

Aircraft Accident/Incident Report No.: 211210-2

Date of Accident: December 10, 2021

Location: Bedford, NH (near KMHT)

NTSB File No.: ERA22FA086

Aircraft: Swearingen SA226-AT

Registration No.: N54GP

Serial No.: AT034 (Year of Manufacture 1975)

Operator: per FAA registry:
Castle Aviation Inc.
5430 Lauby Rd.
North Canton, OH 44720-1581

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

Report Date: April 13, 2022

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ACCIDENT SYNOPSIS

The following is excerpted from the NTSB preliminary report.

“On December 10, 2021, about 2330 eastern standard time, a Swearingen SA-226AT, N54GP, was destroyed when it was involved in an accident near Bedford, New Hampshire. The commercial pilot was fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 135 on demand cargo flight.

According to preliminary information from the Federal Aviation Administration, the airplane was on the instrument landing system approach to runway 6 at Manchester Boston Regional Airport (MHT), Manchester, New Hampshire. During the approach, the pilot reported an engine failure at 2330:42 but did not specify which engine. Radio and radar contact were lost at 2330:51, when the airplane was about 1/4 mile from the runway.

The wreckage was located on a river sand jetty, oriented north, and a post crash fire consumed the cockpit, cabin, and both wings. No debris path was observed. A crater about 6 ft. long, 3 ft. wide, and 2 ft. deep was observed at the beginning of the sand jetty. The left aileron was recovered in the water near the crater. The empennage was located just beyond the crater. The empennage remained intact, with the elevator and rudder attached and undamaged except for the right elevator tip. The right wingtip was located near the empennage and an outboard left-wing section was located 60 ft. left of the main wreckage. Three landing gear were located near the main wreckage and the radome was located at the end of the sand jetty, in water. Elevator control continuity was confirmed from the elevator to the cockpit area. Rudder control continuity was confirmed from the rudder to the cabin area. No aileron cables were identified.

The left engine was located in the main wreckage. The left propeller had separated and was partially embedded in mud to the left of the left engine. All three blades remained attached to the hub and did not exhibit rotational damage. The right engine was located forward and left of the main wreckage. The right propeller remained attached to the right engine and all three propeller blade roots remained attached to the hub and were charred. The right propeller blades appeared to be at or near the feathered position.”

Aircraft Damage: Destroyed
Injuries: One fatal (pilot)

SUMMARY AND ANALYSIS OF FINDINGS

The accident propellers were examined at Anglin Aircraft Recovery Services on January 4, 2022 to evaluate damage and attempt to estimate state of operation and power/thrust at time of impact.

Propeller blade damage on both propellers indicated neither propeller was under high power at the time of impact. Low power impact signatures included blades bent aft with little or no remarkable twisting, no remarkable face-side chordwise/rotational scoring, no deep, blade-to-hub impact marks, no remarkable

slippage in the blade clamps, no damage or distortion of the blade clamps or bolts, and relatively light link arm damage. The blades on each propeller showing the highest degree of blade butt damage were R1 and L3 as shown in Photo #1, and was relatively light damage compared to previous experience on steel-hub propellers at high power. All three blades of the left propeller appeared to be full-length with no evidence of tip fractures. A fractured tip was found at the crash scene, adjacent to a tree limb with slice marks (Photo #2). It is presumed to be from a right propeller blade, but due to fire damage it could not be determined from which blade it originated. Tip fractures are typically a signature of RPM with some amount of power.

The feather stop screws on both propellers appeared undamaged suggesting neither propeller was feathered at time of impact. Additionally, piston and cylinder impact marks suggested both propellers were in the mid-range of normal operation. Signatures on the right propeller pitch change components suggested a blade angle in the range of 34-50° for the right propeller and 16-48.5° for the left propeller.

The degree of blade damage (bending and twisting) was similar on blades R3 and L3 as shown in Photo #3.

CONCLUSIONS

There were no discrepancies noted that would prevent or degrade normal operation prior to impact with terrain. All damage was consistent with high impact forces. Impact signatures suggested blade angles on both propellers were in the mid-range of normal operation and not feathered. Blade damage suggested the propellers were rotating with little-to-no power.

Photo #1 – Similar blade butt damage on L3 and R1

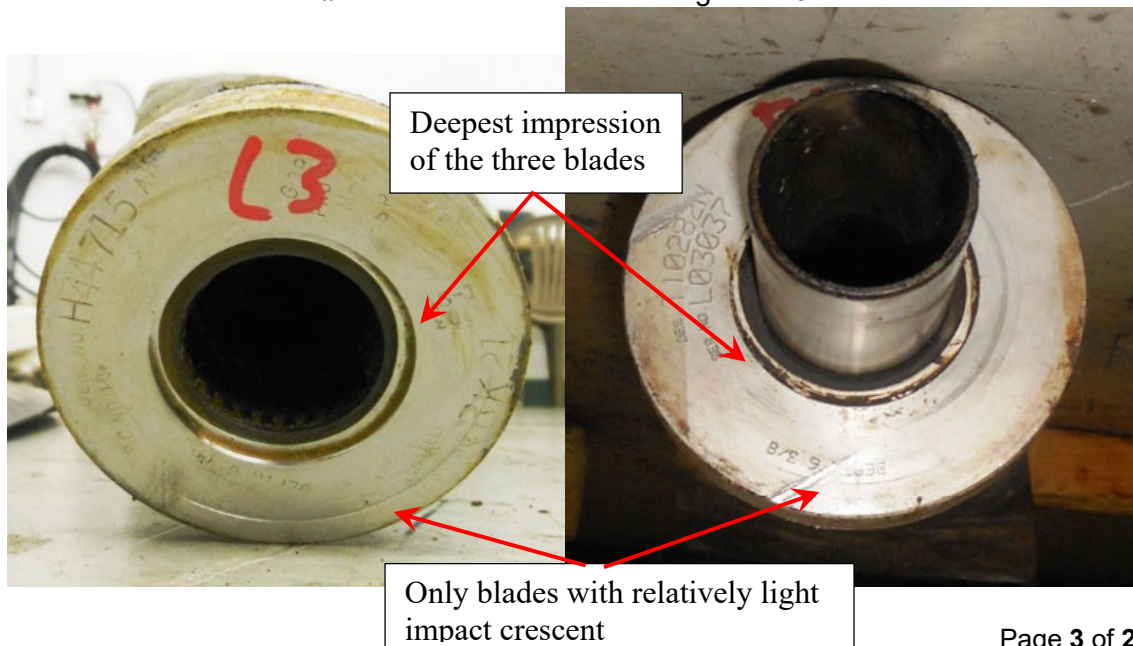


Photo #2 – Fractured tip at crash scene (photo courtesy of Honeywell)



Photo #3 - Blade L3 (bottom) comparison to Blade R3 (top)



PROPELLER TEARDOWN EXAM REPORT

Date of Investigation: January 4, 2022 and January 11, 2022 (virtual exam)

Location: Anglin Aircraft Recovery Services
4901 Holletts Corner Rd.
Clayton, DE 19938

Propeller Model: HC-B3TN-5E with T10282NB blades

Representatives: Les Doud Hartzell Propeller Inc.
Bob Gretz NTSB Investigator in Charge
Dana Metz Honeywell ASI

General Comments: The propellers examined are 102-inch diameter, 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 provide a twisting moment and feathering springs provide forces that actuate the blades towards the high pitch direction in the absence of governor oil pressure. The propeller incorporates a start lock mechanism that holds the blades at a low blade angle during engine start. The propeller accommodates a beta tube that provides blade angle information to the engine-mounted propeller controls when blade angles are lower than the flight idle position. The blades are of aluminum construction. The hub and blade clamps are steel. Propeller rotation is clockwise as viewed from the rear.

Installation Data: Refer to Hartzell Installation Data Sheet No. 507 and Aircraft TCDS A5SW for propeller settings referenced below:

(Angles referenced at the 30-inch radius)

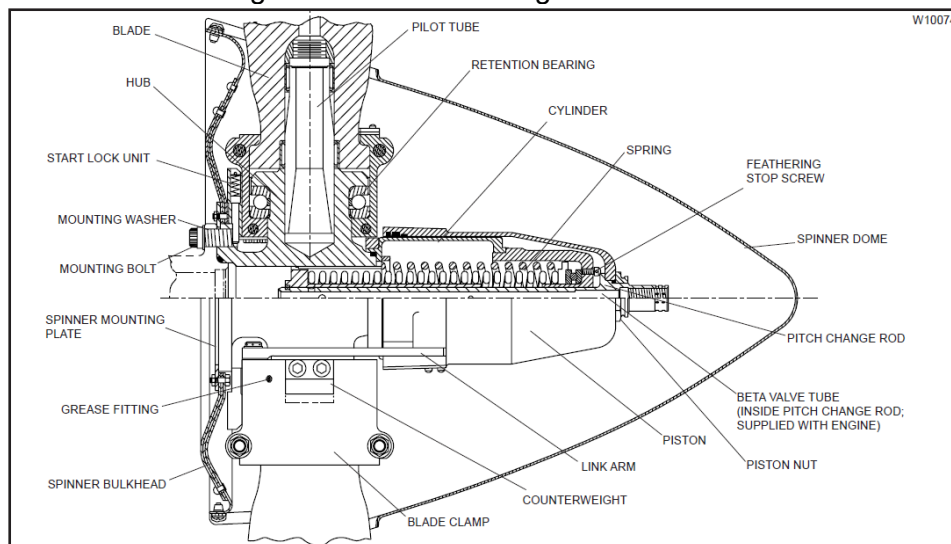
Reverse: -6.0 ± 0.5 degrees

Low Pitch/Flight Idle: Set per aircraft manufacturer instructions

Start Lock: 2.0 ± 0.1

Feather: 89.0 ± 0.5 degrees

Counterweight: 4.5 Min degrees



Position Right

Propeller Model: HC-B3TN-5E with T10282NB blades

Propeller Assembly S/N: BVA6615

Service History: The last propeller service was a periodic inspection conducted on 11/30/2021 at a TSN of 10633.9 hours and TSO of 603.1 hours. The individual component service times at the time of the accident are unknown.

	<u>S/N</u>	<u>Date of Manufacture</u>	<u>TTSN</u>	<u>TSO</u>
Hub/Factory	B2306A	6/5/1998	UNK	UNK
Blade R1	L03037	7/28/2010	UNK	UNK
Blade R2	L03042	7/28/2010	UNK	UNK
Blade R3	L03040	7/28/2010	UNK	UNK

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.

“As Received” Condition: The propeller as-presented was securely attached to the propeller shaft flange (Photo #4) with all mounting hardware present, secure and lock-wired. The hydraulic unit (cylinder, piston and feathering spring assembly) had separated during the impact sequence and was recovered at the crash scene. The propeller exhibited remarkable heat damage, charring and sooting. All three blades remained attached to the hub/clamps and the counterweights were intact. All three blades were partially consumed by a post-crash fire and were in a feathered position. The mostly-intact blade was in a low pitch position and could be partially rotated by hand force. The spinner dome was 90+% consumed by a post-crash fire, only a fragment remained attached to the bulkhead. The de-ice slip ring potting compound was consumed and the rings separated from the platter and were loose around the propeller shaft.

Spinner Dome: The spinner dome was 90+% consumed by a post-crash fire and there were no discernable counterweight impact marks on the remaining fragment.

Spinner Bulkhead: The spinner bulkhead was bent and partially consumed by a post-crash fire and exhibited remarkable heat damage.

Propeller Cycling: Propeller cycling was not possible due to the separation of the hydraulic unit.

Engine/Propeller Mounting: The propeller was securely mounted to the propeller shaft flange with all mounting bolts present and lock-wired. The mounting flanges appeared undamaged.

Blade/Clamp Rotation:

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Rotation of clamp possible?
R1	High/feathered position	Undeterminable	No
R2	High/feathered position	Undeterminable	No
R3	Low pitch position	Undeterminable	Yes

Hydraulic Unit: Disassembly of the feathering spring required special tooling so the hydraulic unit inspection was conducted on January 11, 2022 at Hartzell Propeller via a virtual exam with the NTSB Investigator in Charge. Unloading and removal of the feathering spring allowed observation of pitch change rod signatures, spring and low pitch stop sleeve. Components observed at this inspection are shown in Photo #7.

Pitch Stops:

Low Pitch Stop: The low pitch stop sleeve was intact, thermally damaged but was easily removed from the pitch change rod.

Start Lock: All three start lock brackets were intact on the spinner bulkhead and appeared undamaged except for heat exposure. Two start lock plungers (R2 and R3) were in the retracted state and one (R1) was extended. See Photo #5. The start lock plate for R1 was missing and not recovered. The start lock plates for R2 and R3 were intact with screws present and lock-wired.

Feather Stop Screws: The feather stop screws were intact and appeared undamaged (Photo #6). Undamaged feather stop screws suggest the piston was not in the feathered position at impact.

Beta Tube: The beta tube was fractured at the aft engine of the pitch change rod.

Piston: The piston was thermally damaged and removed from the cylinder/spring assembly without difficulty. One side of the piston had partially melted and appeared to have a thermal crack (Photo #8). Another side of the piston had a hole/puncture (Photo #9). Material deformation on the internal surface of the piston suggested this hole was made with the piston in a forward (low pitch) position and then either retracted or was forced aft (high pitch), see Photo #10. There were no discernable marks on the internal surface of the piston that would provide blade angle information.

Link Arms: All three link arms were bent in compression, there was no remarkable twisting. The link screw holes on two arms was elongated (Photo #11). Note: In Photo #11, the link arms were mistakenly labeled RA, RB and RC which is equivalent to R1, R2 and R3 respectively.

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Cylinder: The cylinder was intact with the forward spring cup, pitch change rod, feathering spring assembly and rear spring retainer attached. The cylinder had some localized dents and exhibited charring and sooting. There was a discoloration discontinuity on the cylinder wall measured approximately 2.9" from the forward/top corner (Photo #12). This distance represents a blade angle of 36.7°.

Feathering Spring Assembly: The feathering springs were intact and loaded with the spring keepers in-place. It was removed without difficulty using a spring compressor. The springs exhibited heat exposure and surface corrosion (Photo #7). The spring support sleeve was torn at the aft edge where it engages the aft spring retainer.

Pitch Change Rod: The pitch change rod was intact and did not appear to be bent and slid smoothly out of the forward spring cup. Segments of the rod exhibited heat exposure while another segment appeared to be protected/covered by the low pitch stop sleeve (Photo #13). The forward section of the rod appeared to have some molten aluminum splatter on the surface and measured approximately 0.73" in length. This section represents the resting position of the rod after impact and during the post-crash fire. The section aft of that measured approximately 2.77" in length and exhibited heat exposure discoloration. The section protected by the low pitch stop sleeve started approximately 3.5" from the forward rod flange. The distance from the forward end of the low pitch stop sleeve to the aft end of the forward spring cup sleeve would be approximately 1.6" (3.5" charred region - 0.2" feather stop screw height - 1.7" forward spring cup sleeve length = 1.6"). This pitch change rod displacement from feather represents a blade angle of approximately 34°, and from the reverse stop a blade angle of approximately 50°.

Clamps and Counterweights: The clamps and counterweights were thermally damaged with surface charring, sooting and corrosion. There were no discernable cracks and no discernable deformation in the clamps with all clamp bolts present on all three clamps. See Photo #14.

Clamp Pos.	Clamp S/N	Clamp Condition	Counterweight Condition
R1	EF5729	Link screw missing, hole deformation opposite low pitch. Start lock plate missing and not recovered.	Intact
R2	EF6460	Link screw intact with localized dent on end in cotter pin hole zone indicating over-rotation toward low pitch and contact with hub arm. Start lock plate intact with screws present and lock-wired.	Intact
R3	EF6436	Link screw intact with localized dent on end in cotter pin hole zone indicating over-rotation toward low pitch and contact with hub arm. Start lock plate intact with screws present and lock-wired.	Intact

Hub Unit: The hub exhibited heat discoloration, charring and sooting. The hub mounting flange appeared undamaged. There was some damage and thread whiskers in the cylinder mounting threads. There were no discernable blade-to-hub contact

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witness marks on any of the three blade arm flanges. The R1 pilot tube pulled-out with the blade shank during removal.

Blade Properties: All three blades exhibited thermal damage and were partially consumed in varying degrees. See Photos #15 through #17.

Blade # R1 – The blade was thermally consumed outboard of approximately 20-22” from the blade butt.

Camber side	Thermal damage
Face side	Thermal damage
Bend	Slight forward bend but could be caused by thermal distortion
Twist	Indeterminable
Lead edge damage	Indeterminable
Trail edge damage	Indeterminable
Blade bearings	Intact, ball spacer partially melted and grease partially coked.
Butt/shank impact marks	Small impact crescent in the face side quadrat. Pilot tube shoulder impression centered on the face side. The pilot tube pulled out with the blade shank.
De-Ice boot	Consumed

Blade # R2 – The blade was thermally consumed outboard of approximately 14-16” from the butt

Camber side	Thermal damage
Face side	Thermal damage
Bend	Not discernable
Twist	Not discernable
Lead edge damage	Not discernable
Trail edge damage	Not discernable
Blade bearings	Intact, ball spacer partially melted and grease partially coked.
Butt/shank impact marks	Pilot tube shoulder impression centered on the face/trailing edge quadrant.
De-Ice boot	Consumed

Blade # R3 – The outboard 12” exhibited thermal damage/melting around the tip edges

Camber side	Thermal damage
Face side	Thermal damage
Bend	Aft and opposite rotation
Twist	Not remarkable
Lead edge damage	Not remarkable
Trail edge damage	Not remarkable
Blade bearings	Intact, ball spacer partially melted and grease partially coked.
Butt/shank impact marks	Pilot tube shoulder impression centered on the face side quadrant.
De-Ice boot	Mostly consumed by fire, a small area of charred rubber and wires remained in the boot mid-span area.

Photo #4- Right propeller as-presented



Photo #5 - R2 start lock bracket and plunger shown retracted

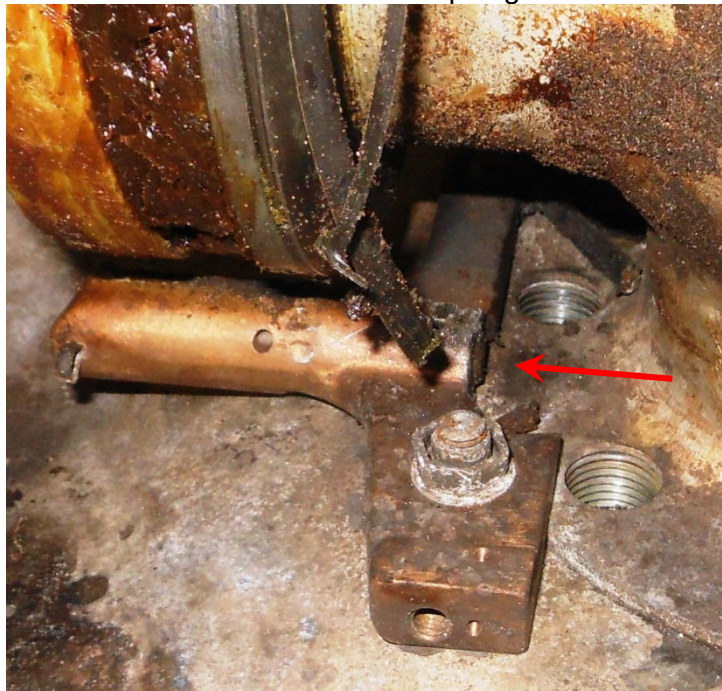


Photo #6 - Right propeller feathering stop screws

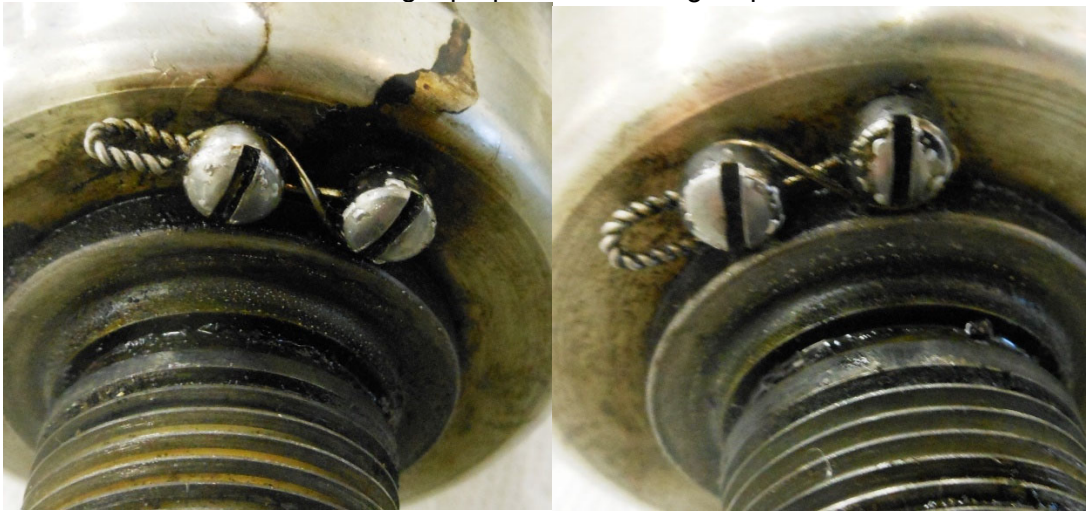


Photo #7 - Right hydraulic unit disassembled



Photo #8 - Right propeller piston thermal damage



Photo #9 - Right propeller piston hole/puncture



Photo #10 - Right propeller piston internal surface



Photo #11 - Right link arms



Photo #12 - Right cylinder discoloration discontinuity



Photo #13 - Right pitch change rod



Photo #14 - Right propeller clamps



Photo #15 - Right propeller blades, camber side



Photo #16 - Right propeller blades, face side



Photo #17 - Right blade butt montage



Position **Left**

Propeller Model: HC-B3TN-5E with T10282NB blades

Propeller Assembly S/N: BVA7836

Service History: The last propeller service was a periodic inspection conducted on 11/30/2021 at a TSN of 10633.9 hours and TSO of 745.4 hours. The individual component service times at the time of the accident are unknown. The blades on this propeller were originally manufactured as Design No. T10282+4 and cut-down to the T10282 length at some time in their service history.

	<u>S/N</u>	<u>Date of Manufacture</u>	<u>TTSN</u>	<u>TSO</u>
Hub/Factory	C2153A	12/17/2001	UNK	UNK
Blade L1	H44708	2/21/1992	UNK	UNK
Blade L2	H84628	12/16/1995	UNK	UNK
Blade L3	H44715	2/21/1992	UNK	UNK

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

“As Received” Condition: The left propeller fractured from the propeller shaft flange during the impact sequence and was presented for examination as shown in Photo #18. A small segment of the propeller shaft flange remained attached to the propeller mounting flange with one of the eight mounting bolts. Six bolts remained with the engine flange (Photo #19). The engine beta rod remained intact and attached to the propeller but was bent. The aft feathering spring retainer was missing one of the two keepers. Two blades were bent aft and one had some apparent twisting toward low pitch. The propeller blades appeared to be at low pitch or on the start locks (Photo #28). All three blades exhibited heat exposure damage; charring and sooting but there was no remarkable evidence of material melting or being consumed. The spinner dome was crushed, torn and partially formed around the hydraulic unit with a counterweight puncture near the low pitch position. After the spinner dome was removed it was noted the cylinder/hydraulic unit separated from the hub. All three link arms remained attached at both the piston and clamp link screws.

Spinner Dome: The spinner dome was crushed and torn. One counterweight punctured through the dome and the angle was measured with the Theodolite App at 21° which equates to a blade angle of approximately 10.5° (Photo #20).

Spinner Bulkhead: The spinner bulkhead was bent aft, predominately between blades L1 and L2.

Propeller Cycling: Propeller cycling was not attempted due to the separation of the hydraulic unit.

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Engine/Propeller Mounting: The propeller mounting flange fractured/pulled from the engine propeller shaft flange. One fragment of the shaft flange remained attached to the hub flange. The mounting bolt holes were contaminated with dirt/sand.

Blade/Clamp Rotation:

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Rotation of clamp possible?
L1	Low pitch	No	Yes, after link arm disconnect
L2	Low pitch	No	Yes, after link arm disconnect
L3	Low pitch	No	Yes, after link arm disconnect

Hydraulic Unit: The hydraulic unit (cylinder, piston and feathering spring assembly) and guide ring separated from the hub mounting threads during the impact sequence. It was removed from the propeller as an assembly. The piston was removed from the unit but no further disassembly was conducted. Its final state is shown in Photo #21.

Pitch Stops:

Low Pitch Stop: The low pitch stop sleeve was not removed or observed.

Start Lock: The L1 and L2 start lock assembly brackets were fractured from the bulkhead assembly (Photo #22). Some of the bracket fragments were not recovered. The L3 start lock bracket was intact but bent and the plunger would not move by finger force. All three start lock plates were attached to their clamps with fasteners secure and lockwired. The L1 lock plate had a "wiping gouge" along the edge in the low pitch end. The L3 lock plate had a dent in the same approximate location as the L1 plate (Photo #23).

Feather Stop Screws: The feather stop screws appeared intact and undamaged (Photo #29).

Beta Tube: The beta tube was intact but bent. It is shown exiting the pitch change rod in Photo #21.

Piston: The piston was secure on the pitch change rod and whole, but one side was dented/smashed with two visible cracks emanating from the base, with one adjacent to the link arm connection point for blade L3 (Photo #24). There were also two impact marks made by contact with counterweight arm on the bottom edge of the piston indicating the piston was in a forward/low pitch position when they were made. There was a cylinder impact marks on the internal surface of the piston ranging from approximately 3.3" to 2.2" from the bottom edge (Photo #25).

Table #1 - Summary of Piston Impact Signatures

Internal Marks from Bottom Piston Edge	Approximate Equivalent Blade Angle	Pre-impact Confidence Level / Why?
2.2" - 3.3"	16° - 48.5°	Medium: Impact forces pushed piston when marks were made on side of piston that was smashed.

Link Arms: Link arms and L1 and L3 were bent in compression (Photo #27). L3 was also remarkably twisted. Link arm L2 appeared undamaged.

Cylinder: The cylinder mounting threads were damaged when it forced from the hub. The cylinder had a dent/crease approximately 3.3" from the top corner that was consistent with the mark in the piston (Photo #30). This is approximately equivalent to 48.5° blade angle.

Feathering Spring Assembly: The feathering spring appeared intact and loaded on the pitch change rod with one spring keeper that was partially displaced, the other keeper was missing. The spring sleeve was torn on the aft edge that engages the aft spring retainer. There were two circumferential creases in the sleeve that were made as it separated from the hub. No attempt was made to remove the spring from the hydraulic unit.

Pitch Change Rod: The pitch change rod appeared intact and undamaged.

Clamps and Counterweights: The L1 and L2 clamps and counterweights were intact. The L3 counterweight was displaced and one bolt appeared fractured. There were no discernable cracks and no discernable deformation with all clamp bolts present on all three clamps. See Photo #31.

Clamp Pos.	Clamp S/N	Clamp Condition	Counterweight Condition
L1	EE9431	Intact with link screw intact	Intact
L2	EF9862	Intact with link screw intact	Intact
L3	EF9047	Intact with link screw intact	Displaced, one bolt appeared fractured

Hub Unit: The hub was intact (Photo #26) and the mounting flange appeared undamaged. There was some damage and thread whiskers in the cylinder mounting threads. There were no discernable blade-to-hub contact witness marks on any of the three blade arm flanges.

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Blade Properties: All three blades exhibited varying degrees of heat exposure discoloration (charring, sooting, paint blistering). See Photos #28, and #32 through #34.

Blade # L1

Camber side	Some chordwise/rotational scoring in the mid-blade region, charring/sooting, otherwise normal erosion
Face side	Charring/sooting heat discoloration, spanwise scoring
Bend	Aft at tip
Twist	Not remarkable
Lead edge damage	Dents and gouges in mid-blade area
Trail edge damage	Localized bending
Blade bearings	Intact, grease serviceable
Butt/shank impact marks	Relatively shallow pilot tube shoulder impact mark centered in the aft/face side direction
De-Ice boot	Charred

Blade # L2

Camber side	Normal erosion, charring/sooting
Face side	Charring/sooting paint blistering
Bend	Aft near tip
Twist	Not remarkable
Lead edge damage	Dents and gouges
Trail edge damage	Local bends and nicks
Blade bearings	Intact, grease serviceable
Butt/shank impact marks	Pilot tube shoulder impact mark centered in the aft/leading edge quadrant
De-Ice boot	Charred on face side

Blade # L3

Camber side	Chordwise/rotational abrasion in mid-blade, normal erosion outboard
Face side	Chordwise/rotational abrasion in mid-blade isolated to leading edge
Bend	Aft and opposite rotation
Twist	Toward low pitch
Lead edge damage	Nicks
Trail edge damage	Local bends and nicks
Blade bearings	Intact, grease serviceable
Butt/shank impact marks	Pilot tube shoulder impact depression and hub arm impact crescent impression both centered in the aft/trailing edge direction.
De-Ice boot	Cuts and tears

Photo #18 - Left propeller as-presented for examination



Photo #19 - Left engine propeller shaft flange

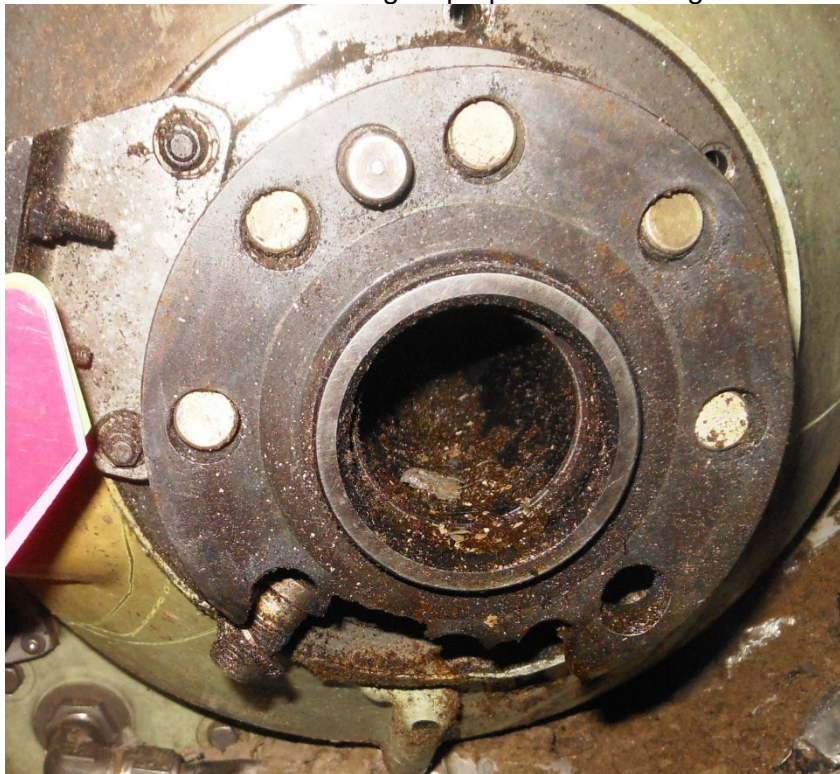


Photo #20 - Left spinner dome counterweight puncture and angle

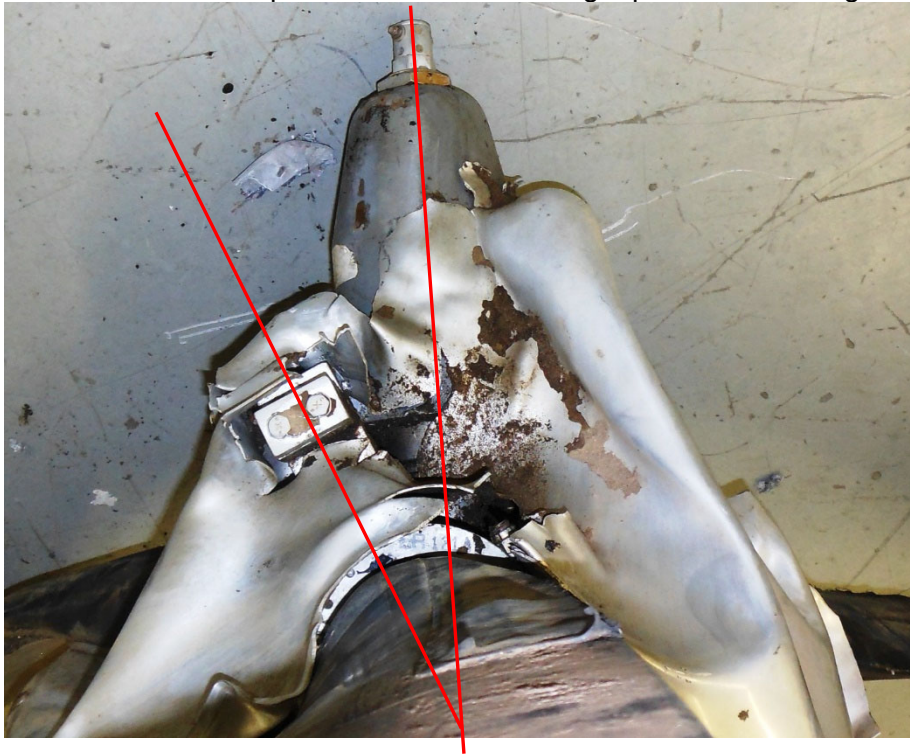


Photo #21 - Left hydraulic unit in final state



Photo #22 - Fractured/missing start lock brackets



Photo #23 - L1 and L3 start lock plate damage

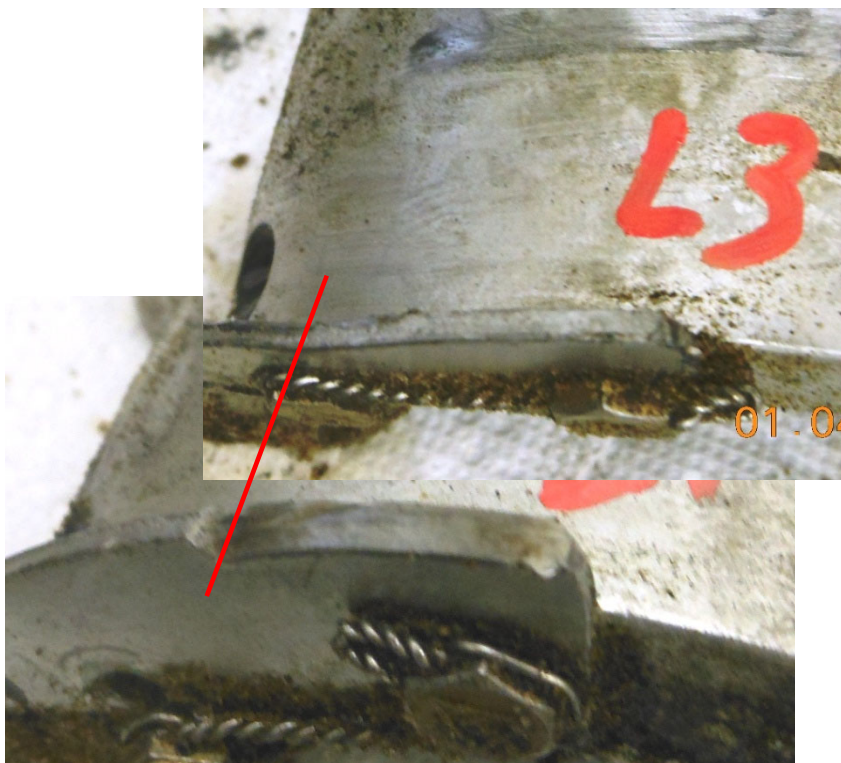


Photo #24 - Left piston



Photo #25 - Left piston internal cylinder impact signatures



Photo #26 - Left propeller hub and spinner bulkhead



Photo #27 - Left link arms



Photo #28 - Left propeller blade damage, as-presented



Photo #29 - Left feather stop screws montage

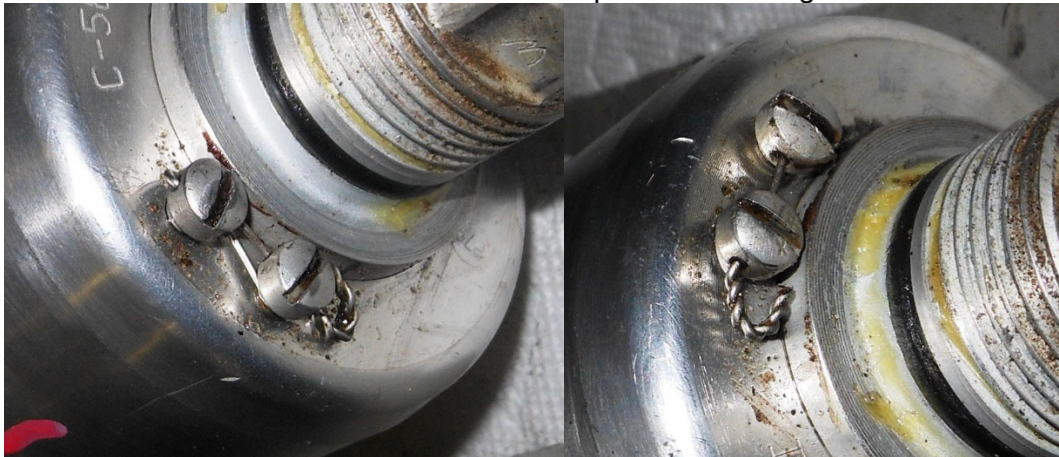


Photo #30 - Left cylinder/hydraulic unit



Photo #31 - Left clamps



Photo #32 - Left blades camber side



Photo #33 - Left blades face side



Photo #34 - Left propeller blade butts

