

**National Transportation Safety Board
Washington, DC 20594**

Brief of Accident

Adopted 09/26/2008

CHI07LA093					
File No. 24299	03/15/2007	Chicago, IL	Aircraft Reg No. N662UA	Time (Local): 21:35 CDT	
Make/Model:	Boeing / 767-300		Fatal	Serious	Minor/None
Engine Make/Model:	Pratt & Whitney / 4060		Crew 0	0	10
Aircraft Damage:	Substantial		Pass 0	0	193
Number of Engines:	2				
Operating Certificate(s):	Flag Carrier/Domestic				
Name of Carrier:	United Airlines				
Type of Flight Operation:	Scheduled; International; Passenger Only				
Reg. Flight Conducted Under:	Part 121: Air Carrier				
Last Depart. Point:	Same as Accident/Incident Location		Condition of Light:	Night	
Destination:	Sao Paulo		Weather Info Src:	Weather Observation Facility	
Airport Proximity:	Off Airport/Airstrip		Basic Weather:	Visual Conditions	
			Lowest Ceiling:	25000 Ft. AGL, Broken	
			Visibility:	10.00 SM	
			Wind Dir/Speed:	030 / 010 Kts	
			Temperature (°C):	1	
			Precip/Obscuration:		
Pilot-in-Command Age:	40		Flight Time (Hours)		
Certificate(s)/Rating(s)			Total All Aircraft:	13965	
Airline Transport; Flight Instructor; Flight Engineer; Multi-engine Land; Single-engine Land			Last 90 Days:	Unk/Nr	
Instrument Ratings			Total Make/Model:	2898	
Airplane			Total Instrument Time:	Unk/Nr	

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HISTORY OF FLIGHT

On March 15, 2007, about 2135 central daylight time, a Boeing 767-300, N662UA, operated by United Airlines Inc. as flight 843, experienced a bird strike after takeoff from runway 9R (10,144 feet by 150 feet, asphalt) at Chicago O'Hare International Airport (ORD), Chicago, Illinois. The airplane impacted a flock of canvas back ducks about 800 feet above ground level (AGL) and experienced a total loss of left engine power. Night visual meteorological conditions prevailed at the time. The Title 14 Code of Federal Regulations Part 121 scheduled-international passenger flight was operating on an instrument rules flight plan. There were no injuries reported to the flight crew or passengers. The flight was originating at the time of the accident and was en route to Sao Paulo, Brazil, when it returned and landed at ORD without further incident.

According to the captain, the landing lights illuminated the birds for "less than a second" before the airplane impacted them. There were multiple bird strikes in

the vicinity of the cockpit. The left engine then experienced a series of compressor stalls and there were 3 or 4 "bangs" before the first officer retarded the throttle. The engine stabilized around the mid throttle position for a few seconds. The first officer adjusted the throttle again and then there was one more "bang" after which the engine flamed out. The left engine was secured and they continued flying towards Lake Michigan climbing to 5,000 feet mean sea level. There were no problematic right engine indications. The flight crew then executed an approach to and performed an overweight landing on runway 32 where it landed without further incident.

AIRCRAFT INFORMATION

The engine was a P&W PW4060, serial number 727334, engine that accumulated 50,604 hours and 7,300 cycles since new at the time of the incident. The engine accumulated 9,190 hours and 1,475 cycles since it had been installed on the airplane on January 29, 2005.

WRECKAGE AND IMPACT INFORMATION

The engine did not exhibit evidence of fire, case rupture, or uncontainment. The fan rotated freely and the 6th stage turbine blades rotated concurrently with the fan blades.

The fan spinner cap was intact and contained smears that fluoresced when illuminated by an ultraviolet light. The spinner exhibited several locations where the paint was missing and the laminate was damaged. The spinner was punctured at the forward edge adjacent to the spinner cap. The spinner had two spiral shaped smears the fluoresced when illuminated by an ultraviolet light.

The fan case was intact and had a bulge in the fan blade plane of rotation. The fan rub strip was rubbed 360 degrees around between the fan case's front flange and 4 3/8 inches aft of the front flange. The rub strip was missing between: 11:45 and 12:30 o'clock, 12:45 and 1:30 o'clock, and at 2 o'clock.

All 38 fan blades were in place in the fan disk. One fan blade, part number 56A601B, serial number CBDUBS4978, identified as blade 1, was fractured approximately in line with the midspan shroud. Most of the fractured fan blade's fracture surface was at an angle to the surface of the blade except for a section of the fracture in the center of the blade that was smeared and had heat discoloration. Fan blade 1, inboard from the fracture, had a large radius bend on the leading edge that curled back opposite the direction of rotation. Fan blade 38 had a large radius bend on the leading edge in line with the midspan shroud that was curled back opposite the direction of rotation. All the other fan blades exhibited damage that ranged from small nicks and deep gouges on the leading edge to tears and missing corners on the trailing edge tips. Fan blade 36 had a hole in the center of the blade. Fan blade 38's concave side midspan shroud was broken off. Fan blades 5-19 were rubbed on the tips that included heat discoloration and material displaced opposite the direction of rotation. The tips of fan blades 5-14 had material on both sides of the airfoil that was the same color as that of the fan rub strip. There were seven locations where the fan blade midspan shroud overlapped the midspan shroud of the adjacent blade. These seven locations were between blade 9 and 10, 10 and 11, 16 and 17, 19 and 20, 20 and 21, 34 and 35, 35 and 36. Fan blades 18-20, 28-30, 35, and 36 had soft body impact damage or their leading edges cusped slightly. These blades had debris and material on their rear face and/or underside of the midspan shroud that fluoresced when illuminated with an ultraviolet light. Biological remains were collected from the leading edges, the convex airfoil surfaces, and the underside of the midspan shrouds of several fan blades and were submitted to the Smithsonian Institute for analysis.

All the fan exit vanes were in place and damaged. The metal strip on the fan exit vanes were bent in the direction of rotation at the outer end of the vane. There

was one vane at the 5 o'clock and two vanes at 10 o'clock that were delaminated. There were three consecutive fan exit vanes between 9 o'clock and 9:30 o'clock that had their outer feet fractured and were displaced in the direction of rotation.

The low pressure compressor inlet guide vanes were undamaged and contained small spots that fluoresced when illuminated with an ultraviolet light. The 1.6 stage compressor blades were undamaged. The 4th stage compressor blades were in place with all of the blade tips darkened. Several of the 4th stage compressor blades had the trailing edge tip corners bent opposite the direction of rotation.

The high pressure compressor was able to be rotated through the gear box.

Two clamps that hold the low pressure turbine case cooling tube bracket at 8:45 o'clock were broken. All of the 6th stage turbine blades were in place and did not appear to have any damage. There was no metal debris in the exhaust duct.

The hydraulic pressure supply manifold, part number 54T182-01 (also referred to as CP01), was broken in a bend approximately 1 1/2 inches from the B-nut at the forward end. The forward end of the fractured tube aft of the fracture was deflected downward. The tube, aft of the fracture, had two creases on the upper side that were at an approximately 45 degree angle to the axis of the tube and a crease at the bottom of the tube that was perpendicular to the axis of the tube. The creases on top of the tube corresponded to witness marks on an adjacent fitting and the crease on the bottom of the tube corresponded to the rail under the inner V-groove on the rear of the intermediate case. The tube fracture is in line with a bolt head on an adjacent boss that had a burnish mark. The clamp, left of the T-fitting that was connected to the CP01 manifold, was broken.

The gearbox housing was cracked between the top right side of the housing just inboard of the mount lug and the center boss on the front of the housing. The crack ran down the right side of the housing around the bottom of the fuel pump mount pad on the right front side of the housing and terminated at the manual crank mount pad.

The oil tank had an oil level that was at the top of the oil filler neck. There were no significant debris on any of the magnetic chip detectors.

The steel mesh shock mounts on both the upper and lower igniter boxes were frayed and the boxes were loose.

The inlet duct had a 19-inch long dent on the lip that was covered with dried blood at 12 o'clock. The inlet duct had a 6-inch long axial by 5-inch wide circumferential hole adjacent to the rear flange at 10 o'clock. There was a 19-inch ling spiral cut from the rear flange between 10 and 11 o'clock adjacent to the hole. There were several marks on the inside of the inlet duct that spiraled forward from the rear flange. Two of these marks initially spiraled forward from 12 o'clock to about the 6 or 7 o'clock location then spiraled rearward one of which terminated at the hole at 10 o'clock.

TESTS AND RESEARCH

Ornithology

The biological remains that were collected from the engine as well as bird remains that were found at the departure end of runway 9R immediately following the incident were submitted to the Smithsonian Institute Ornithology Department for identification. According to the Smithsonian Institute, the biological remains that were recovered during the disassembly of the engine were from male and female canvas back ducks. The bird remains that were found at the

departure end of runway 9R were also identified as canvas back ducks.

According to the Cornell University Ornithology Department website, an adult canvas back duck (*Aythya valisineria*) can be 19-22 inches tall, have a wingspan of 31-35 inches, and weigh between 1.9-3.5 pounds. The website showed that the Chicago area is a migration area for the canvas back duck between the winter non-breeding and summer breeding areas.

Flight Data Recorder

The flight data recorder (FDR) data show that both engines spooled up evenly for takeoff with all of the engine parameters increasing. About 18 seconds after takeoff and about 800 feet AGL, the left and right engine low pressure rotor speed (N1), high pressure rotor speed (N2), burner pressure (Pb), engine pressure ratio (EPR) decreased while the exhaust gas temperature increased and the engines surged. The right engine N1 and EPR decreased to about 86 percent and 1.3, respectively and returned to previous levels within 5 seconds. The left engine N1, EPR, and Pb indications decreased to about 75 percent, 1.14, and 150 psia, respectively. For the next 12 seconds, the left engine N1 varied between 74-84 percent, and the EPR and Pb varied rapidly between 1.12-1.24 and between 150-250 psi, respectively. The left engine surged concurrently with rapid changes in EPR and Pb. During the next 10 seconds, the left engine N1, EPR, and Pb slowly increase from 74 to 83 percent, 1.14 to 1.2, and 200 to 245 psia, respectively. About 22 seconds after the initial decrease in left engine parameters, all of the parameters decreased to or near zero indications even though the left engine fuel cutoff indication remained in run. Also, the left engine vibration level increased from 0.3 units to 4 units about 7 seconds after the initial parameter decrease. The left engine vibration level decreased to about 1.5 units over the next 10 seconds. Over the next 10 seconds, the left engine vibration level increased to about 3 units and then over the next 10 seconds decreased to about 0.5 units. During the parameter decrease, the right engine 2.5 bleed valve opened to about 40 percent and the left engine 2.5 bleed valve opened completely. The right engine 2.5 valve reclosed within 2 seconds, and the left engine 2.5 bleed valve closed to the 40 percent open position, opened further to about the 65 percent open position for 2 seconds, and then remained 40 percent open before it went to the full open position. Concurrently with the decrease in the engines' parameters, the left engine stator vane angle went from about 88 - 66 percent open and then varied rapidly between 66-82 percent open for the next 10 seconds before stabilizing at 75 percent open. About 24 seconds after the initial decrease in engine parameters, the left engine stator vane angle increased to the 95 percent open.

Metallurgy

The broken fan blade was fractured between 19.7-23 inches above the blade root platform. The fracture intersected the leading edge at a smoothly curving bulge.. The fracture surfaces were rough, matte gray, and at a slant angle that was consistent with overstress fracture. The fan blade material hardness was within the typical hardness range for the material.

The hydraulic pressure supply manifold was fractured at a bend in the manifold. The longer end of the manifold was dented and rubbed on the inside and outside radius, but the opposite side of the fractured manifold did not have any corresponding dents or rubmarks. The fracture surface had multiple planes consistent with high stress, high frequency loading typical of excessive vibration.

The broken clamp fracture surface had multiple planes consistent with high stress, high frequency reverse bending typical of excessive vibration.

Engine Certification

PW4000 engine certification requirements required P&W to conduct bird ingestion and fan blade separation tests.

Pratt & Whitney's July 1, 1986, report to the FAA on the fan blade separation test documented their conclusion that the test successfully met the certification requirements. The report stated that a fan blade was liberated by activating an explosive device that had been placed in a hole that had been drilled into the root of the fan blade. The report stated the blade was liberated at an N1 speed of 3,860 rpm that corresponded to the N1 speed on a hot day at 3,500 feet and Mach 0.25 to obtain the 60,000 pound thrust rating. The report stated that after the fan blade was liberated there was a 15 second hands off period (to simulate a pilot's reaction time) before the throttle was retarded after which the engine was shutdown normally. However, the graph of the N1 rpm shows that fan speed quickly decreased from the 3,860 rpm to less than 500 rpm within 5 seconds after the fan blade was liberated. The report stated the liberated fan blade was contained within the fan containment ring. The report also stated that the front surface of the gearbox housing was found cracked, although no oil leaked out through the crack. In addition, the report stated "all external fuel and oil lines remained intact during the test event and spool down." The certification hardware assembly list showed hydraulic pressure supply manifold CP01 was part number 51T696-01. According to P&W, the PW4000-94 Illustrated Parts Catalog states the current CP01 hydraulic pressure supply manifold is part number 54T182-01. P&W stated that CP01 part number 51T696-01 was replaced by part number 54T182-01 through Service Bulletin PW4ENG 72-321 that affected several tube assemblies by replacing the double angle conical seat ferrule with a single angle conical seat ferrule.

P&W also provided information that there have been 18 previous PW4000-94 engine bird ingestion events that have resulted in traverse fractures of fan blades and that none of those events resulted in a CP01 hydraulic pressure supply manifold fracture.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The contained fan blade tip separation following the ingestion of several birds into the left engine during takeoff and the lack of an adequate response time available to crew to avert the bird strike.