NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
West Chicago, Illinois 60185

July 11, 2008

OPERATIONS/AIRWORTHINESS FACTUAL REPORT

A. ACCIDENT

Accident:	CHI06FA210
Operator:	Skydive Quantum Leap
Location:	Sullivan, Missouri
Date:	July 29, 2006
Time:	1345 central daylight time
Airplane:	de Havilland DHC-6-100, N203E

B. OPERATIONS/AIRWORTHINESS GROUP

Group not formed.

Ed Malinowski, Investigator-in-Charge (IIC)
National Transportation Safety Board
West Chicago, Illinois

C. SUMMARY

On July 29, 2006, about 1345 central daylight time, a de Havilland DHC-6-100,[1] N203E, registered to Adventure Aviation, LLC, and operated by Skydive Quantum Leap as a parachute operations flight, crashed into trees and terrain after takeoff from Sullivan Regional Airport (UUV), near Sullivan, Missouri. The pilot and five parachutists sustained fatal injuries, and two parachutists were seriously injured. The parachutists consisted of three solo parachutists and two tandem pairs (one parachutist-in-command and one passenger parachutist per pair). The local flight was operated under 14 *Code of Federal Regulations* (CFR) Part 91 with no flight plan filed. Visual meteorological conditions prevailed.

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[1] Although the DHC-6-100 was originally manufactured by de Havilland, the type certificate is currently held by Viking Air Limited of Sidney, British Columbia, Canada.

D. DETAILS OF THE INVESTIGATION

1. HISTORY OF THE FLIGHT

The National Transportation Safety Board (NTSB) IIC was supplied with photographic images from witnesses near the skydiving school at UUV who were taking pictures of the takeoff. These and other witnesses also provided statements that described the airplane's taxi, takeoff roll, flight, and collision with trees and the ground. One of these witnesses, who was in her backyard pool area adjacent to the accident site, stated that the airplane was low and flying straight and level toward her. She said that the airplane "nosed over." She and her father were the first on scene and placed the 911 call. She reported that local emergency medical service arrived within minutes.

Federal Aviation Administration (FAA) Inspectors were asked to interview the surviving skydivers. The survivors were not able to make statements.

2. PERSONNEL INFORMATION

FAA records revealed that pilot held an airline transport pilot certificate with a rating for multiengine land airplanes and commercial privileges for single-engine land airplanes. He held a first-class airman medical certificate, issued June 8, 2006, with no restrictions. On his application for the medical certificate, the pilot reported that he had accumulated 6,000 total civilian flight hours, with 400 hours accumulated in the previous 6 months. The pilot held an airline transport pilot certificate with an airplane multiengine land rating and commercial privileges for single-engine land airplanes. The pilot's logbook was requested from family members and was not located for NTSB review.

3. AIRPLANE INFORMATION

The accident airplane, a de Havilland DHC-6-100 "Twin Otter," serial number 53, was an all-metal, high-wing, semimonocoque construction, fixed tricycle landing gear, twin-engine airplane that was manufactured in 1967. Two Pratt & Whitney Canada PT6A-20, 550-horsepower, engines powered the airplane. The engines drove three-bladed, single acting, hydraulically operated, constant speed, reversible, and feathering Hartzell propellers. The airplane's maximum gross weight was 11,579 pounds.

3.1 Cabin Modifications

As viewed at the accident site and evident from airplane modification records, the airplane was modified from its original configuration to accommodate parachute operations; these modifications included the removal of the original cabin seating and the installation of a sliding windblock. According to an FAA Form 337 dated April 17,

2000, submitted to the Greensboro (GSO), North Carolina, FSDO,[2] the airplane was modified with a troop seating configuration that allowed the airplane to carry the pilot and up to 23 parachutists. According to the form, this modification included the installation of 22 sets of seatbelt restraints for parachutists in the cabin, which were attached to seat tracks on the cabin walls by 4,000-lb-rated cargo tiedown rings in accordance with technical standard order C22F, and one parachutist could occupy the cockpit right front seat.

According to an FAA Form 337 dated October 5, 2000, submitted to the GSO FSDO, the airplane was modified with the installation of two straddle benches, which, according to the manufacturer's engineering drawings, consist of two structural, metal benches that attach to the cabin floor.[3] However, the straddle benches described in the Form 337 were not observed in the wreckage. The FAA had no documents on file for the bench removal modification.

3.2 Propeller Autofeather System Modification

The DHC-6-100 airplane was originally certificated without a propeller autofeather system. The accident airplane was modified with a propeller autofeather system. According to the airplane's flight manual:

> PROPELLER AUTOFEATHER SYSTEM.
>
> When Mod 6/1278 is incorporated, an automatic propeller feathering system is installed which automatically feathers the propeller of an underpowered engine when a decrease in torque to 13 - 11 psi is detected. Autofeathering is controlled by the torque indicating system of each engine, either of which initiates a feathering cycle at the propeller overspeed governor of the affected engine when the decrease in torque pressure is sensed by a low pressure switch at the torque indicator transmitter. Subsequent autofeathering of the other propeller is prevented by a blocking relay which disarms the autofeather system. The system is armed for operation when the AUTO FEATH switch is at ON and left and right arming limit switches are actuated when the power levers are advanced beyond

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[2] An FAA Form 337 is used as part of the field approval process for approving a major repair or alteration of an aircraft. An applicant wishing to perform a major repair or alteration must submit to the local FAA FSDO a completed FAA Form 337 that identifies the aircraft by serial number, describes the intended modification, and includes any applicable engineering drawings and/or other data, such as a flight manual supplement, pertinent to the change. FSDO inspectors review the submitted information, and, depending on the scope and complexity of the proposed modification, the FSDO may approve the proposed modifications as presented, request more data and support from the applicant, or forward the data to the aircraft certification office for further review.

[3] The engineering drawings and photographs of exemplar straddle benches were provided to the IIC by the bench manufacturer.

86 - 88% gas generator rpm. Reduction in power of either engine below 86 - 88% rpm disarms the autofeather system. Two autofeather indicator lights illuminate to signify when the system is selected and when it is armed.

3.3 Maintenance Information

The airplane was maintained under an equalized maintenance for maximum availability (EMMA) controlled inspection program. The EMMA inspection program was designed to use work cards to inspect the airplane in five delineated areas over 48 checks to take place every 125 flight hours. Special cards were included to address items affected by calendar rather than flying hours, routine inspections, airworthiness directives, and corrosion inspections.

An endorsement in the airplane maintenance logbooks showed that an EMMA 16 inspection[4] was performed on May 21, 2006. The airplane had accumulated 37,434.4 hours total time at the time of the inspection and the Hobbs meter read 4508.4 hours. At the time of the accident, the left engine, serial number 20463, had accumulated 15,155 hours since new, 5,829 hours since overhaul, and 881 hours since a hot section inspection. The right engine, serial number 20529, had accumulated 17,264 hours since new, 6,493 hours since overhaul, 1,225 hours since a hot section inspection, and 326 hours since the last major repair. That repair included compressor rotor replacements and a skim cut of the compressor turbine disk.

Cycle information for the engines was not recorded at the last EMMA inspection, however, records for the EMMA check number 15 inspection, dated September 8, 2005, indicated that the left and right engines had accumulated 7,032 and 7,216 cycles since overhaul, respectively.

During an interview, the mechanic who performed the airplane's most recent inspection recalled that, during the inspection, he observed that the airplane's autofeather system was inoperative. He notified the operator of the discrepancy, but the operator did not want him to repair it, so he ensured the system was deactivated and placed a "DEACTIVATED" placard in the cockpit near the autofeather switch; the placard was observed at the accident site. The rudder trim system was observed at the accident site placarded "INOP" (inoperative). The mechanic recalled that the system was working when he last inspected the airplane.

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[4] According to the EMMA inspection record, the number 16 inspection work cards specify, in general, a detailed grouping of tasks designed to inspect a wide variety of listed items on the airplane, such as specific airframe and powerplant items; electrical, hydraulic, and fuel system items; and communication/navigation system items, among others. The tasks include, in general, inspecting the specified items for security, condition, freedom of movement, cleanliness, corrosion, function, and operability, and the cards specify for the removal, reinstallation, and/or replacement of items, as indicated.

The mechanic stated that he did not recall whether the operator had a minimum equipment list (MEL) for the airplane.

A review of records on file at the St. Louis, Missouri, FSDO revealed that the operator had no letter of authorization or MEL on file for the accident airplane. For an operator to develop an MEL for an aircraft and submit it for FAA approval, the MEL must be no less restrictive than the FAA's master minimum equipment list (MMEL) for that aircraft. According to the MMEL for DHC-6-series airplanes, the autofeather system is considered a "Category C" item, which means that it must be repaired within ... 10 consecutive calendar days ..., excluding the day the malfunction was recorded in the aircraft maintenance record/logbook."[5]

The engine manufacturer published service bulletins (SBs) applicable to PT6A-20 engines. According to Pratt & Whitney Canada SB 1803R1, "Turboprop Engine Operating Time Between Overhauls [(TBO)] and Hot Section Inspection Frequency," the basic industry recommended TBO for the PT6A-20 is 3,600 hours. Another SB, Pratt & Whitney Canada SB 1002R24, "Tuboprop Engine Rotor Components - Service Life," specified that the service life limits for various components of the PT6A-20 range from 2,300 cycles to 33,000 cycles, depending on the component. According to SB 1002R24, the life limit of the compressor turbine disk in the accident airplane's model engine is 18,000 cycles (the limits for that component range from 16,000 to 18,000 cycles, depending on the engine model).

3.4 Emergency Procedures Information – Loss of Engine Power

The airplane's flight manual, which was found in the wreckage, contained an emergency procedures section. The section on engine failure stated, in part:

> 3.1 ENGINE FAILURE
> 3.1.1 ENGINE FAILURE DURING TAKE-OFF.
>
> a. If engine failure occurs during the take-off run and sufficient runway remains for stopping safely, proceed as follows:
> 1. Power levers - IDLE.
> 2. Brakes - Apply.
> b. If engine failure occurs airborne, but at a speed below VMC: [6]
> 1. Power levers - IDLE.

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[5] The MMEL does not reference the rudder trim system for DHC-6-100 series airplanes.

[6] According to FAA definitions, Vmc is the minimum airspeed at which the airplane could remain controllable with its critical engine inoperative; for twin-engine airplanes, the critical engine is the engine in which a failure would have the most adverse effect on directional control. On the DHC-6-100 airplane, which has engines that both rotate in conventional, clockwise rotation as viewed from the pilot's seat, the left engine is the critical engine.

2. Land straight ahead, turn to avoid obstacles if necessary.
Note If time permits, fuel levers OFF, DC master switch OFF.
c. If engine failure occurs above VMC and a decision is made to continue the take-off, proceed as follows:
1. Maintain heading by applying rudder and lowering wing against the live engine as necessary and lower nose to hold desired airspeed.
2. Advance power levers up to the T5, torque, or Ng limit, whichever is reached first.
3. Power lever of failed engine - IDLE.
4. Propeller lever of failed engine - FEATHER.
5. Hold 71 knots IAS if flaps at 30 [degrees]; 73 knots IAS if flaps at 15 [degrees]; 83 knots IAS if flaps at 0[degrees].
6. When clear of obstacles, the flaps should be retracted in increments and the airspeed increased appropriately per the above schedule in order not to lose altitude during retraction. Best single engine rate of climb is achieved with flaps 0 [degrees] at 83 knots IAS.
7. Trim aircraft as desired.
8. Fuel lever of failed engine - OFF.
9. Booster pump switch of failed engine - OFF.
10. Generator switch of failed engine - OFF.
11. BLEED AIR switch of failed engine - OFF.
12. Post Mod 6/1044 and 6/1086 airplanes only. If both booster pump caution lights for the failed engine are not illuminated select the STBY BOOST PUMP EMER switch on and restart the engine in accordance with the procedure given in paragraph 3.1.3.
13. Fuel emergency shutoff switch of failed engine - OFF.
14. Compute continuous power setting.
15. Check generator load and reduce if necessary.
16. Balance fuel tanks if necessary to maintain C of G within limits.

4. METEOROLOGICAL INFORMATION

At 1253, the recorded weather at the Rolla National Airport, near Rolla, Missouri, about 29 nautical miles (nm) and 255° magnetic from the accident site was: wind from 290° at 9 knots; visibility 10 statute miles; sky condition few clouds at 5,000 feet; temperature 35° Celsius (C); dew point 20° C; altimeter 30.04 inches of mercury.

5. AIRPORT INFORMATION

UUV is a nontowered airport with an elevation of 933 feet above mean seal level. Its single runway, 6/24, is 4,500 feet long and 75 feet wide, and its surface is concrete. According to an airport layout drawing, the remaining distance on runway 24 from the intersecting taxiway is about 1,700 feet. A review of aerial imagery photographs for UUV revealed that the trees off the west end of runway 24 are about 1,200 feet from the end of the runway. Estimated tree heights are about 30 to 40 feet tall.

6. WRECKAGE AND IMPACT INFORMATION

The airplane impacted trees and terrain behind a residence about a half mile northwest of the end of runway 24, and it came to rest vertically, nose-down against a tree. The airplane's nose,[7] cockpit, and cabin were crushed rearward to an area immediately forward of the second window in the cabin passenger compartment. Greater crush intrusion was observed on the right side of the airplane than on the left. The empennage separated from the fuselage and remained connected to the fuselage through the control cables. The right wing was separated from the fuselage at the wing root. The right flap was extended. The left wing was separated from the fuselage at its rear spar. The left wing's forward spar remained attached. The left wing's flap was retracted. The outboard section of both wings exhibited rearward crushing. A wooden pole that supported the electrical service to the residence was found on the ground. The electrical wires from the pole were found resting on the left wing.

The left engine and propeller separated from its wing and were found resting on the ground under the left wing engine nacelle. The left propeller's blades exhibited "S" shaped bends and leading edge nicks. One of the left propeller's blade tip separated from its blade. The left propeller's spinner exhibited rotational and rearward deformation. The right engine separated from its wing. The right engine's exhaust section separated. The forward exhaust section, propeller gearbox, and propeller were found about 3 feet west of the right engine nacelle. The right propeller's spinner crushed rearward. The spinner bound the propeller blades and they were consistent with a high blade angle. The remainder of the right engine was found about 10 feet west of the right engine nacelle. The smell of fuel was present at the site.

During the on-scene investigation, the flight control cables were traced from the flight controls in the cockpit to each flight control surface. All breaks in cables were in overload. Flight control continuity was established. Engine control cables were traced from the cockpit engine controls to each engine. All breaks were in overload. Engine control continuity was established. The light bulbs from the stall warning light were removed and they exhibited stretched filaments. The autofeather system was placarded "DEACTIVATED." The rudder trim was placarded "INOP." The Hobbs meter read 4,564.0 hours on-scene. The forward fuel cell was torn. Liquid was found in the forward and aft fuel cells. The engine and propellers were retained for further examination.

7. MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot by the Franklin County Office of the Medical Examiner in St. Louis on July 31, 2006. The report stated the pilot's death was caused by "blunt cervical and chest trauma." The FAA Civil Aerospace Medical Institute

[7] According to a representative of Viking Air, the airplane's nose is not structural; it is constructed of wood and composite materials.

(CAMI) performed forensic toxicology on specimens from the pilot. The report stated that no carbon monoxide, cyanide, ethanol, or drugs were detected in the blood.

The Franklin County Medical Examiner's Office also performed autopsy examinations on three of the parachutists. According to the reports, the cause of death of one parachutist was "closed head and thoracoabdominal trauma," and the cause of death of two parachutists was "craniocerebrospinal trauma."

The St. Louis County Office of the Medical Examiner in St. Louis performed external examinations on two of the parachutists. The cause of death for both parachutists was reported as "pelvic blunt trauma."

8. ORGANIZATIONAL AND MANAGEMENT INFORMATION

According to information provided by the accident pilot's brother in a telephone interview, Skydive Quantum Leap was corporately owned and operated by the accident pilot since November 1993 and carried an estimated 10,000 to 12,000 parachutists per year, with a maximum of about 15,000 parachutists in one year. The operator had one airplane, the accident airplane, which was owned by an LLC controlled by the accident pilot. At the time of the accident, the operator had initiated arrangements that the airplane would be sold and that the operator would acquire a Beech King Air airplane to replace it. The accident pilot performed flying duties along with one or two other pilots, who were paid to fly on an as-needed basis.

The operator used an independent maintenance facility to perform maintenance and inspections on the airplane. The mechanic at the facility who had performed most of the recent routine maintenance on the airplane (including its most recent inspection on May 31, 2006) reported that he would perform only the maintenance that the operator requested and that he would notify them any time he noted additional discrepancies. The operator would decide whether or not they wanted him to repair any such discrepancies. The mechanic reported that he would perform only the maintenance that the operator would pay him to perform. According to the accident pilot's brother, the mechanic would notify the operator of maintenance discrepancies in person or over the telephone.

The FAA's St. Louis FSDO had jurisdiction over the geographic area that included Skydive Quantum Leap's operations. Following the accident, a review of FAA Program Tracking and Reporting Subsystem (PTRS) data and Safety Performance Analysis System (SPAS) data showed three SPAS records of FAA contacts with Skydive Quantum Leap regarding the operator's Certification of Waiver or Authorization Application requests for airspace associated with the parachute operations. No PTRS or SPAS data showed records of any FAA contacts with the operator for maintenance or operations surveillance. FAA Notice 8900.1 contains guidance for inspectors in Volume 6, "Surveillance;" Chapter 11, "Other Surveillance;" Section 5, "Surveillance of Sport Parachute Activities." FAA Order 1800.56H, "National Flight Standards Work Program

Guidelines" (NPG), contains no requirements for FAA inspectors to provide direct surveillance of parachute jump operators as part of their required work functions.[8]

9. TESTS AND RESEARCH

9.1 Engine Examinations

The right and left engines were examined under oversight of the IIC at a Pratt & Whitney Canada facility near Longueuil, Quebec, from November 14 to 16, 2006. Disassembly of the right engine revealed the compressor turbine disk was intact and its attached blades were fractured. Microscopic examination revealed the fracture surfaces were consistent with overload. There were no observed preimpact anomalies forward of this point in the engine's gas path. Damage aft of this point in the gas path was consistent with foreign object damage from separated turbine blade sections. Disassembly of the left engine revealed rubbing in the compressor and turbine sections. No preimpact anomalies were detected.

9.2 Propeller Examinations

The right and left propellers were examined under oversight of the IIC with the technical assistance of a Hartzell Propeller party representative at the Pratt & Whitney Canada facility near Longueuil, Quebec, from November 15 to 16, 2006. The right propeller cycled from high to low pitch when air pressure was applied to a fixture attached to the hub's mounting flange. The right propeller's beta rods were bent consistent with blades at high blade angles. Disassembly of both propellers revealed no preimpact anomalies.

9.3 Fuel Sample Testing

A liquid sample collected from the fuel tank was taken to the DuPage County Crime Laboratory, Wheaton, Illinois, for analysis. The analysis of the sample revealed that the liquid was a heavy petroleum distillate consistent with jet fuel.

10. ADDITIONAL INFORMATION

The airplane's current type certificate holder, Viking Air Limited, supplied performance data for the accident airplane's model based on the weather conditions present, airport altitude, and calculated weight. The performance data calculations showed that the airplane should be capable of a positive single-engine climb rate of about 300 feet-per-minute (fpm) if configured properly according to the published

[8] At the time of the accident, FAA Order 1800.56F, which was issued September 22, 2005, was current; it did not contain requirements for direct surveillance of parachute jump operators.

procedures with the propeller on the failed engine feathered and the published indicated airspeed attained. The certificate holder indicated that no rate of climb would be possible until the propeller was feathered.

NTSB report number NTSB-AAR-79-10 investigated an accident with a DHC-6-300 airplane. That report, in part, stated, "Expected climb performance can be degraded by ... turns into the failed engine, by failure to minimize drag by inducing a sideslip or not maintaining correct speeds, and by turns away from the headwind."

Parties to the investigation were the FAA, Honeywell, Woodward Governor Company, and Hartzell Propeller. In accordance with the provisions of Annex 13 paragraph 5.18 to the Convention on International Civil Aviation, the Transportation Safety Board of Canada (TSB) participated in the investigation as the representative of the State of Design and Manufacture (powerplants). Pratt & Whitney Canada and Viking Air Limited participated in the investigation as technical advisors to the TSB. In accordance with the provisions of Annex 13 paragraph 5.27 to the Convention on International Civil Aviation, the United Kingdom (England) and the Commonwealth of Australia were notified of the investigation as representatives of States with special interest in the accident by virtue of fatalities to its citizens.

The airplane wreckage was released to a member of the pilot's family.

Edward Malinowski, IIC
Air Safety Investigator