importance of being familiar with the use of the MOR and noted Pilatus' release of Pilot's Operating Handbook (POH) Temporary Revision No. 13.

POH Temporary Revision No. 13 stated that the previous Engine Power Loss and Fuel Control Unit Failure procedures specified that the power control lever (PCL) was to be placed in the forward position. The revision noted, "It has been [found] during flight tests that following the procedure incorrectly could possibly lead to engine parameter exceedences." The temporary revision provided a revised Engine Partial Power Loss In Flight procedure which combined the two previous procedures. Information regarding the MOR system was also updated. The temporary revision was subsequently incorporated into the POH in February 2005.

The revision also stated that "the MOR lever is an emergency device and it is possible to exceed engine limits if the MOR lever is operated too fast." It stated that the MOR "directly operates the fuel metering valve by . . . compressing the pneumatic bellows . . . in the FCU."

Woodward and PWC released an improved FCU design in April 2005. The revised design included a more robust bellows configuration, in which both bellows plies are sealed. In the original design, only one of the plies was sealed. In addition, a baffle was placed in the compressor discharge air (P3) stream to prevent the airflow impingement on the bellows. The survey of in-service bellows observed a tendency for pitting to be located near the area where the compressor discharge air (P3) impinged on the surface of the bellows.

Pratt & Whitney Canada issued Service Bulletin No. 14371 in April 2005. Alert Service Bulletin No. A14371R1 was issued in May 2005 and superseded the previous bulletin. Each of these recommended replacement of the FCU with one that incorporated the improved bellows design. Compliance with the alert bulletin was recommended within 250 flight hours or 6 months for the date of the letter.

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID: CHI05LA045

Occurrence Date: 12/14/2004

Occurrence Type: Accident

Narrative (Continued)

Concurrent with the release of the enhanced FCU design, Pilatus, and PWC initiated a retrofit campaign for PC-12 operators. The PC-12 in-service fleet, production aircraft, and rental engines were retrofitted with FCU's which incorporated the new bellows design.

Woodward conducted a post-accident audit of the bellows manufacturer. As a sub-contractor, oversight of the bellows manufacturer was the responsibility of Woodward. The audit identified several process deficiencies. These deficiencies included incomplete internal fabrication documents, improper concentration of solutions used for cleaning and finishing the bellows, and an inadequate quality control system related to maintaining those solutions. Woodward stated that corrective action was implemented for the noted discrepancies. In addition, 100-percent quality control inspections were introduced both prior to shipment from the bellows manufacturer and when received at Woodward.

Parties to the investigation were the Federal Aviation Administration, Transportation Safety Board of Canada, Pilatus Business Aircraft, Pratt & Whitney, Woodward Governor Company, and Greenhill Aviation.

National Transportation Safety Board

FACTUAL REPORT AVIATION

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Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
South Bend Regional	SBN	799 Ft. MSL	NA		

Runway Surface Type:

Runway Surface Condition:

Type Instrument Approach: NONE

VFR Approach/Landing: Forced Landing

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
Pilatus	PC-12/45	409

Airworthiness Certificate(s): Normal

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	8	9921 LBS	1

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Prop	Pratt & Whitney Canada	PT6A-67B	1200 HP

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Annual	07/2004	84 Hours	599 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?	ELT Operated?	ELT Aided in Locating Accident Site?
Yes	No	No

Owner/Operator Information

Registered Aircraft Owner	Street Address	City	State	Zip Code
Riversville Aircraft Corp.	433 Riversville Rd	Greenwich	CT	06831

Operator of Aircraft	Street Address	City	State	Zip Code
Greenhill Aviation Co., LLC	16 Hangar Road	White Plains	NY	10604

Operator Does Business As:

Operator Designator Code:

- Type of U.S. Certificate(s) Held: None

Air Carrier Operating Certificate(s):

Operating Certificate:

Operator Certificate:

Regulation Flight Conducted Under: Part 91: General Aviation

Type of Flight Operation Conducted: Executive/Corporate

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI05LA045

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First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	25

Sex: M | Seat Occupied: Left | Principal Profession: Occupational Pilot | Certificate Number: On File

Certificate(s): Airline Transport; Flight Instructor

Airplane Rating(s): Multi-engine Land; Multi-engine Sea; Single-engine Land; Single-engine Sea

Rotorcraft/Glider/LTA:

Instrument Rating(s): Airplane

Instructor Rating(s): Airplane Multi-engine; Airplane Single-engine; Instrument Airplane

Type Rating/Endorsement for Accident/Incident Aircraft? | Current Biennial Flight Review? 10/2004

Medical Cert.: Class 1 | Medical Cert. Status: Without Waivers/Limitations | Date of Last Medical Exam: 03/2004

- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	2879	30	1990	889	371	195	43			
Pilot In Command(PIC)	2385	30	2255	529						
Instructor										
Last 90 Days	115	30	79	36	24	11				
Last 30 Days	50	30	29	3	5	8				
Last 24 Hours	4	3	4	0	0	1				

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? No

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
South Bend	IN	SBN	1315	EST

Destination	State	Airport Identifier
White Plains	NY	HPN

Type of Clearance: IFR

Type of Airspace:

Weather Information

Source of Briefing: Flight Service Station

Method of Briefing:

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI05LA045

Occurrence Date: 12/14/2004

Occurrence Type: Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
SBN	1254	EST	799 Ft. MSL	3 NM	270 Deg. Mag.

Sky/Lowest Cloud Condition: Scattered 2400 Ft. AGL

Condition of Light: Day

Lowest Ceiling: Overcast 3000 Ft. AGL

Visibility: 9 SM

Altimeter: 30.48 "Hg

Temperature: -4 °C

Dew Point: -7 °C

Wind Direction:

Density Altitude: Ft.

Wind Speed: Calm

Gusts:

Weather Condtions at Accident Site: Visual Conditions

Visibility (RVR): Ft.

Visibility (RVV) SM

Intensity of Precipitation:

Restrictions to Visibility: No Obscuration; No Precipitation

Type of Precipitation:

Accident Information

Aircraft Damage: Substantial

Aircraft Fire: None

Aircraft Explosion None

Classification:

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot					
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew					
Passengers				4	4
- TOTAL ABOARD -				5	5
Other Ground					
- GRAND TOTAL -				5	5

National Transportation Safety Board **FACTUAL REPORT** **AVIATION**	NTSB ID: CHI05LA045 Occurrence Date: 12/14/2004 Occurrence Type: Accident	

Administrative Information

Investigator-In-Charge (IIC)

Tim Sorensen

Additional Persons Participating in This Accident/Incident Investigation:

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