National Transportation Safety Board
Aviation Accident Final Report

Location:	Globe, AZ	**Accident Number:**	LAX05LA244
Date & Time:	07/22/2005, 0830 MST	**Registration:**	N717BT
Aircraft:	Cessna 208B	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Minor
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled		

Analysis

The airplane impacted a road and scrub brush during a forced landing, which was preceded by a total loss of engine power. According to the pilot, he heard a loud "thunk" during takeoff climb and noted a loss of engine power. He manipulated the power lever from the full forward position to the full aft position ("stop-to-stop") and noted he had no power. Post-accident examination of the Pratt & Whitney Canada PT6A -114A engine revealed that the compressor turbine (CT) vane's outer rim liberated a section of metal that damaged the turbine blades downstream. The area of liberated material from the CT vane outer rim was examined by the manufacturer's metallurgists. The fracture surface of the outer rim showed evidence of fatigue with signs of oxidation in some areas indicating the crack had been in existence for some time. The liberated material impact damaged the CT blades and resulted in a loss of power. Review of the operator's records revealed that the engine was approved for an extension beyond the normally recommended 3,600-hour overhaul period, to 5,100 hours. The engine had accumulated 4,461.3 hours at the time of the accident. In addition, the turbine section (hot section) had a recommended overhaul period of 1,800 hours; however, the operator instead elected to utilize an engine trend monitoring program in accordance with a manufacturer issued service bulletin. Many errors were noted with the operator's manually recorded data utilized for the trend monitoring. However, it is not likely that the engine trend data, even had it been correctly recorded and monitored, would have depicted the fatigue cracking in the CT vane outer rim. As a result, the manufacturer issued a service information letter (SIL) PT6A-116 in January 27, 2003 (following a similar investigation), which reminded operators to conduct borescope inspections of the CT vane during routine fuel nozzle maintenance, as the manufacturer's maintenance manual recommended. Review of the maintenance record entries for the accident engine revealed no evidence that a borescope inspection had been conducted in conjunction with the fuel nozzle checks.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The fatigue failure of the compressor turbine stator vane, the liberation of vane material into the compressor turbine, and the total loss of engine power. Also causal was the operator's

failure to inspect the compressor turbine vane during fuel nozzle checks.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings
1. (C) TURBINE ASSEMBLY,NOZZLE - FATIGUE
2. (C) TURBINE ASSEMBLY,NOZZLE - FAILURE,PARTIAL
3. (C) MAINTENANCE,INSPECTION - NOT COMPLIED WITH - COMPANY MAINTENANCE PERSONNEL
4. MAINTENANCE,RECORDKEEPING - INADEQUATE - COMPANY MAINTENANCE PERSONNEL
5. (C) TURBINE ASSEMBLY,TURBINE BLADE - FAILURE,TOTAL

Occurrence #2: FORCED LANDING
Phase of Operation: DESCENT - EMERGENCY

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Findings
6. TERRAIN CONDITION - ROADWAY/HIGHWAY
7. TERRAIN CONDITION - DROP-OFF/DESCENDING EMBANKMENT
8. OBJECT - TREE(S)

Factual Information

HISTORY OF FLIGHT

On July 22, 2005, about 0830 mountain standard time, a Cessna 208B single-engine airplane, N717BT, lost engine power during takeoff climb from the San Carlos Apache Airport (P13) in Globe, Arizona, and impacted the ground east of the airport. The airplane came to rest about 50 yards from highway 70 on the San Carlos Indian Reservation. Baltimore Air Transport (B.A.T.) of Atlanta, Georgia, d.b.a. CorpJet, operated the airplane as a contract cargo flight for United Parcel Service (UPS) under the provisions of 14 CFR Part 135. The airplane sustained substantial damage and the airline transport pilot, sole occupant, sustained minor injuries. Visual meteorological conditions prevailed and a company visual flight rules flight plan was filed for the cross-country flight. The flight's intended destination was Safford Regional Airport (SAD), Safford, Arizona.

On the morning of the accident, the pilot flew the airplane from Phoenix to Globe with about 600 pounds of cargo and 1,600 pounds of fuel. The flight lasted approximately 30 minutes and he experienced no problems and noted no anomalies. At Globe, the pilot offloaded about 200 pounds of cargo and departed for Safford. He did not add fuel at Globe.

Departing Globe, the pilot noted the winds were very light, if not calm, and there was a high overcast cloud layer (around 25,000 feet). He took off with a normal takeoff flap setting of 20 degrees, and a takeoff power setting just below normal (which according to the pilot was between 1,800 and 1,900 RPM). During engine start he noted a normal inlet turbine temperature (ITT) and oil pressure indication, but during takeoff, he concentrated on torque setting and didn't notice the ITT and oil pressure during climb out.

The pilot heard a loud "thunk" and noted a loss of engine power. Shortly after the "thunk" he looked at the engine instruments, but could not remember their readings. He noted that three annunciator lights were illuminated ("low oil pressure, low fuel pressure, and low vacuum pressure"). He manipulated the power lever from the full forward position to the full aft position ("stop-to-stop") and noted he had no power. When asked if he performed any of the emergency procedures, he indicated that he did not remember but didn't think so because he was more concerned about finding a suitable landing site. When asked if he tried to feather the propeller he said he did not believe he did because he was focused on flying the airplane.

The pilot could not remember what altitude he was when he heard a loud "thunk" but knew he was high enough to make a turn back toward the departure airport. During the turn, the descent rate was such that he realized he would not be able to make it back to the airport and concentrated on finding a landing area. After realizing he would not make it to the airport, the pilot initially set up to land on highway 70, but believed there was too much traffic and he would hit something. He then focused on landing in a field adjacent to the highway. When asked if he had manipulated the flaps, the pilot said he could not remember. He said he put in 20 degrees of flaps for takeoff, but could not remember if he ever retracted them following takeoff or during the initial climb.

The airplane touched down on the edge of highway 70, bounced down an incline on the side of the road and came to rest upright in the dirt among scrub brush.

PERSONNEL INFORMATION

The pilot held a second-class medical certificate issued on March 23, 2005, with a limitation indicating that the medical was "not valid for any class after March 31, 2006." He was an airline transport pilot with an airplane multi-engine land (AMEL) rating, and held a commercial pilot certificate with an airplane single-engine land (ASEL) rating. He was also a certificated flight instructor with ASEL, AMEL, and instrument airplane ratings. According to the Pilot/Operator Aircraft Accident Report (NTSB form 6120.1/2) submitted by the pilot, he accumulated a total of 5,545.5 flight hours, of which 203.0 hours were logged in the same make and model as the accident airplane.

The pilot completed his basic indoctrination, aircraft ground, and emergency training on June 25, 2005. On June 26, 2005, the pilot completed a 1.9-hour airman competency/proficiency check ride required by 14 CFR Parts 135.293, 135.297, and 135.299. Review of the company's training record revealed instructors "discussed" abnormal/emergency procedures with the pilot.

AIRCRAFT INFORMATION

The accident airplane (serial number 208B0863) was manufactured in 2000, and was delivered with the same 675-shaft horsepower Pratt & Whitney Canada (P&WC) PT6A-114A engine that was installed at the time of the accident (serial number PCE-PC0823).

The PT6A-114A engine is positioned in the nose of the Cessna 208 with the inlet to the compressor section oriented toward the aft end of the engine by the accessory section. When looking at the profile view of the engine, the propeller reduction gearbox is oriented toward the front, followed aft by the turbine section, combustion section, compressor section, and ending with the accessory gearbox. The airflow through the engine flows into the inlet and moves forward through the compressor section, before making an "S" turn through the diffuser and turns 180 degrees to enter the combustion chamber. Fuel is introduced, ignited and the expanding hot gas exits the combustion chamber and turns 180 degrees back toward the nose of the airplane where it then enters the turbine section. The hot gas continues through two turbines before exiting the exhaust, which is located toward the front of the engine near the propeller reduction gearbox. The compressor section consists of three axial stage compressors and one centrifugal impeller, which are all driven by the compressor turbine (referred to as the CT or N1). Forward of the compressor turbine is the power turbine (referred to as the PT or N2), which drives the propeller. The two rotating assemblies are not connected and turn at different speeds and in opposite directions, which is referred to as a "free turbine engine."

Review of the B.A.T.'s operations specifications revealed the accident airplane was on an approved airworthiness inspection program (AAIP), which followed the Cessna 208 phasecard inspection program. The engine was to be maintained in accordance with the manufacturer's maintenance manual and P&WC's service bulletin (SB) 1003R25, which allowed the time-in-service interval for overhaul to be extended beyond the normal recommendation of 3,600 hours, and hot section inspections to be conducted on condition. The operations specifications further dictated that the operator must also incorporate the manufacturer's recommended engine trend monitoring program.

Review of the aforementioned SB revealed operators could extend the time-between-overhaul (TBO) by 500-hour intervals on a sampling basis. The operator must have submitted at least one engine from their fleet that has reached its 3,600-hour TBO interval, had it inspected and overhauled, and requested a TBO evaluation report from a P&W Distributor and Designated

Overhaul Facility (DDOF). If the sample engine proved to be in a satisfactory condition, P&W would consider recommending a fleet extension to 4,100 hours. In addition, the hot section inspection (HSI) was to be conducted within 50 hours of its normal HSI interval of 1,800 hours, unless it underwent engine condition trend monitoring in accordance with the Engine Condition Trend Monitoring Analytical Guide (EAG) Manual part number (P/N) 3043607.

B.A.T. had undergone 3 separate sampling approvals to reach their approved TBO of 5,100 hours; the last approval was dated July 19, 2001.

According to B.A.T. maintenance personnel, the accident engine had been on P&WC's approved trend monitoring program since its delivery in 2000. Pilot's recorded engine data manually (as opposed to an electronic recording device) on a data sheet, which required that they:

1. Record the data on the first suitable flight of every flying day,

2. Allow engine parameters to stabilize in cruise,

3. Read engine parameters with engine anti-ice off and cabin bleed off, and to

4. Take actual readings rather than targets.

B.A.T.'s director of maintenance indicated that their department received the trend data from the pilots every Monday. The data was then entered into the trend analysis program by either him or his staff assistant. When asked how often he reviewed the trend plots, he indicated he did so regularly. When asked how often regularly was, he said every two weeks. B.A.T. maintenance personnel provided the NTSB copies of the trend data since August 10, 2004. However, the last week of trend data was not provided (according to the pilot, it was located on a clipboard in the airplane. This data was not located throughout the course of the investigation).

The EAG Manual 3043607 (ECTM - Engine Condition Trend Monitoring) indicated that, "ambient parameters and engine performance data should be recorded once every day, or once every six flight hours if the engine is flown more than 6 to 8 hours a day, and should be processed the following day...Under exceptional circumstances...a maximum of three days or 24 (running) hours of missing data is acceptable." In addition, the manual indicated that variable loads, such as generator, hydraulic, air conditioning, and bleed air should be minimized during the readings. The manual continues by indicating that "Optimized feedback will be realized when the data, after having been collected, are processed and analyzed on a frequent basis. Therefore, P&WC recommended that the data be reviewed on a daily basis whenever possible. However, the data should be analyzed at least every five days when the engine is being operated." P&WC further recommended that any operator wishing to institute an "on condition HSI" program and do not have the time, technical personnel, and/or equipment to conduct trend analysis, should contract the analysis to a specialized analysis center."

The available turbine trend data sheets were provided to P&WC personnel for analysis of the raw data and the graphic depiction of the engine trend data. According to P&WC, they were unable to provide a valid conclusion regarding the data because of the following reasons:

"The original base line date appears to be corrupted, therefore the validity of the reported base lines for gas generator speed (Ng), inter-turbine temperature (ITT) and fuel flow (Wf) is questionable. Furthermore, some of the data is missing. Based on these observations, no

meaningful conclusions could be drawn from the data provided. There is no evidence that the ECTM data was analyzed as required for operators that schedule hot section inspections based on ECTM."

Review of the aircraft's maintenance records revealed that the aircraft underwent a Cessna Phase Card Inspection Program "mini-check" (also referred to as a 100-hour inspection) on July 1, 2005, at an aircraft total time of 4,372.8 hours. On June 8, 2005, at an aircraft total time of 4,270.8 hours, the airplane underwent a Phase 6 inspection (of a 12-phase program) in accordance with Cessna's Phase Card Inspection Program. At the time of the accident the airplane accumulated a total time of 4,461.4 hours. On April 19, 2005, the airplane underwent a Phase 5 inspection along with a fuel nozzle flow check in accordance with the P&WC maintenance manual.

On January 27, 2003, P&WC issued Service Information Letter (SIL) PT6A-116: Borescope Inspection in Conjunction with Fuel Nozzle Check, which covered all PT6A engine models. The SIL reported that P&WC investigated a compressor turbine (CT) blade fracture event where they became aware "that not all operators [were] performing the recommended borescope inspection at the same time as their scheduled fuel nozzle maintenance." The borescope requirement was issued to "help detect the presence of heat distress at the CT vane ring. P&WC has determined that the loss of a part of a CT vane trailing edge as a result of heat distress may not necessarily result in a significant change to the CT vane flow class or overall efficiency of the vane assembly. Overall engine performance deterioration may not be seen at regular ground power checks or during flight data collection for the ECTM plots." Therefore, P&WC recommended that operators comply with a borescope inspection during fuel nozzle checks as per their maintenance manual (section 72-00-00, table 601, Periodic Inspection). Review of the maintenance record entries for the accident engine revealed no evidence that a borescope inspection had been conducted in conjunction with a fuel nozzle check.

On November 13, 2003, N717BT was involved in a non-injury accident when the airplane taxied behind a corporate jet and encountered a jet blast. The left wing and propeller were damaged when they came into contact with the ground. Examination of the maintenance records revealed the power section was removed and disassembled. The power turbine blades were replaced along with hardware, including a new gearbox rear housing and air seal. There was no indication that the hot section (turbine section) was examined at that time.

During his three-week experience with N717BT, the pilot noticed nothing out of the ordinary with the airplane or its engine.

WRECKAGE AND IMPACT INFORMATION

Photographs taken of the aircraft at the accident site revealed that the left main landing gear was torn aft and the left wing was structurally damaged outboard of the left strut. The engine was displaced aft, down and to the left. The airplane was taken to Air Transport's facility in Phoenix, Arizona, where it was examined by the NTSB investigator-in-charge, Federal Aviation Administration airworthiness inspectors, Cessna Aircraft Company, Pratt & Whitney Canada, and CorpJet personnel. Examination of the engine revealed that all of the compressor and power turbine blades were fractured. Examination of the cockpit revealed that the emergency power lever was in the normal position and the frangible wire was intact and secure. Examination of the flap actuator revealed it was extended to an approximate 30-degree flap setting.

TESTS AND RESEARCH

On November 1-3, 2005, the NTSB investigator-in-charge, along with an investigator from Cessna Aircraft Company and an air safety engineer from Pratt & Whitney Canada, conducted a teardown examination of the engine at the P&WC manufacturing facility located in Longueuil, Quebec, Canada.

The accessory gearbox (AGB) dipstick was removed and no oil was present on the stick. Oil was drained from the line leading from the gearbox to the cooler. The AGB chip detector was removed and oil drained from the fitting. The AGB chip detector had some metallic fuzz adhering to the magnet. The reduction gearbox (RGB) chip detector was removed and a lesser amount of metallic material was found adhering to the magnet. Approximately a total of 5 quarts of oil were drained from the engine (total system capacity is 14 quarts).

The fuel control unit (with fuel pump attached) was removed from the AGB. The shaft was intact. The propeller governor was removed and its shaft was intact and could be rotated smoothly with manual manipulation. The overspeed governor was removed and it also had an intact drive shaft that rotated freely. Testing of these components revealed no anomalies that would have contributed to the loss of engine power.

The fuel nozzles were removed and examined. None displayed any notable anomalies. The #4 nozzle displayed some heavier sooting and deposits than the rest. Five of the fourteen nozzles exceeded the maximum streakiness flow tests.

Examination of the combustion chamber liner revealed no anomalies. The large exit duct displayed some distortion, discoloration, and missing metal on the 6-o'clock position (when viewed from the front looking rear toward the compressor). No anomalies were noted with the surrounding material in the area of the distorted, missing metal area of the large exit duct.

Upon separating the turbine section from the compressor, manual rotation of the compressor was attempted to no avail. Removal of the AGB resulted in successful rotation of the compressor section with no binding noted. Manual manipulation of the AGB drive shaft revealed the gears were binding. Separation of the AGB revealed all the gears were intact, in place, and did not display any discoloration or distress. The oil pump gearing was the only shaft that would not rotate. Disassembly of the oil pump housing revealed an impact gouge on the inside housing corresponding to one of the gear teeth. The impact gouge corresponded to the same location of a broken and distorted attach ear, which was a result of impact damage. None of the gears or bearings displayed heat distress or distortion.

The engine was separated at the c-flange, which exposed the compressor turbine (CT) wheel and power turbine (PT) nozzles. All of the CT blades were separated at various locations throughout their span; however, all of them were above the fir-tree attachments.

The leading edges of the CT vane assembly (located upstream of the CT to control the speed, direction, and pressure of the hot gasses as they enter the turbine) did not display any impact damage or FOD. The trailing edge of the CT vanes displayed impact damage relating to the failed CT blades. The CT vane assembly also displayed missing material from the outer, downstream side of the rim. The CT vane and CT were examined at P&WC's material laboratory, and a NTSB materials laboratory reviewed their findings.

A 2.5-inch long section of CT vane ring outer rim was fractured. The fractured section was the result of 4 different cracks. The axial crack of the section showed evidence of fatigue, initiating

on the outside diameter flange and propagating towards the imprint of a cooling hole. Four axial cracks, located at 7, 9, 10 and 11 o'clock, were also observed on the outer rim and also showed signs of fatigue crack propagation. No evidence of impact damage was observed in the vicinities of all axial cracks.

The visual examination of the CT blades did not show any evidence of creep. The fracture surfaces showed a branching pattern with the presence of coating cracks, parallel to the fracture surface, on the convex side of the airfoils. The upper section of the damaged airfoils showed a bluish discoloration typical of an elevated heat exposure.

Metallographic examination of one blade with a large remaining airfoil, blade #37, was selected for cross sectioning along the trailing edge. The microstructure through the airfoil section varied progressively from its normal condition in the platform region to complete solutioning in the region of the fracture.

ADDITIONAL INFORMATION

The wreckage was released to the operator's representative on December 4, 2006.

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	**Age:**	43, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 With Waivers/Limitations	**Last FAA Medical Exam:**	03/01/2005
Occupational Pilot:		**Last Flight Review or Equivalent:**	06/01/2005
Flight Time:	5545 hours (Total, all aircraft), 203 hours (Total, this make and model), 5305 hours (Pilot In Command, all aircraft), 184 hours (Last 90 days, all aircraft), 58 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N717BT
Model/Series:	208B	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	208B0863
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	07/01/2005, 100 Hour	**Certified Max Gross Wt.:**	8750 lbs
Time Since Last Inspection:	4372.8 Hours	**Engines:**	1 Turbo Prop
Airframe Total Time:	4461.4 Hours at time of accident	**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:	Installed	**Engine Model/Series:**	PT6A-114A
Registered Owner:	Tarene Leasing LLC	**Rated Power:**	675 hp
Operator:	Baltimore Air Transport	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)
Operator Does Business As:	CorpJet	**Operator Designator Code:**	B7LA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Thin Overcast / 25000 ft agl	**Visibility**	60 Miles
Lowest Ceiling:	Overcast / 25000 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	Calm /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	27°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Globe, AZ (P13)	**Type of Flight Plan Filed:**	IFR
Destination:	Safford, AZ (SAD)	**Type of Clearance:**	None
Departure Time:	MST	**Type of Airspace:**	

Airport Information

Airport:	San Carlos Apache Airport (P13)	**Runway Surface Type:**	
Airport Elevation:	3261 ft	**Runway Surface Condition:**	
Runway Used:	NA	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced Landing

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Minor	**Latitude, Longitude:**	33.350278, -110.638333

Administrative Information

Investigator In Charge (IIC):	Nicole L Charnon	**Report Date:**	05/29/2007
Additional Participating Persons:	Scott G Boek; Federal Aviation Administration; Scottsdale, AZ Thomas Teplick; Cessna Aircraft Company; Wichita, KS Doug Hardy; Pratt & Whitney Canada; Longueuil; QB, Joe Epperson; NTSB; Washington, DC		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		