

Date of Accident: March 7, 2023

Location: Willows, CA

NTSB File No.: WPR23FA122

Aircraft: Rockwell International S-2R

Registration No.: N8424V

Serial No.: 2184R (Year of Manufacture 1976)

Operator: per FAA registry:
Jones Aviation Inc.
PO Box 497
Biggs, CA 95917-0497

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

Report Date: July 20, 2023

Contents:	Page
Accident Synopsis.....	2
Summary and Analysis of Findings.....	3
Conclusions.....	3
Propeller Teardown Report.....	4

ACCIDENT SYNOPSIS

The following is excerpted from the NTSB preliminary report.

“On March 7, 2023, about 1611 Pacific standard time, a Rockwell International S-2R, N8424V was substantially damaged when it was involved in an accident near Willows, California. The pilot was fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 137 aerial application flight.

According to the operator, the pilot was scheduled to spray fungicide over several almond orchards. Preliminary data retrieved from an onboard GPS aerial application guidance system showed that the airplane departed Willows/Glenn County Airport, Willows, California about 1354, and tracked towards the south and then turned right to a westerly heading. The airplane flew a racetrack pattern in a north/south direction over a field located immediately west of a bank of powerlines. The flight track ceased at 1611 about 0.6 nm southwest of the accident site. A witness located about 0.5 nm northwest of the accident site reported that he observed the airplane make several passes in a racetrack pattern on a north/south heading directly over him at 1545 as it sprayed the field. The airplane left the area and then returned about 1610, and made additional passes. He heard a loud noise about 2 minutes after the last pass. The operator reported that the pilot had been flying for about 8 hours when the accident occurred.

The airplane came to rest inverted in an almond orchard about 500 ft northeast of a powerline tower and was oriented on a heading of 038° magnetic and adjacent to a severed conductor (powerline). All the major structural components of the airplane were accounted for at the accident site. The debris field was marked by several broken tree branches about 50 ft southeast of the accident site. A ground scar about 5 ft in diameter was collocated with the main wreckage. Both ailerons and flaps remained attached to their respective wings, which were both attached to the fuselage. The right wing displayed a depression about 3 ft in diameter with accordion style deformation and tree remnants several feet outboard of the wing root. The left wing leading edge exhibited a depression about 10 ft from the wing root. A section of conductor, about 2 inches in diameter, was wrapped around the propeller hub. The conductor line was traced through the left wing depression to the trees southeast of the accident site. Both elevators remained connected at their respective horizontal stabilizers and the rudder remained attached to the vertical stabilizer. The right elevator was bent downward about midspan and the vertical stabilizer was bent to the left, also about midspan. The elevator trim tabs were attached to their respective elevators; the left elevator trim tab was deflected downward and the right elevator trim tab exhibited an upward deflection.”

SUMMARY AND ANALYSIS OF FINDINGS

The propeller was removed from the engine and the blades intentionally cut for shipping to Honeywell in Phoenix. The propeller was examined on July 18-20, 2023 in the Product Integrity Lab to evaluate the blade damage and search for impact signatures that could offer estimates of blade angle and thus condition of operation prior to impact. This report documents the detailed findings of those examinations.

The propeller blade damage included chordwise/rotational scoring and leading edge cable notch/cuts that are consistent with inflight impact into a cable while rotating. Blade #2 pitch mechanisms indicated the blade was forcefully rotated toward high pitch by the cable strike. An impact signature on the internal surface of the piston is equivalent to a blade angle of approximately 17.7° and would be consistent with a power condition inflight. The two dowel pin holes on the mounting flange appeared deformed in direction of rotation also indicating moderate-to-high torque.

Cable remnants wrapped around the propeller shaft suggested it may have reduced rotational energy prior to impact into terrain. A counterweight impact mark in the spinner dome at 17.4° is equivalent to a blade angle of approximately 4° , which would be closer to flight idle and consistent with lower power at time of impact with terrain.

No pilot tubes were fractured suggesting that rotational energy was relatively low by the time of impact with terrain. Additionally, there was only simple aft bending in blades #3 and #4 with no remarkable twisting or bending opposite rotation, also consistent with a lower power at impact with terrain.

CONCLUSIONS

There were no discrepancies noted that would prevent or degrade normal operation prior to impact with a power line. All damage was consistent with high impact forces associated with a power line strike and impact with terrain. An impact signature in the piston suggested power level was moderate-to-high at the time of the cable strike and decreased prior to impact with terrain.

PROPELLER TEARDOWN REPORT

Date of Investigation: July 18-20, 2023

Location: Honeywell Aerospace - Product Integrity Lab
1944 E. Sky Harbor Circle N.
Phoenix, AZ 85034

Propeller Model: HC-B4TN-5NL with LT1089N blades

Representatives: Les Doud Hartzell Propeller Inc.
Dana Metz Honeywell ASI
Stephen Stein NTSB Investigator in Charge (virtual)

General Comments: The propeller model examined is a 109.5-inch diameter, 4-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 a feathering spring provides 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 counter-clockwise as viewed from the rear.

Installation Data: Refer to Hartzell Installation Data Sheet No. 1725 and Aircraft STC SA00172SE for propeller settings referenced below:

(Angles referenced at the 42-inch radius)

Reverse: -11.5 ± 0.5 degrees

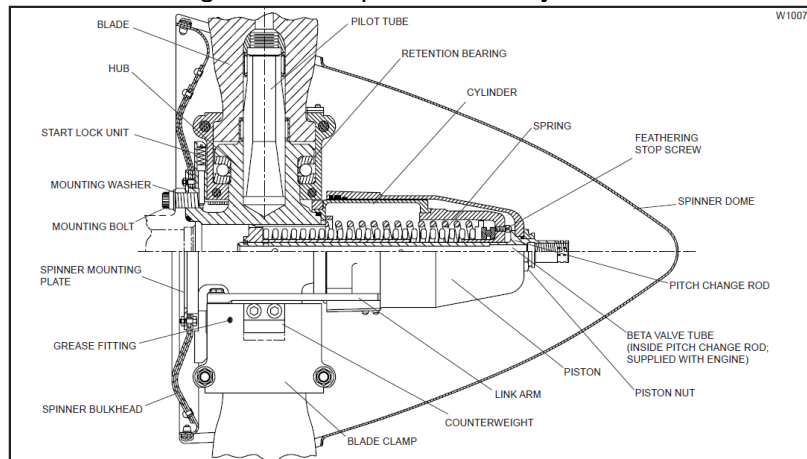
Start Lock: -1.4 ± 0.1

Flight Idle/Low Pitch: Set per STC Installation Instructions

Feather: 81.2 ± 0.5 degrees

Counterweight: 2.0 ± 1.0

Figure 1 – Propeller Cutaway Sketch



Propeller Assembly S/N: CDA5274

Service History: The propeller logbooks were not available at this examination so service history is unknown. The propeller was manufactured as-new on 11/26/2008. The hub, blade and clamp serial numbers recorded during this examination matched the original build records.

	<u>S/N</u>	<u>Date of Manufacture</u>	<u>TTSN</u>	<u>TSO</u>
Hub/Factory	D1261A	11/26/2008	Unknown	Unknown
Blade R1	K83249	11/11/2008	Unknown	Unknown
Blade R2	K83248	11/11/2008	Unknown	Unknown
Blade R3	K83247	11/11/2008	Unknown	Unknown
Blade R4	K83244	11/11/2008	Unknown	Unknown

Blade Orientation: The blades were identified as 1-2-3-4 clockwise as viewed from the rear of the propeller. The assembly serial number was between the #1 and #4 blades.

As Received Condition: The propeller is shown in Photo #1 before removal from the engine. There were remnants of a power line wrapped around the propeller and engine propeller shaft. The propeller was removed by on-scene investigators and recovery personnel. The spinner dome was removed and all four blades were cut to facilitate shipping. The propeller was shipped to Honeywell in a crate. It arrived at Honeywell as shown in Photo #2.

All four blades were cut approximately 16-21" from the blade butts. There were cable "notches" in the leading edges of blades #1, #2 and #4. Blades #1, #3, and #4 were in a low pitch position, blade #2 was in a position beyond feather and the counterweight impacted the spinner bulkhead. The #2 link screw was fractured from the clamp and not recovered. Therefore the #2 link arm was not attached at the clamp allowing free rotation of the #2 blade. The piston was jammed in a forward/low pitch position, under feathering spring tension with no apparent fractures. All four link arms remained attached to the piston. The cylinder remained attached to the hub. There was no apparent blade slippage in the clamps. The propeller is shown in Photo #3 prior to disassembly.

Spinner Dome: The spinner dome was crushed and torn. There was visible torsional distortion. There were two counterweight impressions/cuts in the dome, one at approximately 17.4° (Photo #5) and another at 8.6°. It was not determined which blade/counterweight made each mark. There were also braided cable scoring marks in the dome (Photo #4).

Spinner Bulkhead: The spinner bulkhead was intact but the dome flange was bent in the area between blade #2 and #3. There was a counterweight impact mark from blade #2 in the feathered position. There were also two, large stacks of dynamic balance weight washers near the blade #1 position.

Propeller Cycling: Propeller cycling was not attempted due to lack of fixturing to pressurize the hydraulic unit.

Engine/Propeller Mounting: According to the Honeywell ASI, the propeller remained securely attached to the propeller shaft flange with all eight mounting bolts secure. The flange was intact but both dowel pin holes appeared to have deformation in the direction of rotation indicating torque at impact (Photo #6).

Blade/Clamp Rotation: All four clamps remained secure on their respective hub arm with all four clamp bolts in each clamp secure. None of the four slip indicators indicated any slippage.

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Rotation of clamp possible?
1	Low pitch, angle not measured	No	Yes
2	Beyond the feathered position, counterweight against the spinner bulkhead	No	Yes
3	Low pitch, angle not measured	No	Yes
4	Low pitch, angle not measured	No	Yes, but stiff/ratchety

Pitch Stops:

Low Pitch Stop: The low pitch stop sleeve appeared intact on the pitch change rod but was not removed for closer inspection.

Start Lock: All four start lock brackets were intact but the #3 bracket was smashed thus retaining the pin in the retracted position (Photo #7). None of the pins appeared to have impact damage indicating forceful contact with the start lock plates. The pins for #1, #2 and #4 actuated with finger force. The #1 start lock plate was impact-separated from the clamp and not recovered. The other three plates remained attached to their clamps.

Feather Stop Screws: The feather stop screws appeared intact and undamaged confirming the propeller was not on the feather stop at impact (Photo #8).

Beta Tube: The beta tube was removed by the Honeywell ASI when removing the propeller and was not observed.

Piston: The piston was intact and secured by the piston nut. There were no apparent fractures, cracks or indications of oil leakage. There some random scoring on the external surface due to contact with the spinner dome. There was one remarkable impact mark on the internal surface of the piston due to contact with the cylinder top corner (Photo #9) and is described in Table #1.

Table #1 - Details of Piston Impact Signature

Internal Marks from Bottom Piston Edge	Approximate Equivalent Blade Angle	Pre-impact Confidence Level / Why?
2.2" from bottom edge	17.7°	HIGH – At 100 KTAS SL/ISA this blade angle absorbs 409 Hp @ 1591 RPM

Link Arms: All four link arms remained attached to the piston link pins. The link arms are shown in Photo #10.

Link Arm	Link Arm Condition
1	Bent in compression/buckled
2	Stretched in tension, link screw hole elongated
3	Unremarkable
4	Bent in compression/buckled

Cylinder: The cylinder appeared intact and undamaged.

Feathering Spring Assembly: The feathering spring assembly remained intact and appeared undamaged (Photo #11).

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

Clamps and Counterweights: All four clamps remained secure on the hub with all four fasteners secure.

Clamp Pos.	Clamp S/N	Clamp Condition	Counterweight Condition
1	EM21520	Start lock plate fracture-separated	Intact
2	EM21448	Link screw fracture-separated	Intact
3	EM21509	Unremarkable	Intact
4	EM21514	Unremarkable	Intact

Hub Unit: The hub unit remained intact with no apparent fractures. The mounting flange remained intact with all eight bolts secured before removal. The dowel pin holes appeared to have deformation in the direction of rotation. All four pilot tubes remained intact. There were some clamp-to-hub arm contact marks on the trailing edge side of the hub arm. The bearings appeared intact with fresh/serviceable grease.

The cylinder and forward spring cup remained attached. There was a gouge in the guide collar made by forceful impact rotation of the clamp link screw/link arm rotation towards low pitch. There were no remarkable impression marks on the hub arm flanges made by contact with the blade butts.

Blade Properties: See Photos #12 through #16

Blade # 1 – Cut at approximately 18-21” from butt to facilitate shipping

Camber side	Chordwise/rotation scoring
Face side	Chordwise/rotation scoring
Bend	Not remarkable
Twist	Not remarkable
Lead edge damage	Cable notch/cut approximately 9.5” from tip (Photo #14)
Trail edge damage	Not remarkable
Blade bearings	Intact, not removed, new/serviceable grease
Butt/shank impact marks	Pilot tube shoulder impact crescent around bore in the trailing edge direction

Blade # 2 - Cut at approximately 18” from butt to facilitate shipping

Camber side	Chordwise/rotation scoring, cable wrap pattern (Photo #15)
Face side	Chordwise/rotation scoring, cable wrap pattern (Photo #15)
Bend	Some indication of bending in the forward/thrust direction
Twist	Not remarkable
Lead edge damage	Cable notch/cut 19” from tip (Photo #14)
Trail edge damage	Cable wrap tear 7-11” from tip
Blade bearings	Intact, not removed, new/serviceable grease
Butt/shank impact marks	Pilot tube shoulder impact crescent around bore in the trailing edge/face direction. There was some braided cable scoring marks wrapped around the leading edge to the face side in the blade shank area.

Blade # 3 - Cut at approximately 16-18” from butt to facilitate shipping

Camber side	Chordwise/rotation scoring
Face side	Chordwise/rotation scoring
Bend	Aft
Twist	Not remarkable
Lead edge damage	Not remarkable
Trail edge damage	Not remarkable
Blade bearings	Intact, not removed, new/serviceable grease
Butt/shank impact marks	Pilot tube shoulder impact crescent around bore in the face/aft direction

Blade # 4 - Cut at approximately 17-18” from butt to facilitate shipping

Camber side	Chordwise/rotation scoring
Face side	Chordwise/rotation scoring
Bend	Aft
Twist	Not remarkable
Lead edge damage	Cable notch/cut 13” from tip (Photo #14)
Trail edge damage	Not remarkable
Blade bearings	Intact, not removed, new/serviceable grease
Butt/shank impact marks	Pilot tube shoulder impact crescent around bore in the face/aft direction

Photo #1 - Propeller prior to removal from engine (photo courtesy of Honeywell)



Photo #2 – Propeller as presented for examination



Photo #3 - Propeller prior to disassembly



Photo #4 - Braided cable scoring marks in spinner dome



Photo #5 - Counterweight impression measurement



Photo #6 - Dowel holes deformation in direction of rotation

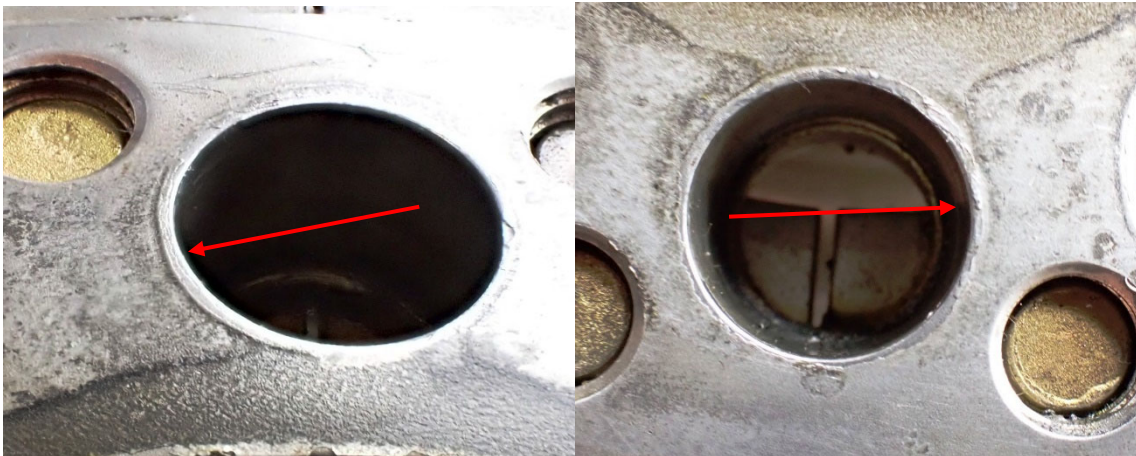


Photo #7 - Start lock assemblies



Photo #8 - Feather stop screws



Photo #9 - Cylinder impact mark on internal surface of piston

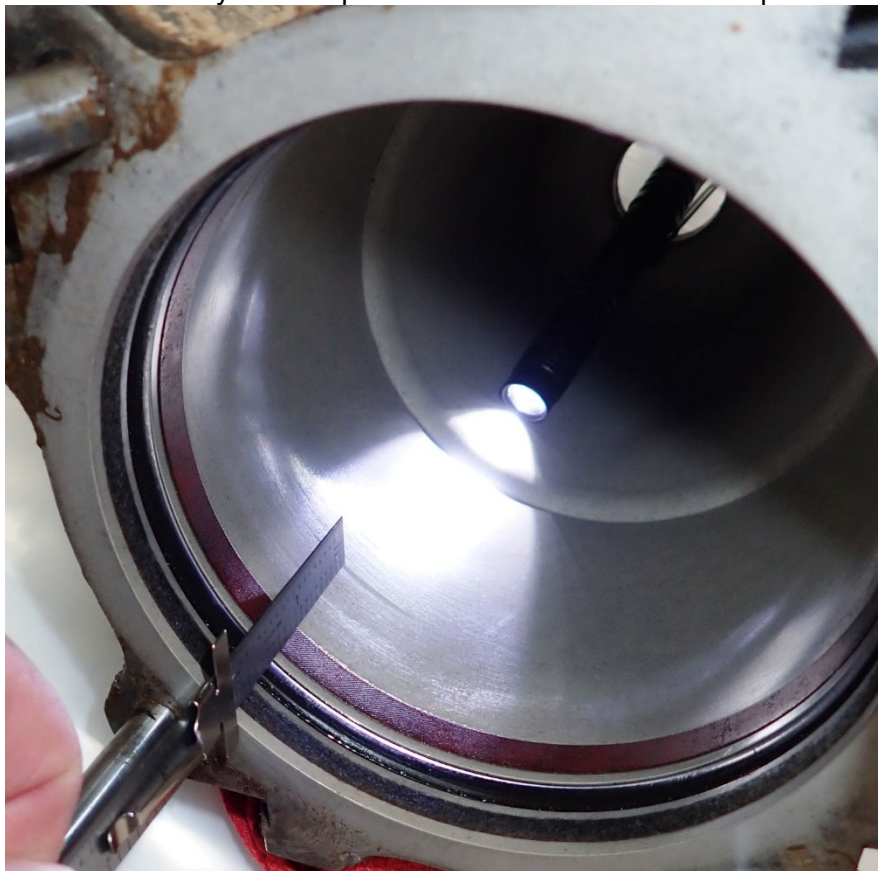


Photo #10 - Link arms



Photo #11 - Feathering spring assembly



Photo #12 - Blades camber side



Photo #13 - Blades face side



Photo #14 - Blade leading edge cable notch/cuts



Photo #15 - Blade #2 "cable wrap" pattern

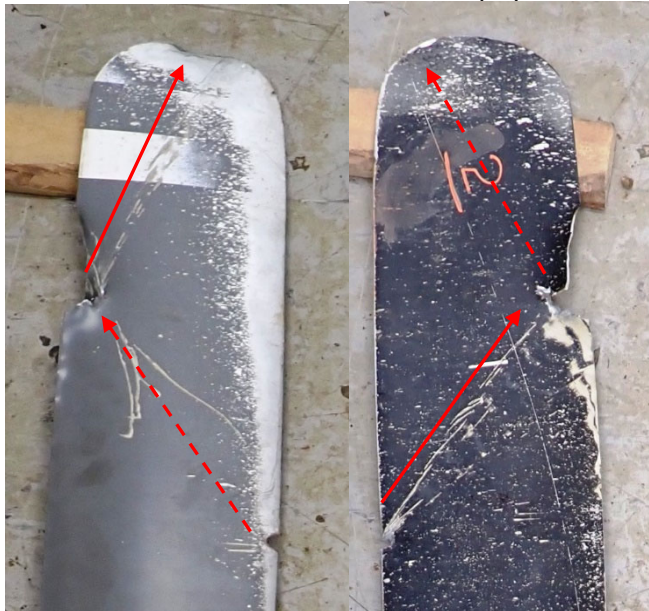


Photo #16 - Blades trailing edge view/progressive bending

