HARTZELL PROPELLER INC.

Aircraft Accident/Incident Report No.: 060729

Date of Accident:	July 29, 2006
Location:	Sullivan, MO
NTSB File No.:	CHI06FA210
Aircraft:	DeHavilland DHC-6-100 Twin Otter
Registration No.:	N203E
Serial No.:	53
Operator:	per FAA registry: Adventure Aviation LLC 505 Brookfield Dr. Dover, DE 19901

Written by:	Tom McCreary Air Safety Investigation Manager
Date:	January 23, 2006

Contents:

ACCIDENT SYNOPSIS

The NTSB preliminary report stated that the aircraft crashed shortly after take off. Witnesses observed flame emitting from the right engine during the take off. It crashed in a steep, nose down attitude at low speed.

Aircraft Damage: Substantial
Injuries: Eight persons on board, six fatal, two injured

SUMMARY AND ANALYSIS OF FINDINGS

Left Propeller:

The blades of the left propeller had rotational scoring and leading edge damage. They had multiple bends, twisting, and tearing in the tip area of all three blades. The tip of one blade was torn off. This is characteristic of impact at high rotational energy, i.e. power ON.

There were no meaningful blade angle indications.

Right Propeller:

Blade damage was very mild. There were two small nicks in one blade. One blade was bent aft but not twisted and the other two blades were neither bent nor twisted. Blade damage did not indicate that the propeller was rotating at the time of impact.

The beta rods were bent while the piston was at a high blade angle, estimated 47^{o} - 51^{o} There was also an impact mark on a hub arm that indicated one blade was at a similar high blade angle.

There were light impression marks in the piston from contact with feather stop screws, indicative of normal operation.

On-scene photos of the impact crater of the right propeller show a spiral motion of one blade, which possibly suggests some rotation at impact. (However, Pratt & Whitney reported that the power turbine had created static imprint marks.)

On-scene photos show a crushed spinner dome encompassing two blade counterweights protruding at a high blade angle position. The estimated blade angle in this photo (photo page 5) is approximately 65^{o} to 70^{o}.

Cockpit Controls:

On-scene photos of the cockpit controls did not provide any evidence to indicate that the pilot had attempted to feather the right propeller (photo page 7).

CONCLUSION

The left propeller was rotating with power ON at the time of impact. An accurate estimate of blade angle or power output could not be determined, but the blade damage suggested high power.

The right propeller was either feathered or at a high blade angle (higher than that for normal operation) at the time of impact. The blade damage indicated that the propeller had no rotational energy at impact.

There were no discrepancies noted that would preclude normal operation. All damage was consistent with impact damage.

ON-SCENE PHOTOS

General Comments:

Hartzell did not participate in the on-scene investigation. However, Hartzell obtained photos of the on-scene investigation taken by the NTSB and Franklin County Sheriff's department.

Left Propeller:

On-scene photos show the left propeller with the spinner dome installed. One photo shows a severed blade tip. (The spinner dome and blade tip were not observed during the investigation in Montreal).

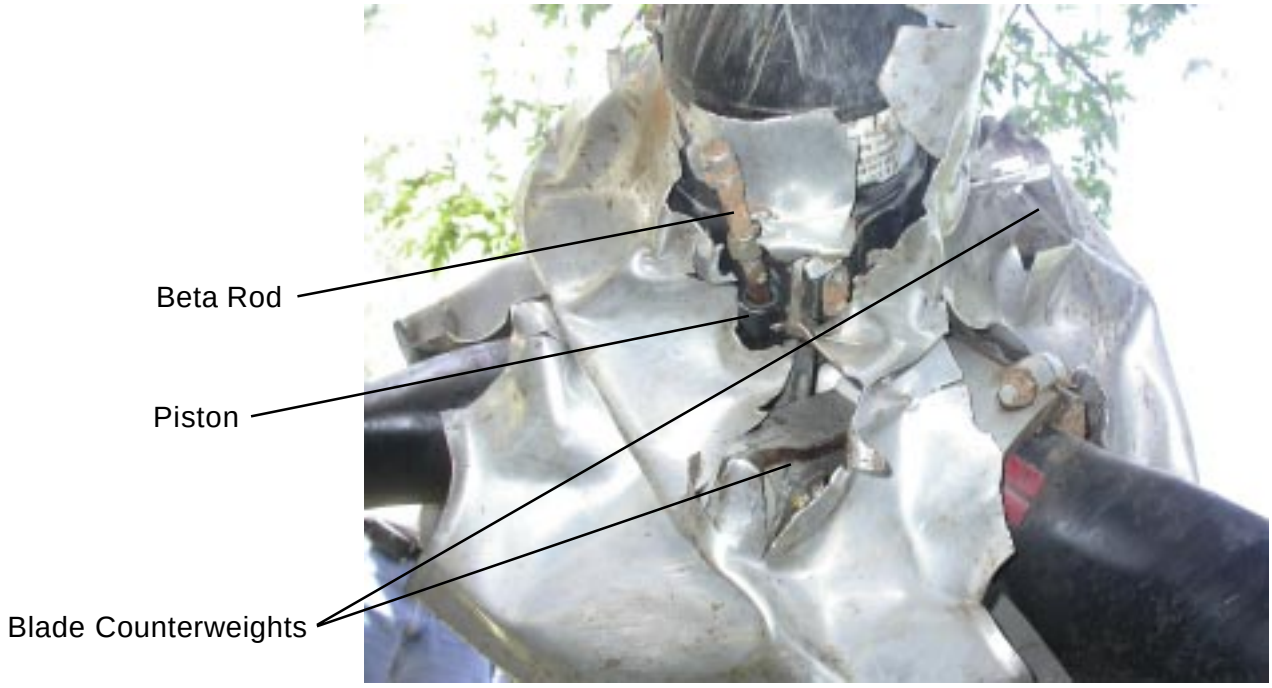
Left propeller at accident site

Left propeller blade tip

Right Propeller:

On-scene photos show the right propeller and portion of the engine located behind the right wing. In these photos the propeller is at a high blade angle, estimated to be 65º to 70º.

Right propeller at accident site (Sheriff's Dept. photo)



Right propeller with spinner crushed over blade counterweights (NTSB photo)

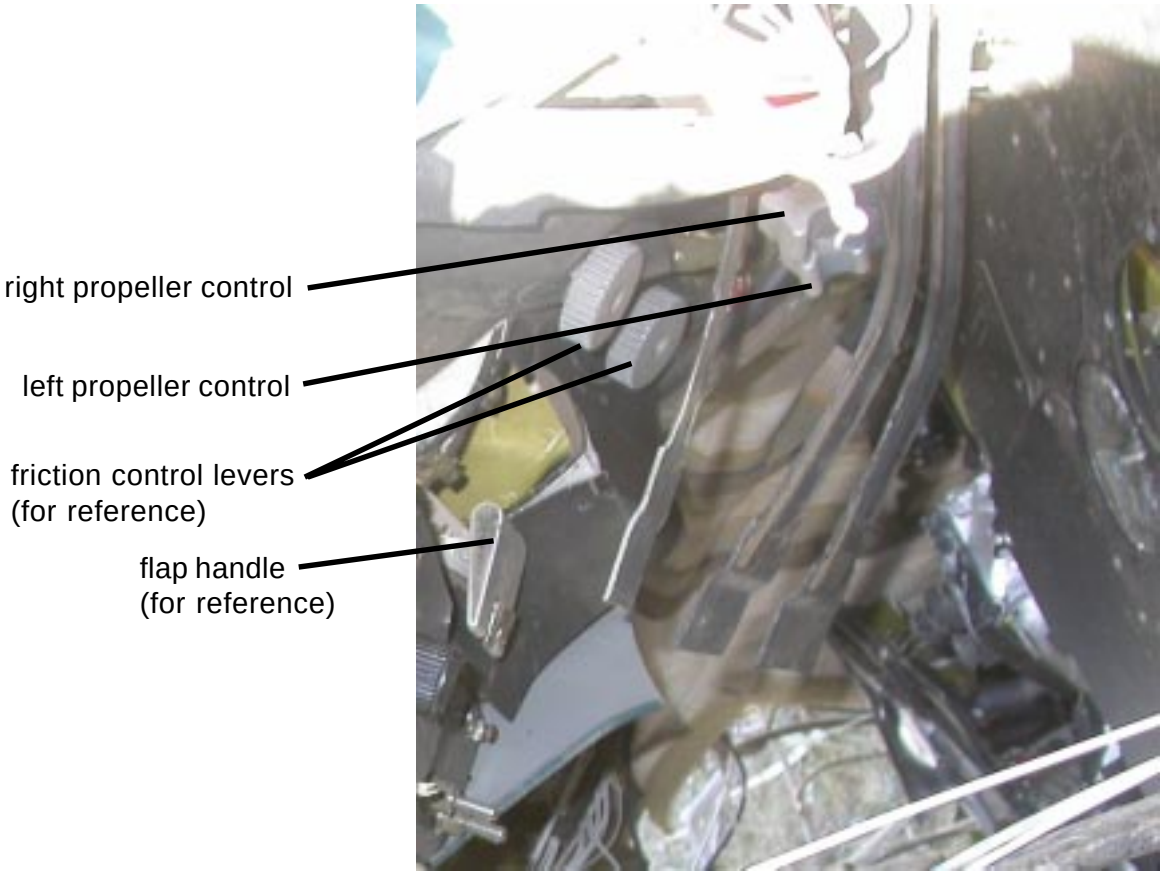
Right Propeller (continued):

The NTSB reported that during the recovery operation the propeller was attached to a hoist and relocated to the crater formed by initial impact of the right propeller as shown below. The impact crater was located in front of the right wing. In these photos the propeller is partially imbedded in the ground and there is a cable (hoist) attached to the propeller. In the photo below, the right propeller is in the feather position and the spinner dome has been removed. (Evidently the blade angle changed from a high angle to feather after the spinner dome was removed.)

Right propeller repositioned in impact crater during NTSB investigation
(NTSB photo)

Cockpit Controls:

On-scene photos show both of the propeller control levers in nearly the same position. Photos also show a placard indicating that the autofeather system was deactivated.



Overhead engine controls (NTSB photo)

Autofeather placard
(NTSB photo)

PROPELLER TEARDOWN REPORT

Date of Investigation: November 15 and 16, 2006

Location: Pratt & Whitney Canada
Longueil, Quebec

Propeller Model: HC-B3TN-3BY with T10173N+1 blades

Representatives:

Tom McCreary	Hartzell Propeller Inc.
Ed Malinowski	NTSB Chicago
Yvon Boileau	Pratt & Whitney Canada
Glen White	FAA Washington, D.C.
Lorne Barr	Viking Air
Paul Frechette	TSB Montreal, Canada

General Comments:

This type propeller is a 3-blade single-acting, hydraulically operated, constant speed model with feathering and reversing capabilities. Oil pressure from the propeller governor is used to move the blades to the low pitch (blade angle) direction. Blade mounted counterweights and feathering springs actuate the blades towards the high pitch direction in the absence of governor oil pressure. The propeller incorporates a Beta mechanism that actuates when blade angles are lower than the flight idle position. The propeller incorporates a start lock mechanism that can hold the blades at a low blade angle during engine start. The blades are of aluminum construction. The hub and blade clamps are steel. Propeller rotation is clockwise as viewed from the rear.

Installation Data: (Data reference the 30-inch station)

Reverse:	-14.0 $\pm$ 1.0 degrees
Start Lock:	1.0 $\pm$ 1.0 degrees
Flight idle:	20.0 $\pm$ 0.5 degrees
Feather:	87.0 $\pm$ 1.0 degrees
Counterweight	-1.5 to positive

Service History:

Service history and logbooks were not available. Both propellers had a decal that indicated service by Palm Beach Aircraft Propeller, Lantana, FL. Component parts were noted to be much older than the blades or hubs.

	S/N	Date of manufacture	TTSN	TSO
Left Hub	BUA 19860	3/3/97	unknown	unknown
Blades	H59531	8/8/94	unknown	unknown
	H59529	8/8/94	unknown	unknown
	H67107	8/8/94	unknown	unknown
Right Hub	BUA19821	2/14/97	unknown	unknown
Blades	H67110	8/2/94	unknown	unknown
	H67109	8/2/94	unknown	unknown
	H67111	8/2/94	unknown	unknown

Position: LEFT

Hub Serial Number: BUA19860 **Factory No.:** A9243A

Blade Model: T10173N+1

S/N L1: H59531
S/N L2: H59529
S/N L3: H67107

Blade Orientation:

The blades were identified as L1, L2, L3 clockwise as viewed from the rear of the propeller. The hub serial number was between the L1 and L2 blades. The blades were identified as L1, L2, L3 consistent with chisel marks that were made by the NTSB during the on-scene investigation.

"As Received" Condition:

The blades had been cut off to facilitate shipment. The spinner dome was missing and the propeller remained attached to the engine. The beta rod end ring was fractured and bent aft. L1 link arm was connected. L2 and L3 link arms were disconnected. L2 linkscrew had separated from its clamp. The outer end of L3 link screw was broken off. L1 and L2 blade clamps/ counterweights were at or near the feather position. L3 blade clamp/counterweight was at a low blade angle position. The aft end of the piston was measured to be 22/32 inch from the guide collar. This equates to approximately 68° blade angle.

Spinner Assembly:

The spinner dome was missing. The spinner bulkhead had slight deformation. The bulkhead had an impact mark from L3 counterweight. The mark occurred with the L3 counterweight in the extreme feather position.

Propeller Cycling:

Cycling of the pitch change mechanism was not attempted. L1 and L3 blades were seized and could not be manually turned and the pitch change mechanism was seized as indicated by the feather spring being unable to actuate the piston to the feather position.

Engine/Propeller Mounting:

Intact and unremarkable

Blade/Clamp Rotation:

L1 and L2 blades had not rotated in their blade clamps. L3 blade had turned in its clamp approximately 5^{o} toward higher pitch.

Pitch Stops:

Reverse Pitch Stop: The reverse pitch stop was intact and unremarkable.

Feather Stop: The feather stop had light impression marks.

Beta rods: All three beta rods were slightly bent. They had to be straightened in order to remove the piston.

Start Locks: All three start locks were intact and operable. There were no indications of damage.

Piston: (S/N 7223)

Intact and unremarkable

Link Arms:

L1 link arm was intact and unremarkable.
L2 and L3 link arms both had an elongated linkscrew hole (they had both disconnected from the clamp at the linkscrew).

Cylinder:

Intact and unremarkable

Feathering Spring Assembly:

Front spring retainer S/N W106818.

The spring assembly was intact and unremarkable.

Support Sleeve Broken (Y/N): No

Pitch Change Rod:

Intact and unremarkable

Clamps and Counterweights:

All three blade clamps, counterweights, and start lock stop plates were intact and unremarkable. L1 linkscrew was intact. L2 linkscrew had separated from the clamp and had damaged threads. L3 linkscrew remained attached to the clamp but it was cocked and the outer end was broken off.

Clamp serial numbers:
L1: BB1550
L2: BB1508
L3: BB1420

Hub Unit:

The hub, mounting flange, cylinder attachment, and hub pilot tubes were intact and unremarkable.

The hub arms did not have any an impression marks from blade contact that could be used to calculate a blade angle.

Blades:

See blade photos on Page 12.

L1 blade had multiple fore and aft bends. It was bent forward at 1/3 radius and bent aft at 2/3 radius. It had wavy bends at the tip. The outer 10 inches of the blade had tears, bending and gouges in the leading and trailing edges.

L2 blade was bent aft at 2/3 radius and bent forward at the tip. The outer 6 inches of the tip was torn off and was missing. It had rotational scoring in the paint.

L3 blade had multiple fore and aft bends. It was bent forward at mid-blade. It was curled aft at the tip and twisted toward low pitch. There was rotational scoring on both the flat side and cambered side.


L3
L2
L1


L1


L2


L3

Position: RIGHT

Hub Serial Number: BUA19821 **Factory No.:** A9116A

Blade Model: T10173N+1

S/N R1: H67110
S/N R2: H67109
S/N R3: H67111

Blade Orientation:

The blades were identified as R1, R2, R3 counterclockwise as viewed from the rear of the propeller. The hub serial number was between the R1 and R2 blades. The blades were identified as R1, R2, R3 consistent with punch marks that were made by the NTSB during the on-scene investigation.

"As Received" Condition:

The spinner dome had been removed. The propeller remained attached to the engine. The blades had been cut off to facilitate shipment. All three beta rods were bent; the beta rod end ring was missing. The propeller was in the feather position; the piston and all three clamps/ counterweights were in the feather position. All three start locks were intact. The piston, cylinder, and pitch change linkage was intact. The low pitch stop nuts were measured to be 2 to 2-3/32 inches from the piston with the piston in the feather position.

Spinner Assembly:

The spinner dome was missing. The bulkhead was bent slightly aft between R1 and R2 blades.

Propeller Cycling:

An air fixture was attached to the mounting flange and air pressure was applied. The propeller actuated from the feather position to a low blade angle position (flight idle or lower). The mechanism was cycled from feather to low pitch four times.

NOTE: The pitch change mechanism did not actuate completely to the maximum reverse position and the start locks did not engage. This is attributed to the line pressure being approximately 80 psi. Greater air pressure is required to fully actuate to a deep reverse position.

Engine/Propeller Mounting:

Intact and unremarkable

Blade/Clamp Rotation:

Blades R1 and R2 had not rotated in their clamps. Blade R3 had rotated in its clamp about 20° toward lower pitch.

Pitch Stops:

Reverse Pitch Stop: The reverse pitch stop shims (3) were slightly deformed.

Feather Stop: The feather stop had light impression marks.

Beta rods: All three beta rods were bent about 30°. They had to be straightened in order to remove the piston. The guide collar had shifted (rotated) slightly out of position. The bending of the beta rods appeared to have occurred with the piston positioned roughly 1 to 1-1/4 inches from the feather position, which equates to blade angles in the range of approximately 47° to 55°. *See photos below.*

Start Locks: All three start locks were intact and operable. There were no indications of damage.

Piston: (S/N 6818)

There were light internal gouges caused by contact with the feather stop screws. There was an external witness mark caused by contact with a threaded portion of R2 beta rod. This mark occurred with the piston position approximately 1/4 inch, or further, from the feather position.

Link Arms:

All three link arms were intact and unremarkable.

Cylinder: (S/N 7207)

Intact and unremarkable

Feathering Spring Assembly:

The spring retainer cup was marked with serial number 7227.

The feather spring assembly was intact and unremarkable except for deformation of the reverse stop shims.

Support Sleeve Broken (Y/N): No

Pitch Change Rod:

Intact and unremarkable

Clamps and Counterweights:

All three blade clamps, counterweights, start lock stop plates, and link screws were intact and unremarkable.

Clamp serial numbers:
R1: EJ6122
R2: EJ5925
R3: BB1904

Hub Unit:

The hub, mounting flange, cylinder attachment, and hub pilot tubes were intact and unremarkable.

R3 hub arm had an impression mark from contact with R3 blade butt. Characters from the word “depth” on the blade butt had partially transferred to the hub. The blade was at a high blade angle when the marks were aligned. The angle was higher than that for normal operation but not completely to the feather position.

Blades:

See photos on Page 17.

R1 blade had two small gouges in the leading edge approximately 3 inches from the tip. There was angular scoring in the paint on the camber side (non-rotational) near the leading edge along the full length of the blade. The blade was not bent or twisted.

R2 blade had no significant damage with no bending or twisting.

R3 blade was bent aft approximately 45^{o} and was not twisted.


R3
R2
R1


R1
R1


R2
R2


R3
R3

PHOTOGRAPHIC SUMMARY

NOTE: The following digital photographs are original and unedited and available on compact disc. The numbering sequence may not be chronological as some may have been deleted if out-of-focus, too dark, redundant, etc. Photos used in the text of this report are taken from photos on this list but may have been adjusted from the original. Modifications to images used in the report are limited to cropping, magnification, file compression, or enhancement of color, brightness, or contrast for the sole purpose to improve clarity of the report. No other alterations are permitted.

PHOTOGRAPH NUMBER	DESCRIPTION
	RIGHT PROPELLER
Right Propeller Actuation2.wmv	Windows media file of propeller actuation
Dscn0578.jpg	right propeller as received
Dscn0579.jpg	right propeller as received
Dscn0580.jpg	engine gearbox and aft side of propeller
Dscn0581.jpg	beta ring
Dscn0582.jpg	right propeller as received
Dscn0583.jpg	right propeller as received
Dscn0584.jpg	right propeller as received
Dscn0585.jpg	right propeller as received
Dscn0586.jpg	R1 start lock plate
Dscn0587.jpg	R3 start lock
Dscn0588.jpg	R3 start lock
Dscn0589.jpg	propeller
Dscn0590.jpg	propeller, front view
Dscn0591.jpg	R1 blade and clamp
Dscn0592.jpg	R3 blade and clamp
Dscn0593.jpg	R2 blade and clamp
Dscn0594.jpg	beta pick-up and piston positions
Dscn0595.jpg	beta pick-up and piston positions
Dscn0596.jpg	beta pick-up and piston positions
Dscn0597.jpg	beta pick-up and piston positions
Dscn0598.jpg	beta pick-up and piston positions
Dscn0599.jpg	beta rod
Dscn0600.jpg	R2 beta rod, spring, and start lock pin
Dscn0601.jpg	R2 beta rod, spring, and counterweight
Dscn0602.jpg	R2 beta rod spring
Dscn0603.jpg	R2 start lock
Dscn0604.jpg	mounting flange
Dscn0605.jpg	mounting flange
Dscn0606.jpg	propeller with tool installed, actuated to low pitch
Dscn0607.jpg	propeller with tool installed, actuated to low pitch
Dscn0608.jpg	propeller with tool installed, aft view
Dscn0609.jpg	propeller with tool installed, actuated to feather
Dscn0610.jpg	propeller front view, bent beta rods
Dscn0611.jpg	propeller during initial disassembly
Dscn0612.jpg	miscellaneous parts

Dscn0613.jpg	R1 blade butt
Dscn0614.jpg	R2 blade butt
Dscn0615.jpg	R3 blade butt
Dscn0616.jpg	R1 blade butt
Dscn0617.jpg	R2 blade butt
Dscn0618.jpg	R3 blade butt
Dscn0619.jpg	R3 blade butt
Dscn0620.jpg	R3 blade butt
Dscn0621.jpg	R3 hub arm
Dscn0622.jpg	R3 hub arm
Dscn0623.jpg	R3 hub arm
Dscn0624.jpg	R3 hub arm
Dscn0625.jpg	R2 hub arm
Dscn0626.jpg	R1 hub arm
Dscn0627.jpg	bearings
Dscn0628.jpg	piston and spring assembly
Dscn0629.jpg	R1 blade clamp and link arm
Dscn0630.jpg	R1 blade clamp and link arm
Dscn0631.jpg	R2 blade clamp and link arm
Dscn0632.jpg	R2 blade clamp and link arm
Dscn0633.jpg	R3 blade clamp and link arm
Dscn0634.jpg	R3 blade clamp and link arm
Dscn0635.jpg	all three blade clamps
Dscn0636.jpg	spring assembly
Dscn0637.jpg	feather stop screws
Dscn0638.jpg	piston, inside
Dscn0639.jpg	piston, inside
Dscn0640.jpg	piston, external
Dscn0641.jpg	piston serial number
Dscn0642.jpg	cylinder serial number
Dscn0643.jpg	cylinder serial number
Dscn0644.jpg	cylinder serial number
Dscn0645.jpg	cylinder serial number
Dscn0646.jpg	R3 clamp serial number
Dscn0647.jpg	R2 clamp serial number
Dscn0648.jpg	R1 clamp serial number
Dscn0649.jpg	all three blade, camber side
Dscn0650.jpg	R1 blade tip
Dscn0651.jpg	R1 mid-blade
Dscn0652.jpg	R2 blade tip
Dscn0653.jpg	R3 blade tip
Dscn0654.jpg	all three blades, camber side
Dscn0655.jpg	all three blade, flat side
Dscn0656.jpg	R1 blade tip, flat side
Dscn0657.jpg	R1 mid-blade, flat side
Dscn0658.jpg	all three blades, flat side
Dscn0659.jpg	beta rod impact mark on piston
Dscn0660.jpg	beta rod impact mark on piston
Dscn0661.jpg	beta rod impact mark on piston

Dscn0662.jpg	front spring retainer serial number
Dscn0663.jpg	position of R3 blade with impact marks aligned
Dscn0664.jpg	position of R3 blade with impact marks aligned
Dscn0665.jpg	carbon block
	LEFT PROPELLER
Dscn0666.jpg	left propeller as received
Dscn0667.jpg	left propeller as received
Dscn0668.jpg	left propeller as received
Dscn0669.jpg	beta pick-up and piston positions
Dscn0670.jpg	beta pick-up and piston positions
Dscn0671.jpg	beta pick-up and piston positions
Dscn0672.jpg	L1 blade and clamp
Dscn0673.jpg	L2 blade and clamp
Dscn0674.jpg	L3 blade and clamp
Dscn0675.jpg	propeller after removal from engine
Dscn0676.jpg	blade counterweight impact mark on spinner bulkhead
Dscn0677.jpg	miscellaneous parts
Dscn0678.jpg	bearings and clamps
Dscn0679.jpg	bearings and clamps
Dscn0680.jpg	L1 blade butt
Dscn0681.jpg	L2 blade butt
Dscn0682.jpg	L3 blade butt
Dscn0683.jpg	L1 hub arm
Dscn0684.jpg	L2 hub arm
Dscn0685.jpg	L3 hub arm
Dscn0686.jpg	piston, inside
Dscn0687.jpg	piston, inside
Dscn0688.jpg	piston, external
Dscn0689.jpg	piston, external
Dscn0690.jpg	cylinder
Dscn0691.jpg	mounting flange
Dscn0692.jpg	mounting flange
Dscn0693.jpg	piston serial number
Dscn0694.jpg	piston serial number
Dscn0695.jpg	front spring retainer serial number and feather stop screws
Dscn0696.jpg	all three blade clamps
Dscn0697.jpg	L1 blade clamp and link arm
Dscn0698.jpg	L1 blade clamp and link arm
Dscn0699.jpg	L2 blade clamp and link arm
Dscn0700.jpg	L2 blade clamp, link arm, and link screw
Dscn0701.jpg	L3 blade clamp
Dscn0702.jpg	L3 blade clamp and link screw
Dscn0703.jpg	L3 blade clamp and link screw
Dscn0704.jpg	left spring assembly, disassembled
Dscn0705.jpg	left spring assembly, disassembled
	RIGHT PROPELLER
Dscn0706.jpg	Right spring assembly, disassembled
Dscn0707.jpg	Right reverse stop sleeve and reverse stop shims
Dscn0708.jpg	Right reverse stop sleeve and reverse stop shims

LEFT PROPELLER

Dscn0709.jpg	all three blades, camber side
Dscn0710.jpg	all three blades, camber side
Dscn0711.jpg	L1 blade tip
Dscn0712.jpg	L2 blade tip
Dscn0713.jpg	L3 blade tip
Dscn0714.jpg	L1 blade tip, flat side
Dscn0715.jpg	L1 mid-blade, flat side
Dscn0716.jpg	L2 blade tip, flat side
Dscn0717.jpg	L2 blade, flat side
Dscn0718.jpg	L3 blade, flat side
Dscn0719.jpg	L3 blade, flat side
Dscn0720.jpg	all three blades, flat side
Dscn0721.jpg	all three blades, flat side
Dscn0722.jpg	all three blades, flat side

The following is a partial list of on-scene photos taken by the Sheriff's Department and the NTSB. These photos were used in preparation of this report and will be included with the Hartzell photos provided on compact disk. These photos retain their original photograph number but additional data has been added to indicate the source and subject.

LEFT PROPELLER

NTSB lt propDSCN4114.JPG
NTSB lt propDSCN4157.JPG
NTSB lt propDSCN4215.JPG
NTSB lt propDSCN4216.JPG
SD lt propDSC_0003mod.JPG
SD lt propDSCN0051.JPG

RIGHT PROPELLER

NTSB rt prop craterDSCN4268.JPG
NTSB rt propDSCN4116.JPG
NTSB rt propDSCN4137.JPG
NTSB rt propDSCN4221.JPG
NTSB rt propDSCN4221rotated.JPG
NTSB rt propDSCN4222.JPG
NTSB rt propDSCN4223.JPG
NTSB rt propDSCN4224.JPG
NTSB rt propDSCN4225.JPG
NTSB rt propDSCN4225crop.JPG
NTSB rt propDSCN4226.JPG
SD rt prop sceneDSC_0018.JPG
SD rt propDSC_0011.JPG
SD rt propDSCN0014.JPG
SD rt propDSCN0014mod.JPG
SD rt propDSCN0016.JPG
SD rt propDSCN0016mod.JPG
SD rt propDSCN0029.JPG

POWER LEVERS

NTSB autofeatherDSCN4173.JPG
NTSB engine controlsDSCN4283.JPG
NTSB power leversDSCN4251.JPG
NTSB prop levers fuel leversDSCN4253.JPG
NTSB prop levers modDSCN4257.JPG
NTSB prop leversDSCN4257.JPG

TAKE OFF PHOTOS

DSCF0164.JPG
DSCF0165.JPG
DSCN0557.JPG
DSCN0558.JPG
DSCN0559.JPG