Date of Accident: May 5, 2017

Location: Yeager Airport (KCRW), Charleston, WV

NTSB File No.: DCA17FA109

Aircraft: Shorts SD3-30

Registration No.: N334AC

Serial No.: SH-3029 (Year of Manufacture 1979)

Owner/Operator: per FAA registry:

ACC Integrated Services Inc.
4940 S. Howell Ave.
Milwaukee, WI 53207-5924

Written by: Les Doud
Air Safety Investigator – Hartzell Propeller Inc.

Report Date: September 18, 2017

Contents:

ACCIDENT SYNOPSIS

Aircraft Damage: Destroyed
Injuries: Two onboard; two fatal

The following is excerpted from the NTSB preliminary report:

"On May 5, 2017 at 6:51 a.m. eastern daylight time (EDT), Air Cargo Carriers flight 1260, a Shorts SD3-30, N334AC, crashed during landing on Runway 5 at the Charleston Yeager International Airport (CRW), Charleston, West Virginia. The airplane was destroyed and the two pilots suffered fatal injuries. The flight was operating under the provisions of 14 CFR Part 135 as a cargo flight from Louisville International Airport (SDF), Louisville, Kentucky. Instrument meteorological conditions prevailed at the time of the accident."

Photo mapping of the accident scene conducted by the NTSB indicated the aircraft initially struck near the Runway 5 centerline approximately 400 ft. from the runway threshold line, on a heading of approximately 16° (34° left of runway heading). A security camera on the airport terminal captured the aircraft striking the runway in a left bank, nose low attitude. The left propeller with a section of the engine Reduction Gearbox (RGB) separated from the engine during the initial impact sequence and traveled with the main wreckage down a tree-covered hillside (Photo #2). The right propeller remained attached to the right engine and also traveled with main wreckage, which came to rest approximately 580 ft. from the initial impact point on the north side of Runway 5 (Photos #3 and #4).

SUMMARY AND ANALYSIS OF FINDINGS

Teardown examinations were performed on the accident propellers at AMF Aviation in Springfield, TN on August 1-2, 2017. Both propellers exhibited damage indicating rotation under power.

The initial indication of left propeller rotation were blade strike marks on the runway (see Photo #1). The first six strike marks (one full revolution) exhibited a fairly consistent distance of approximately 16 inches. NTSB analysis of video and radar data indicated the aircraft speed at impact was approximately 92 Knots. That combination of strike mark distance and aircraft speed results in a calculated propeller RPM of approximately 1400.

Blades on both propellers had deep chordwise/rotational scoring on the camber side indicating rotation. Blade damage on both propellers also included tip fractures, camber side scoring, predominant aft bending and forceful rotation towards low pitch. The left propeller had a hub arm impact mark indicating a helical impact angle consistent with the estimated combination of RPM and velocity.

Both propellers had piston-to-cylinder impact marks suggesting a blade angle in the low blade angle range of operation.

Photo #1 – Left Propeller Strike Marks in Runway (photo courtesy of NTSB)

Photo #2 – Left propeller and forward RGB in-situ (photo courtesy of NTSB)

Photo #3 – Right propeller in-situ (photo courtesy of NTSB)

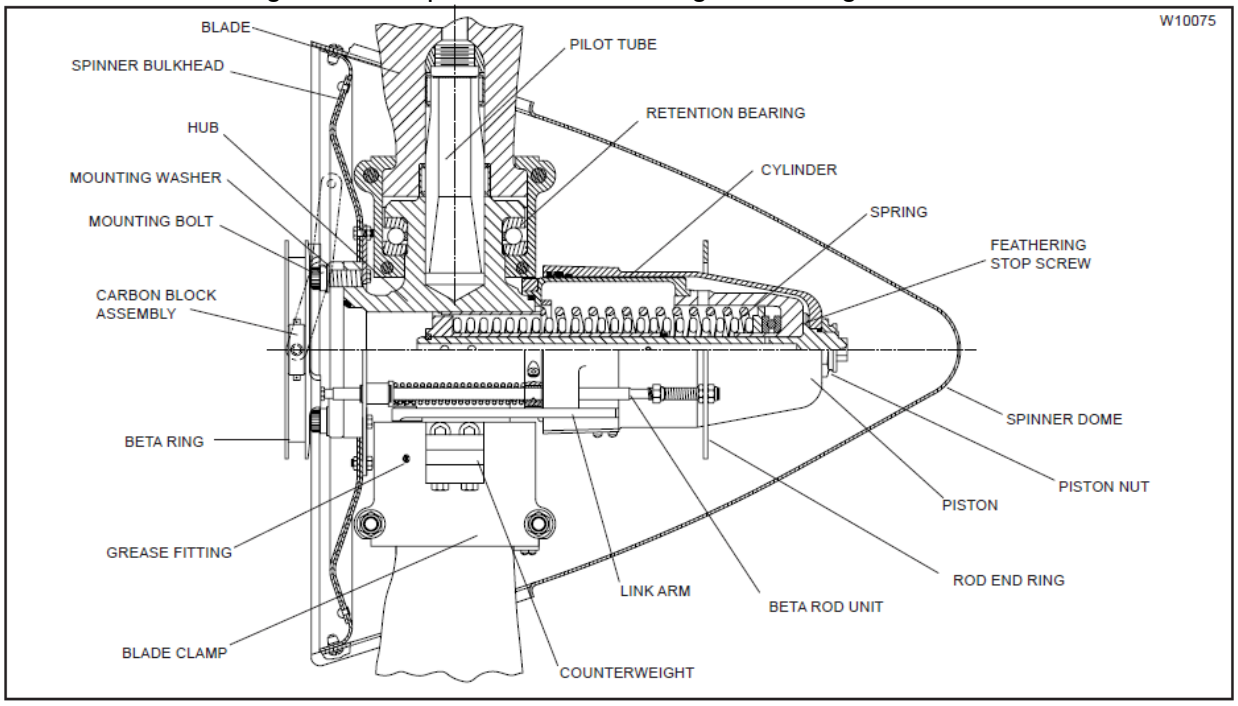
Photo #4 – Right propeller in-situ (photo courtesy of NTSB)

CONCLUSIONS

There were no discrepancies noted on either propeller that would prevent or degrade normal operation prior to impact. All damage on both propellers was consistent with high impact forces. Both propellers were rotating with power ON and in the normal blade angle range of operation; neither propeller appeared feathered or near the reverse stop at time of impact. Damage indicated the propellers impacted while rotating under power in a low-to-windmilling thrust condition.

The difference in damage between the propellers was consistent with the type of material impacted; left propeller initially impacted the concrete runway and right propeller impacted vegetation, soil and/or aircraft structure.

Figure 1 – Propeller General Arrangement Diagram



PROPELLER TEARDOWN EXAMINATION

Date of Investigation: August 1-2, 2017

Location: AMF Aviation
Springfield Robertson County Airport (M91)
4432 Airport Road
Springfield, TN 37172

Propeller Model(s): HC-B5MP-3A with M10282AB+6 blades (both left and right)

Representatives:

Les Doud	Hartzell Propeller Inc.
Clint Crookshanks	NTSB Aerospace Engineer
Adam Huray	NTSB Aerospace Engineer
Charlie Manola	FAA Charleston FSDO ASI
Steve Altnau	President, Air Cargo Carriers
Duane Stroik	Air Cargo Carriers Director of Maintenance

General Comments: The SD3-30 propeller model examined is a 111.3-inch diameter, 5-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 provide twisting moment and a feathering spring provides force to 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 to provide position feedback to the engine/propeller controls. The blades are of aluminum construction. The hub and blade clamps are steel. Propeller rotation is clockwise as viewed from the rear. Refer to Figure 1 for a propeller general arrangement diagram and component terminology.

Installation Data: Refer to Hartzell Installation Data Sheet No. 939 and Aircraft TCDS A41EU for propeller settings referenced below (Angles referenced at the 30-inch radius):

Reverse:	-1.0 $\pm$ 0.5 degrees
Low Pitch:	21.0 $\pm$ 0.1 degrees
Feather:	89.0 $\pm$ 0.5 degrees
Counterweight:	3.5 $\pm$ 1.5 degrees

Position **Right**

Propeller Model: HC-B5MP-3A with M10282AB+6 blades

Propeller Assembly S/N: EVA2602

Service History: The propeller logbook was not available at the time of the propeller examination so propeller component Total Time Since New could not be determined. According to a maintenance log inquiry after the accident, the aircraft total time was 28024.5 and the log indicated the propeller was overhauled on 10/30/2013 with an aircraft total time of 26828.4. The propeller mounting bolt torque check (AD2006-22-12) was conducted with an aircraft total time of 27929.2.

	S/N	Date of Manufacture	TTSN	TSO
Hub/Factory	B9305A	8/24/2000	Unknown	1196.1
Blade R1	F44938	3/21/1984	Unknown	1196.1
Blade R2	H13508	5/23/1989	Unknown	1196.1
Blade R3	H00879	6/22/1988	Unknown	1196.1
Blade R4	F92018	9/28/1987	Unknown	1196.1
Blade R4	F88687	6/22/1988	Unknown	1196.1

Blade Orientation: The blades were identified as R1-R2-R3-R4-R5 counterclockwise as viewed from the rear of the propeller prior to disassembly. The assembly serial number was between the R1 and R2 blades.

"As Received" Condition: The right propeller was presented for examination as shown in Photo #5. The right propeller remained attached to the engine propeller shaft. The prop shaft could not be rotated by hand. The spinner was dented but remained attached to the spinner bulkhead. The nacelle with the engine and propeller still attached was placed on sawhorses to facilitate disassembly of the propeller. The propeller is shown in Photo #6 with the spinner dome removed before disassembly. All five blades remained attached to the hub assembly. One blade had been intentionally cut approximately 15" from the blade butt during the aircraft recovery operation. Three blades were bent aft. Two blades appeared to have rotated 180° and bent aft (face side forward). One blade had approximately 4" of the tip fractured and another had fractured approximately 17" from the butt; the fractured portion was not presented for examination. The piston was in an extended, low pitch positon and four link arms had been pulled from their link screws but all five link arms remained attached to the piston. Four of the five clamps were forcefully rotated beyond the reverse position, one appeared in a low pitch position. The hub and clamp area was wet with oil and various amounts of dirt and vegetation (tree bark, pine needles, grass, etc.). Some of the de-ice boot leads had torn from their terminal blocks.

Spinner Dome: The spinner dome remained in one piece and attached to the bulkhead. The dome was dented adjacent to R5, R1, R2, and R3 blade openings. It was torn at the R3 and R4 openings. There were no discernable counterweight impressions in the dome.

Spinner Bulkhead: The spinner bulkhead remained in one piece and attached to the propeller hub but with the dome attach flange bent adjacent to blade R2. There were counterweight punctures and dents behind the R2, R3, R4 and R5 blades (Photo #8).

Propeller Cycling: Propeller cycling was not possible due to damage.

Engine/Propeller Mounting: The propeller remained attached to the propeller shaft flange and the mount appeared undamaged with all hardware present and safety wired. The de-ice brush block bracket was bent. The de-ice slip ring was fractured/torn adjacent to R2 where the spinner bulkhead was punctured by the counterweight. (see Photo #7).

Blade/Clamp Rotation:

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Clamp Rotates?
R1	Intact, clamp/counterweight in a low pitch position	No slip indicators on blade/clamp, no obvious slippage	Yes
R2	Intact, link arm detached from link screw, clamp rotated to low pitch beyond reverse stop and counterweight punctured spinner bulkhead.	No slip indicators on blade/clamp, Blade appeared to slip in clamp approximately 90° toward low pitch.	Yes
R3	Intact, link arm detached from link screw, clamp rotated to low pitch beyond reverse stop and counterweight dented spinner bulkhead.	No slip indicators on blade/clamp, blade appeared to slip in clamp approximately 90° toward high pitch.	Yes
R4	Intact, link arm detached from link screw, clamp rotated to low pitch beyond reverse stop and counterweight dented spinner bulkhead.	No slip indicators on blade/clamp, blade appeared to slip in clamp approximately 90° toward high pitch.	Yes
R5	Intact, link arm detached from link screw, clamp rotated to low pitch beyond reverse stop and counterweight dented spinner bulkhead.	No slip indicators on blade/clamp, Blade appeared to slip in clamp approximately 90° toward low pitch.	Yes

Pitch Stops:

Reverse Pitch Stop: The reverse stop sleeve was not removed; it appeared undamaged when viewed through the spring coils.

Feather Stop: The crown of the feather stop screws were flattened where they contacted the piston but otherwise appeared undamaged (not smashed, bent, etc.) with an installed height of approximately 0.31".

Low Pitch/Beta: The beta rods appeared intact and undamaged, attached to both the beta ring and the forward beta rod guide ring. The beta ring appeared to be in the full-forward position. The beta arm guide pin attached to the engine gearbox appeared displaced, suggesting the beta arm was properly

positioned. The beta valve was fractured from the propeller governor and hanging loose in the propeller mounting area.

Piston: The piston was intact with all link arms attached. The piston was in an extended/low pitch position against the low pitch adjust nuts. There were impact marks in each link arm slot where the link arm contacted the piston when the clamps rotated over-center. There were cylinder-to-piston contact marks on the internal surface of the piston from approximately 1.84" from the bottom edge down to the phenolic guide bumper (see Photo #9). The 1.84" distance equates to an approximate blade angle of 13°.

Link Arms: (Photo #10) All five link arms displayed a contact mark from the piston indicating the clamps were forcefully rotated toward low pitch, beyond the reverse stop.

Link Arm	Link Arm Condition
R1	Not remarkable
R2	Bent in compression, link screw hole stretched
R3	Not remarkable
R4	Link screw hole stretched
R5	Link screw hole stretched

Cylinder: The cylinder remained attached to the propeller hub. There was residual oil in the cylinder with aluminum thread whiskers from the forward spring cup (Photo #11). The cylinder was dented/creased approximately 1.75" from the top/forward corner (see Photo #12).

Feathering Spring Assembly: The feathering spring was loaded on the pitch change rod with the spring keepers in place. The spring appeared intact and undamaged and no attempt was made to remove/release the spring. The forward aluminum spring cup had been forcefully pulled from the steel cylinder and the cup threads were stripped (Photo #13); there were aluminum thread whiskers in the piston and cylinder cavities.

Pitch Change Rod: The pitch change rod appeared intact and undamaged. No attempt was made to remove the pitch change rod from the spring pack assembly.

Clamps and Counterweights: See Photo #14

Clamp Pos.	Clamp S/N	Clamp Condition	Counterweight Condition
R1	E4127	Intact	Intact
R2	E3966	Intact, link screw bent opposite low pitch	Arm and slug scored/gouged on inboard face
R3	D6522	Intact	Arm and slug scored/gouged on inboard face
R4	E3971	Intact	Intact
R5	D6510	Intact	Slug dented/gouged on inboard face

Hub Unit: The hub spider was intact and appeared undamaged with no visibly detected cracks or fractures (Photo #8). One pilot tube (R5) was fractured, all others were intact and the blades separated from the pilot tubes without significant binding. The mounting flange appeared intact with all mounting hardware in place and safety wired. The cylinder attachment was intact. There were only two blade-to-hub contact marks; a letter transfer on the R5 blade arm flange and a small impact crescent on the trailing edge/camber quadrant of the R2 blade arm.

Blade Properties: (Photos #15 through #22)

Blade # R1 – 3-4" of the tip was fractured from the blade in the aft/leading edge down direction. The fractured piece was not recovered/presented for examination.

Camber side	Chordwise/rotational scoring last 10" of blade
Face side	Random scratches
Bend	Aft
Twist	Leading edge down
Lead edge damage	Nicks last 10" of blade
Trail edge damage	Localized bending last 10" of blade
Blade bearings	Intact
Butt/shank impact marks	Hub arm pilot tube shoulder impressions, one "smile" impact line in trailing edge quadrant
De-Ice boot	Torn on camber side

Blade # R2 – Intentionally cut ~15" from butt

Camber side	Chordwise/rotational scoring
Face side	Spanwise scoring
Bend	Fwd (face toward camber)
Twist	Leading edge down
Lead edge damage	Gouging last 10"
Trail edge damage	Tear through 40% of chord 8-10" from tip
Blade bearings	Intact
Butt/shank impact marks	Hub arm pilot tube shoulder impressions
De-Ice boot	Tear in leading edge and face side

Blade # R3

Camber side	Chordwise/rotational scoring near tip/spanwise mid-blade
Face side	Chordwise/rotational scoring near tip
Bend	Aft
Twist	Leading edge down
Lead edge damage	Nicks, ½" gouge 16" from tip
Trail edge damage	Not remarkable
Blade bearings	Intact
Butt/shank impact marks	Hub arm pilot tube shoulder impressions
De-Ice boot	Intact

Blade # R4

Camber side	Chordwise/rotational scoring near tip
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down
Lead edge damage	Gouging last 4”
Trail edge damage	Not remarkable
Blade bearings	Intact
Butt/shank impact marks	Hub arm pilot tube shoulder impressions
De-Ice boot	Intact

Blade # R5 – Fractured ~17” from butt, piece not recovered/presented for examination

Camber side	Paint chipping
Face side	Chordwise/rotational scratching/scoring
Bend	Forward (face toward camber)
Twist	Indeterminable
Lead edge damage	Not remarkable on recovered portion
Trail edge damage	Not remarkable on recovered portion
Blade bearings	Intact
Butt/shank impact marks	Impact crescents camber/trail and face side of blade. Hub arm pilot tube shoulder impressions.
De-Ice boot	Torn

Photo #5 – Right propeller as-received

Photo #6 – Right propeller as received with spinner dome removed

Photo #7 – Right propeller mounting flange area

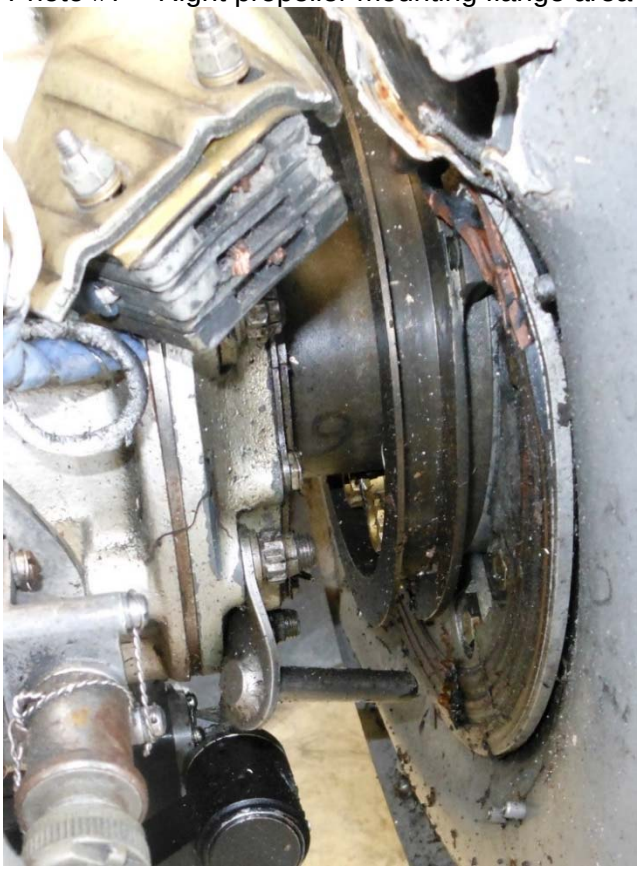


Photo #8 – Right spinner bulkhead puncture

Photo #9 – Right piston, cylinder impact marks

Photo #10 – Right propeller link arms

Photo #11 – Right propeller cylinder internal with thread whiskers

Photo #12 – Right propeller cylinder crease/dent

Photo #13 – Right propeller forward spring cup stripped threads

Photo #14 – Right propeller clamps

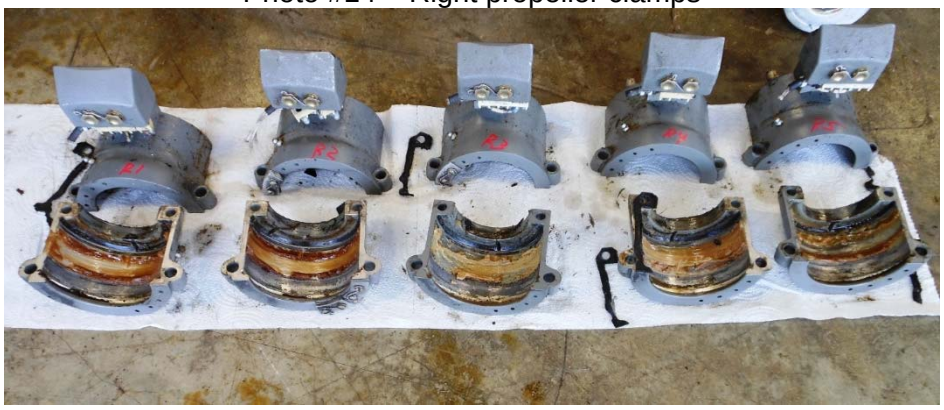


Photo #15 – Right blades (R1 to R5 left to right)

Photo #16 – Right blades leading edge view (R5 to R1 left to right)

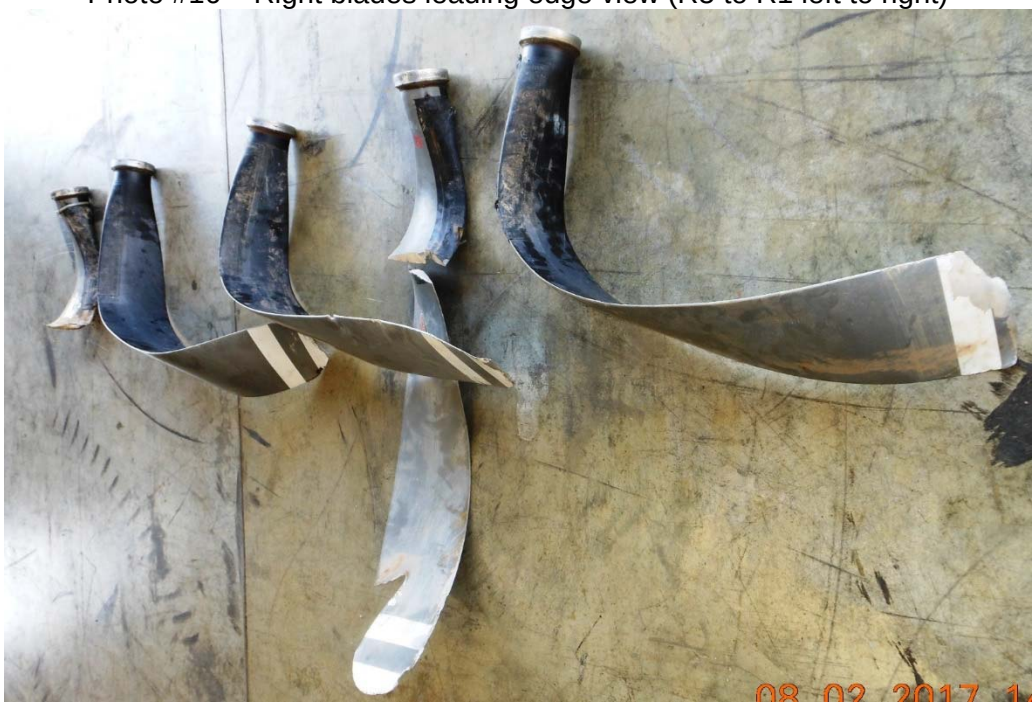


Photo #17 – Right blades trailing edge view (R1 to R5 left to right)

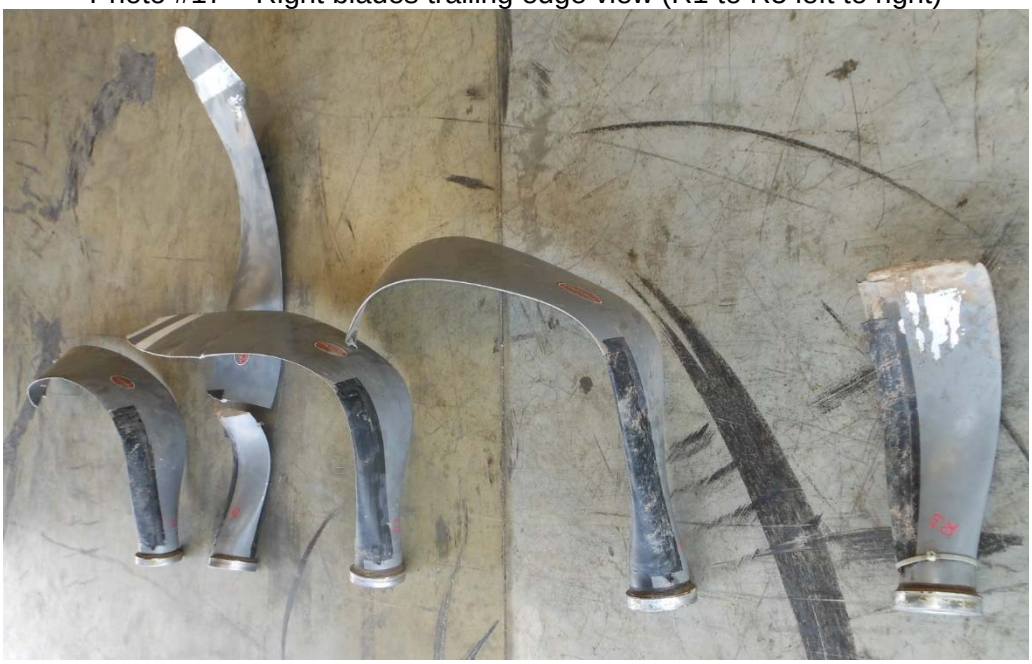


Photo #18 – R1 blade tip fracture and chordwise scoring

Photo #19 – R2 blade tip damage (chordwise scoring, leading edge gouges)

Photo #20 – R3 blade tip damage

Photo #21 – R4 blade tip damage

Photo #22 – R5 blade facture

Position **Left**

Propeller Model: HC-B5MP-3A with M10282AB+6 blades

Propeller Assembly S/N: EVA2610

Service History: The propeller logbook was not available at the time of the propeller examination so propeller component Total Time Since New could not be determined. According to a maintenance log inquiry after the accident, the aircraft total time was 28024.5 and the log indicated the propeller was overhauled on 12/21/2015 with an aircraft total time of 27500.0. The propeller mounting bolt torque check (AD2006-22-12) was conducted with an aircraft total time of 27942.9.

	S/N	Date of Manufacture	TTSN	TSO
Hub/Factory	B9304A	8/24/2000	Unknown	524.5
Blade L1	H22126	10/15/1991	Unknown	524.5
Blade L2	H36818	10/15/1991	Unknown	524.5
Blade L3	H38227	10/15/1991	Unknown	524.5
Blade L4	H24352	10/15/1991	Unknown	524.5
Blade L5	H22129	10/15/1991	Unknown	524.5

Blade Orientation: The blades were identified as L1-L2-L3-L4-L5 counterclockwise as viewed from the rear of the propeller before disassembly. The assembly serial number was between the L1 and L2 blades.

"As Received" Condition: The propeller remained attached to the forward portion of the RGB and propeller shaft and was presented for examination in the condition shown in Photo #23. No attempt was made to remove the propeller from the engine propeller shaft flange. The propeller was positioned on the RGB as shown in Photo #24 for disassembly. The spinner was dented but remained attached to the spinner bulkhead. All five blades remained attached to the hub assembly; one blade was bent forward, the others bent aft. Two blades had a measureable amount of the tips fractured. The piston appeared to be forcibly rotated/twisted clockwise (in direction of rotation) on the cylinder, bending the piston guide rods opposite rotation. The piston was in an extended position, against the low pitch/flight idle stop nuts. Two link arms (L1 and L2) had fractured at the piston attach point and were sitting loosely in the hub area. Four of five blade clamp assemblies had rotated toward low pitch beyond the reverse stop position. Some of the de-ice boot leads had torn from their terminal blocks.

Spinner Dome: The spinner dome remained attached to the spinner bulkhead but was dented and scored. The dome was dented adjacent to L1 and L4. The blade opening around blade L1 was torn. There were counterweight/slug impressions in the dome from the L1, L2 and L5 counterweights corresponding to blade angles between the range of approximately 9-23° (Photo #25).

Spinner Bulkhead: The spinner bulkhead was intact with the dome attach flange area adjacent to L1 and L2 bent. There were counterweight contact marks on the bulkhead indicating blade/clamps L2, L3 and L4 were forcibly rotated beyond the reverse stop.

Propeller Cycling: Propeller cycling was not possible due to damage.

Engine/Propeller Mounting: The propeller mounting appeared intact and undamaged. The mounting bolts appeared properly installed and safety wired. The beta arm was installed below the guide pin and the carbon block was intact. (see Photo #26).

Blade/Clamp Rotation:

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Clamp Rotates?
L1	Intact, link arm fractured from piston and detached from link screw, clamp rotated to low pitch beyond reverse stop (cwt angle approximately -10°)	The blade appears slipped in the clamp ~75° towards low pitch	Yes
L2	Intact, link arm fractured from piston and detached from link screw, clamp rotated to low pitch beyond reverse stop (cwt angle approximately -45°)	The blade appears slipped in the clamp ~75° towards low pitch	Yes
L3	Intact, link arm detached from link screw, clamp rotated to mid-range pitch (cwt angle approximately +45°)	The blade appears slipped in the clamp ~30° towards high pitch	Yes
L4	Intact, link arm partially detached from link screw, clamp rotated to low pitch beyond reverse stop (cwt angle approximately -90°)	The blade appears slipped in the clamp ~90° towards high pitch	Yes
L5	Intact, clamp rotated to low pitch beyond reverse stop (cwt angle approximately -90°)	The blade appears slipped in the clamp ~180° towards high pitch	Yes

Pitch Stops:

Reverse Pitch Stop: The reverse stop sleeve was not removed; it appeared undamaged when viewed through the spring coils.

Feather Stop: The crown of the feather stop screws were flattened where they contacted the piston but otherwise appeared undamaged (Photo #27); the installed height was approximately 0.41".

Low Pitch/Beta: The beta rods appeared intact but bent in direction of piston rotation. The rods were attached to both the beta ring and the forward beta rod guide ring. The beta ring appeared to be in the full-forward position. The beta arm was properly positioned and appeared intact and undamaged.

Piston: The piston remained on the cylinder and attached to the pitch change rod with two link arm/pin attach points (L1 and L2) fractured (Photo #28). Only one of the two fractured pieces was recovered. There were impact marks in each link arm slot were the link arm contacted the piston when the clamps rotated over-center. Two discernable cylinder-to-piston contact marks were measured at approximately 1.6 and 1.9 inches from the aft edge (see Photo #29). These distances equate to an approximate blade angle position of 4.5° and 15° respectively.

Link Arms: All five link arms had a contact mark from the piston indicating the clamps were forcefully rotated over-center, toward low pitch, beyond the reverse stop (Photo #31).

Link Arm	Link Arm Condition
L1	Bent in compression
L2	Bent in compression
L3	Bent in compression, link screw hole stretched, link screw contact damage
L4	Bent in compression, link screw contact damage
L5	Bent in compression, link screw hole stretched

Cylinder: The cylinder remained attached to the propeller hub, appeared intact and undamaged. It exhibited normal wear marks from the piston movement with a band of what appeared to be accelerated rubbing 1" from the top of the cylinder surface. This area would place the piston at a blade angle equivalent of approximately 21°. An unapproved RTV sealant was used on the cylinder-to-hub mounting interface (Photo #30) but there is no indication it affected normal operation. The guide collar around the base of the cylinder was in place but was dented/gouged from contact with the link screws.

Feathering Spring Assembly: The feathering spring was intact and loaded on the pitch change rod. It appeared undamaged and no attempt was made to remove it. The forward spring cup remained attached to the cylinder with safety wire intact.

Pitch Change Rod: The pitch change rod appeared intact and undamaged. A slot was cut into the top of the rod to facilitate removal of the piston nut. No attempt was made to remove the pitch change rod from the spring pack assembly.

Clamps and Counterweights: (see Photo #34) On clamps L3, L4 and L5 there appeared to be an unapproved, metallic shim material between the clamp halves near the outboard, trailing edge clamp bolts; it is unknown why this was used (Photos #32 and #33). However, the shim did not appear to affect the ability of the clamp to hold the blade.

Clamp Position	Clamp S/N	Clamp Condition	Counterweight Condition
L1	D7996	Intact	Intact, arm and slug scored/gouged on inboard face
L2	D8034	Intact	Intact, arm and slug scored/gouged on inboard face
L3	D8055	Intact but end of link screw damaged.	Intact, arm and slug scored/gouged on inboard face
L4	D8137	Intact, link screw bent opposite low pitch with marred cotter key holes	Intact, arm and slug scored/gouged on inboard face
L5	D7359	Intact	Intact

Hub Unit: The hub-prop shaft mounting was intact and appeared undamaged. Four of the five pilot tubes fractured (Photo #35). There were discernable impact marks on the L1 blade arm in face side/trail edge quadrant representative of helical angles of approximately 3.5° and 45° (Photo #36). There also appeared to be a letter stamping transfer on the L2 blade arm.

Blade Properties: (Photos #37 through #41) All of the blades exhibited a "striped scoring pattern" at varying angles across the blade that appeared to be consistent with the runway drainage groove width and spacing.

Blade # L1 – The tip was fractured approximately 29" from the butt of the blade; the fractured portion was not presented for examination.

Camber side	Chordwise/rotational and runway groove scoring
Face side	Random scoring
Bend	Aft
Twist	Not remarkable
Lead edge damage	Nicks
Trail edge damage	Not remarkable
Blade bearings	Intact
Butt/shank impact marks	Impact crescents, shoulder impression, pilot tube fractured and jammed in balance bore
De-Ice boot	Torn on camber side

Blade # L2

Camber side	Chordwise/rotational and runway groove scoring
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down/curled
Lead edge damage	Nicks and gouges
Trail edge damage	Not remarkable
Blade bearings	Intact
Butt/shank impact marks	Hub arm outer corner and shoulder impression entire circumference, pilot tube fractured and jammed in balance bore
De-Ice boot	Torn camber side near shank

Blade # L3

Camber side	Chordwise/rotational and runway groove scoring
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down/curled
Lead edge damage	Nicks and gouges
Trail edge damage	Nicks
Blade bearings	Intact
Butt/shank impact marks	Impact crescents, shoulder impression, pilot tube fractured and jammed in balance bore
De-Ice boot	Boot torn at outboard end

Blade # L4

Camber side	Chordwise/rotational and runway groove scoring
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down/curled
Lead edge damage	Nicks and gouges
Trail edge damage	Gouging and scoring
Blade bearings	Intact
Butt/shank impact marks	Impact crescents, shoulder impression, pilot tube fractured and jammed in balance bore
De-Ice boot	Torn

Blade # L5 – Tip fractured 37” from butt at similar angle to face side/runway groove scoring

Camber side	Chordwise/rotational scoring near tip
Face side	Runway groove scoring
Bend	Forward/thrust direction
Twist	Leading edge up
Lead edge damage	Nicks and scored
Trail edge damage	Gouged
Blade bearings	Intact
Butt/shank impact marks	Pilot tube shoulder impression, pilot tube intact
De-Ice boot	Torn face side

Photo #23 – Left propeller as-presented

Photo #24 – Left propeller before disassembly (photo courtesy of NTSB)

Photo #25 – Left propeller spinner dome

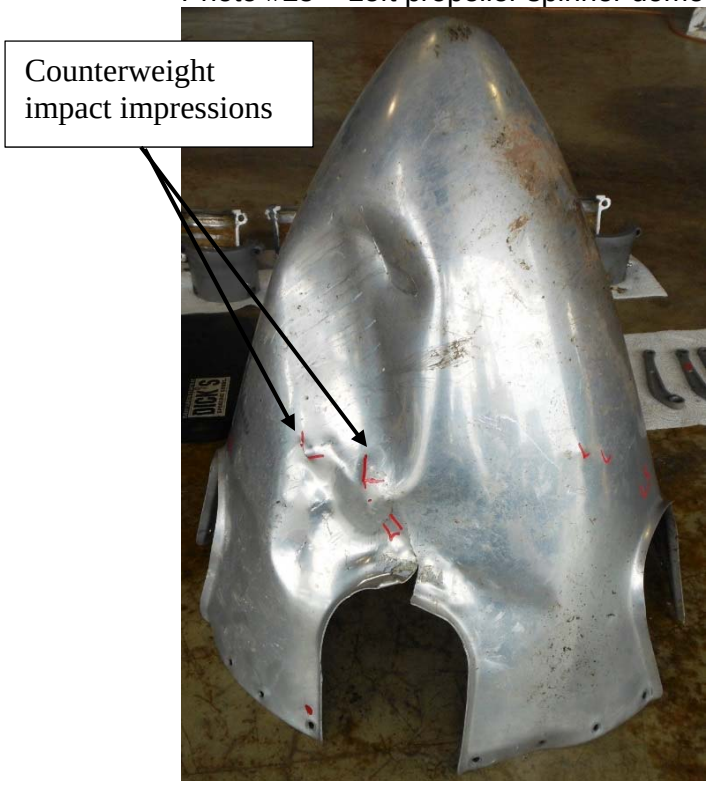


Photo #26 – Left propeller mounting flange area

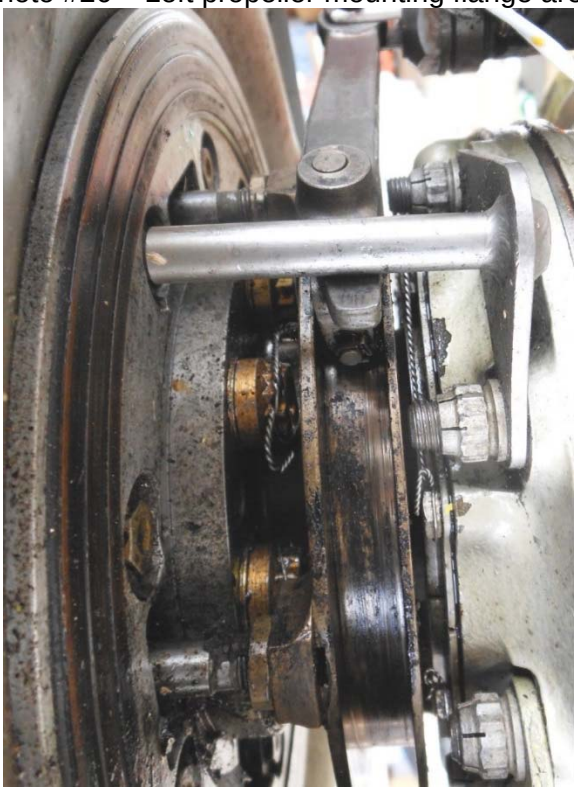


Photo #27 – Feather stop screws

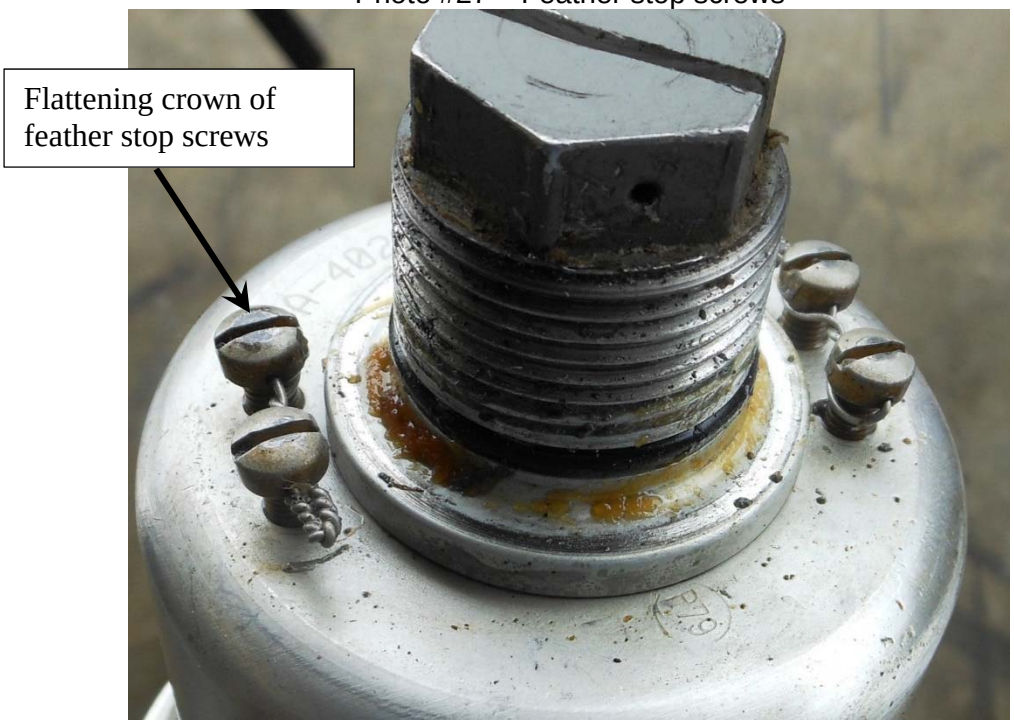


Photo #28 – Left propeller piston link arm fracture at L1

Photo #29 – Left propeller piston impact marks

Photo #30 – Left propeller white RTV squeeze-out at cylinder/hub threaded connection

Photo #31 – Left propeller link arms

Photo #32 - Left propeller shim material in clamps

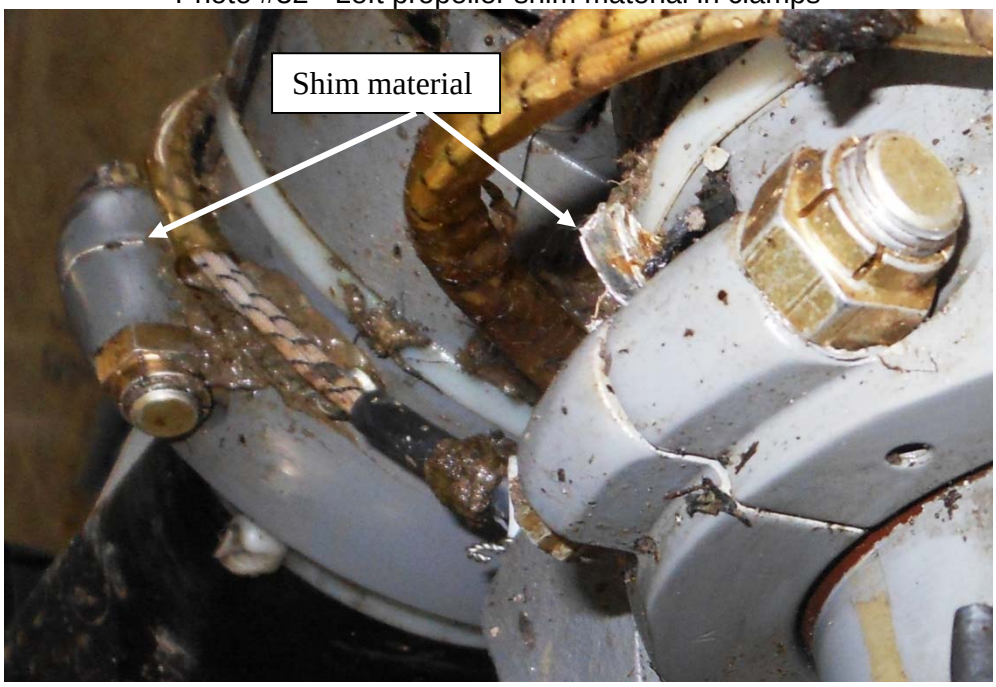


Photo #33 - Shim material when removed

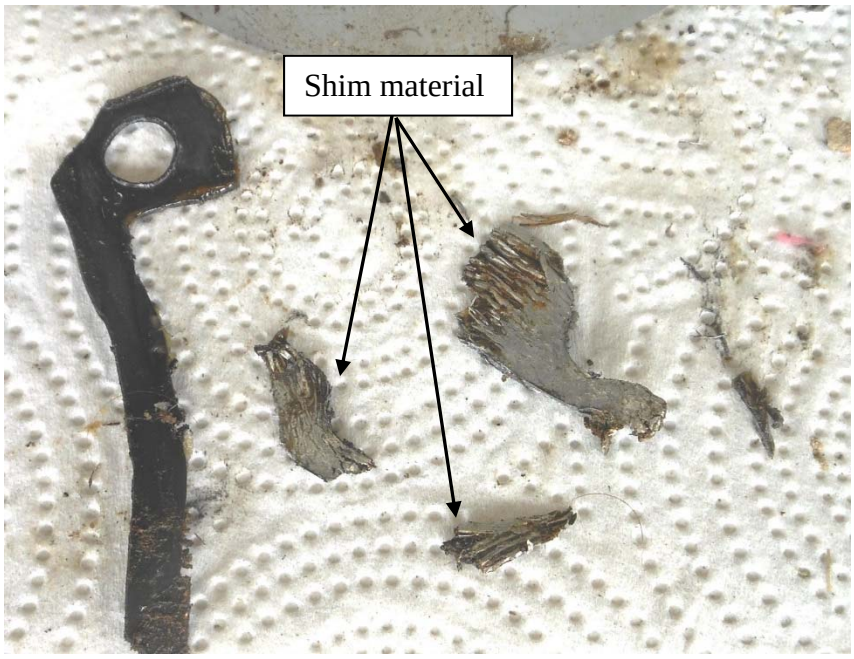


Photo #34 – Left propeller clamps (L1 to L5 left to right)

Photo #35 – Left propeller hub assembly with one pilot tube intact

Photo #36 – L1 blade arm impact marks

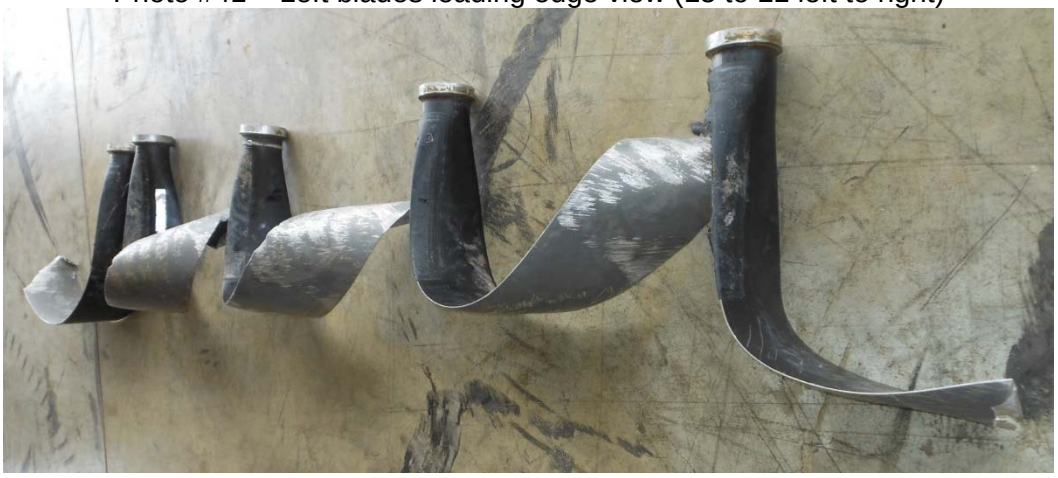
Photo #37 – Left blades view from shank/butt (L1 to L5 left to right)

Photo #38 – Left blades view of tip areas (L5 to L1 left to right)

Photo #39 – Left blades leading edge view (L1 to L5 left to right)

Photo #40 – Left blades leading edge view (L1 to L5 left to right)

Photo #41 – Left blades leading edge view (L5 to L1 left to right)



LIST OF PHOTOGRAPHS

NOTE: The following is a list of the original and unedited digital photographs. The photographs are available in digital format. 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 (unless otherwise noted in caption) 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.

Picture File Name	Description
DSCN5784.JPG	Left Engine RGB prop shaft connection deformation
DSCN5785.JPG	Left propeller as-presented
DSCN5786.JPG	Left propeller with spinner dome removed before disassembly
DSCN5787.JPG	L2 blade slippage marks
DSCN5788.JPG	L1 blade slippage marks
DSCN5789.JPG	L3 blade slippage marks
DSCN5790.JPG	L4 blade slippage marks
DSCN5791.JPG	L5 blade slippage marks
DSCN5792.JPG	Clamp shim material at L4 A
DSCN5793.JPG	Clamp shim material at L4 B
DSCN5794.JPG	Clamp shim material at L4 C
DSCN5795.JPG	Left cylinder/forward spring cup connection
DSCN5796.JPG	Left piston impact marks A
DSCN5797.JPG	Left piston impact marks B
DSCN5798.JPG	Piston link arm fracture at L2 A
DSCN5799.JPG	Piston link arm fracture at L2 B
DSCN5800.JPG	Piston link arm fracture at L1
DSCN5801.JPG	Left piston bent guide rods
DSCN5802.JPG	Left piston link arm attach point fractures
DSCN5803.JPG	Left piston link arm impact mark A
DSCN5804.JPG	Left piston link arm impact mark B
DSCN5805.JPG	Left link arms A
DSCN5806.JPG	Left link arms B
DSCN5807.JPG	L3 link arm damage A
DSCN5808.JPG	L3 link arm damage B
DSCN5809.JPG	Left link arms backside
DSCN5810.JPG	Left clamps
DSCN5811.JPG	L1 and L2 clamps
DSCN5812.JPG	L3 and L4 clamps
DSCN5813.JPG	L4 and L5 clamps
DSCN5814.JPG	Left clamps and counterweights, top view
DSCN5815.JPG	Left spinner dome, top view
DSCN5816.JPG	Left spinner dome, rotational scoring
DSCN5817.JPG	Left spinner dome, dents and tears

DSCN5818.JPG	Left feather stop screws (dark)
DSCN5819.JPG	Left feather stop screws
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DSCN5828.JPG	L5 blade butt
DSCN5829.JPG	Left blades butt/shank view
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DSCN5841.JPG	L1 fracture surface
DSCN5842.JPG	Left blades leading edge view A
DSCN5843.JPG	Left blades view from butt/shank
DSCN5844.JPG	Left blades leading edge view B
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DSCN5924.JPG	R3, R4 and R5 clamps
DSCN5925.JPG	R1 and R2 clamps/backside of counterweight
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IMG_0196.JPG	L5 counterweight impact #1 angle
IMG_0197.JPG	L5 counterweight impact #2 angle