

WPR22LA114

Hartzell Propeller Air Safety Investigator Field Notes **Rev. A March 4, 2024**

Accident

NTSB File No.: WPR22LA114
Accident Date: February 24, 2022
Location: Oceanside, CA
Aircraft: Cessna C-208B
Aircraft Registration: N10JA
Aircraft Total Time: Recorded A/C TT on 2/22/2022 was 9580.6
Propeller TSN: Approximately 1415.9+ Hours

Propeller Examination

Location: Air Transport
3011 W. Buckeye Road
Phoenix, AZ 85009
Exam Date: April 25, 2022
Participants: Les Doud – Hartzell Propeller Air Safety Investigator
Zoe Keliher – NTSB Investigator in Charge
Bobby Bishop – Texas Turbines
Casey Love – Textron Air Safety Investigator
Jennifer McDuffie – Honeywell Air Safety Investigator
David Studtmann – Honeywell Air Safety Investigator

Propeller Description

Propeller Model and S/N
Model: HC-E4N-5KL/JNC10904
Factory S/N: SZ40
Date of Manufacture: 1/10/2020
Blades S/Ns same as original build (numbered clockwise ALF with S/N between #1 and #4)
#1 – C1454
#2 – C2548
#3 – C2549
#4 – C2423

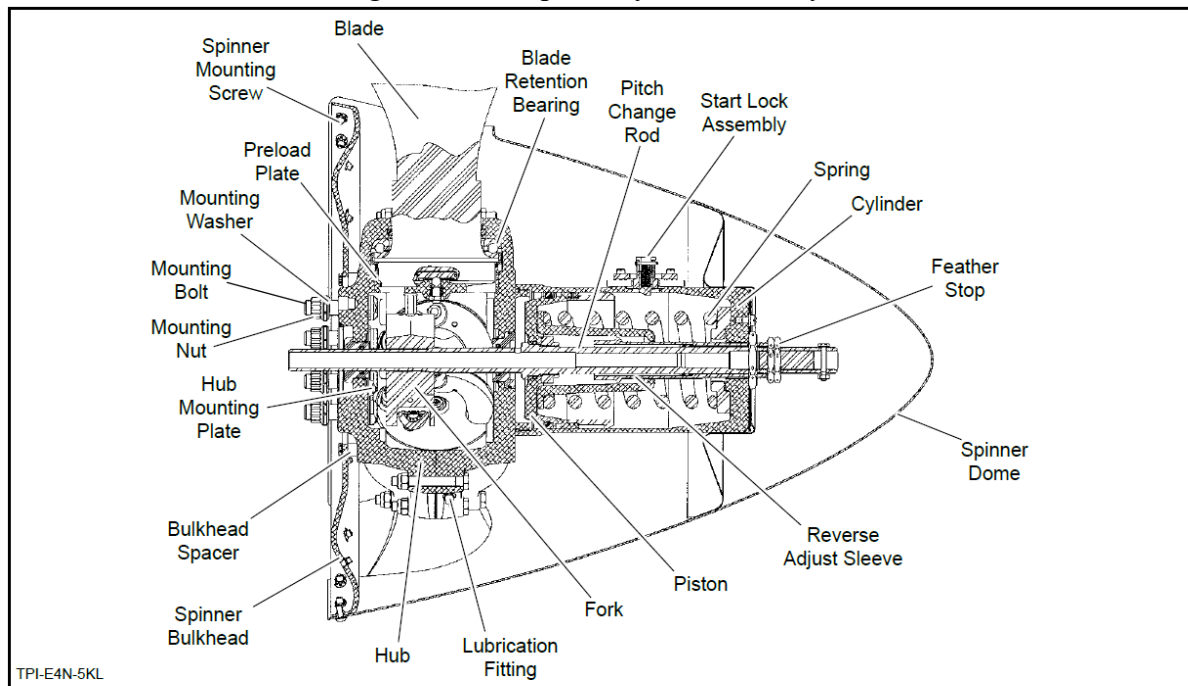
The propeller on the accident airplane is a 110” diameter, 4-blade, single-acting, hydraulically operated constant speed model with feathering and reverse pitch capability. Oil pressure from the propeller governor is used to move the blades to the low pitch (blade angle) direction. A force from a feathering spring and centrifugal twisting moments from the blade counterweights are used to move the blades to the high pitch/feather direction in the absence of governor oil pressure. The propeller incorporates a Beta tube mechanism that provides blade angle information to the prop pitch control when angles are lower than the flight idle position. The

propeller utilizes an aluminum hub with composite blades. Rotation is counterclockwise as viewed from the rear. A cutaway sketch of the propeller system is shown in Figure #1.

Installation Data: Reference Hartzell Installation Data Sheet No. 3508 and STC SA09872AC for additional installation data. (Blade angles referenced at the 30-inch station)

Reverse:	-13.0 ± 0.5 degrees
Start Lock	-4.0 ± 0.1 degrees
Flight Idle Pitch:	5.5 ± 0.5 degrees (STC SA09872AC)
Feather:	81.0 ± 0.5 degrees

Figure #1 – Propeller system cutaway sketch



HC-E4N-5KL Series Propeller

Propeller Examination

The propeller was presented for examination at Air Transport on February 25, 2022 as shown in Photo #1. The propeller remained attached to the engine propeller shaft flange with all four blades fracture-separated at the shank. There were no apparent oil leaks emanating from the propeller or mounting flange. Three blades were recovered in their entirety and only a tip fragment of the fourth blade was recovered near the main wreckage. All eight mounting nuts were present, secure and lockwired. The spinner dome exhibited spiral scoring, was crushed and torn with the majority still attached to the spinner bulkhead. There were no discernable counterweight impressions in the dome that could provide blade angle information. The spinner bulkhead mounting screws sheared opposite rotation and the bulkhead separated from the hub with rotational scoring marks on both forward and aft sides. The blades were numbered #1 through #4 clockwise (in sequence of rotation) as viewed from the aft side. The start lock pins could be actuated by finger force indicating the propeller was not resting on the start locks.

The Blade #3 and Blade #4 counterweights were forcefully rotated over-center towards low pitch, indicating fractured or dislodged pitch change components. The Blade #3 counterweight

was preventing the Blade #2 counterweight from actuating toward feather so #3 counterweight was removed from the shank during this examination. When the propeller was actuated toward the feather stop, Blades #1 and #2 moved smoothly and freely, Blades #3 and #4 did not actuate.

Photo #1 – Propeller as-presented for examination



The fractured blade segments were paired with their respective shanks by matching the fiber fracture patterns as shown in Photo #2. The #2 blade tip fracture-separated and was the only portion of the blade recovered near the main wreckage; it is unknown how much effort was given to searching the area for the remainder of Blade #2? Blades #3 and #4 were recovered mostly intact with chordwise/rotational scoring on the camber side and fracture patterns consistent with bending aft and twisting to low pitch. Leading edge erosion shield damage indicated impact forces were concentrated in the lead-to-trail direction indicating rotation under some power. The tip on Blade #1 was fracture-separated and recovered at the scene. Blade #1 exhibited chordwise/rotational scoring on the majority of the camber side. There were no remarkable chordwise/rotational scoring marks on the face side of any blades.

Photo #2 – Blades 2-3-4-1 left to right



The propeller hydraulic unit (cylinder, piston, feathering spring, pitch change rod) remained attached to the propeller hub and appeared intact and undamaged except for random scratches and scoring where the forward spinner bulkhead is positioned. One ear on one start lock pin was fractured. Both start lock pins actuated smoothly by finger force. The pitch change rod was extended approximately 1.6" from the feather stop with dirt packed into threads. The beta adjust screw was at a depth of 0.258" and took approximately 38.5 turns to remove (left beta rod depth at 0.127") and the beta tube took approximately and additional 17.9 turns to remove from the pitch change rod. The pitch change rod moved smoothly to feather under spring force once counterweight #3 was removed.

The cylinder, pitch change rod, piston and feathering spring were not removed due to lack of a proper fixture to hold the propeller hub. However, both start lock pins were removed and the spring and spring retention cup appeared intact when viewed through a start lock aperture. The start lock pins showed no evidence of forceful contact with the piston suggesting the propeller was not on the start locks at impact.

The hub unit was intact with no visible fractures or cracks and all thru-bolts secure. There were rotational scoring marks on the aft hub where the spinner bulkhead mounts. The hub-side bearing race of Blade #1 exhibited ball bearing impact imprints. All four preload plate shelves were marred in varying degrees.

Two forward tangs on the fork were fractured/cracked/bent toward low pitch. One tang was fracture-separated (Photo #3). The Blade #3 and Blade #4 pitch change knobs were found on the forward side/underneath the pitch change fork due to forceful rotation to low pitch. There were knob/bracket contact marks on the forward hub wall from these two blades. All four pitch change knob assemblies remained intact and secured on the blade butt (seen in Photo #2).

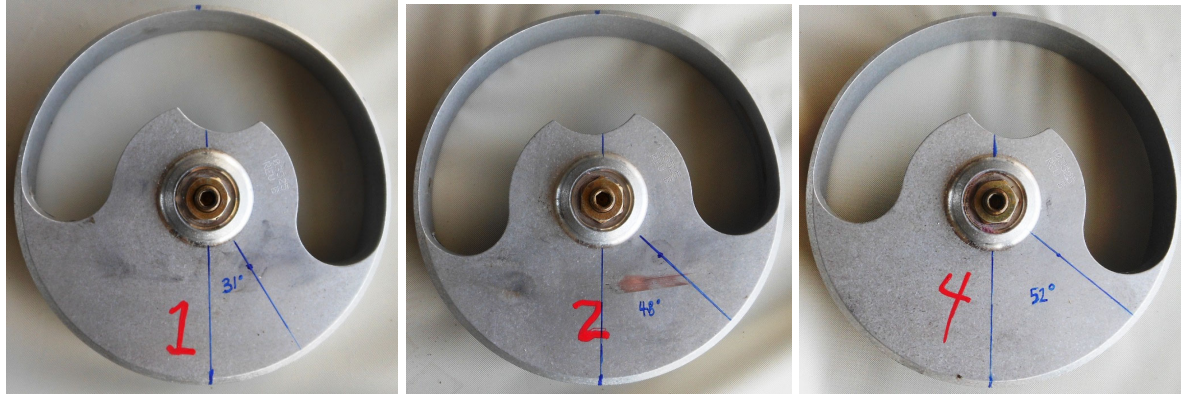
Photo montage #3 – Fractured fork tangs montage



The decal on the propeller cylinder indicated the propeller was serviced with Nyco grease. However, the grease found in the bearings appeared black and not consistent with the normally translucent white/cream color of Nyco grease. It appeared the propeller had been serviced with something other than Nyco grease? Although this did not contribute to any malfunction, it does not comply with Hartzell ICA.

Preload plates #1, #2 and #4 had discernable fork bumper impact marks in the low blade angle range (Photo #4).

Photo #4 – Preload plates with fork bumper marks



All four blades fractured at the blade-shank interface. Chordwise/rotational scoring was evident on the camber side of all four blades (Photo #5), moving progressively to a lower radius in the sequence of rotation. Blade #1 was fractured approximately 10-11" from the tip. Blade #2 was also fractured approximately 11" from the tip. All four blades exhibited leading edge nicks, gouging and some chunking. All four blades also exhibited trailing edge compression delamination.

Photo montage #5 – Camber side blade tip area (1-4-3-2 left-to-right)



Analysis

The fork bumper impact mark measurements shown in Photo #4 translated to the following approximate blade angles:

Preload Plate #1 bumper mark at 31 degrees = ~10.9 degree blade angle

Preload Plate #2 bumper mark at 48 degrees = ~ -17 degree blade angle

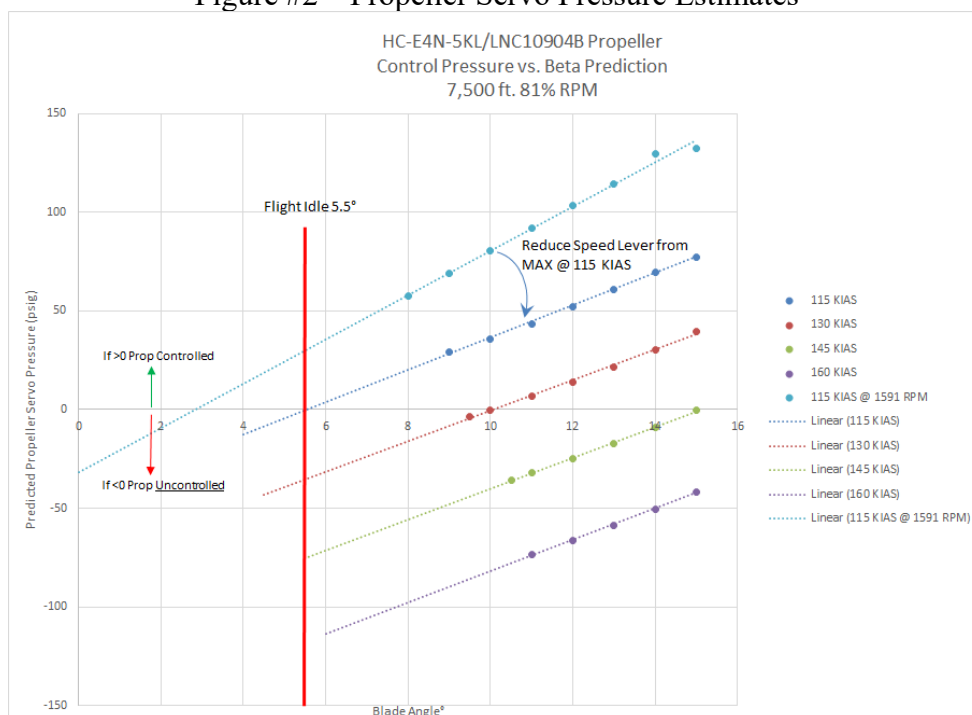
Preload Plate #4 bumper mark at 52 degrees = ~ -33 degree blade angle

The average of these three marks is approximately -13° which coincides with the reverse stop angle.

The pilot's accident report statements and a record of conversation with the pilot are consistent with a propeller in the beta/reverse range of blade angle and turning under power. These statements described high drag that increased with power increases and a lack of pitch control.

An estimate of propeller servo pressure was conducted across a range of decreasing blade angles using Hartzell's PROP Code¹ and at a flight condition representative of the accident descent. The analysis suggests the propeller could become uncontrolled (servo pressure < 0 psi) if the engine speed lever is moved to the LOW position and the power lever is moved below the Flight Idle gate. Figure #2 shows servo pressure estimates as a function of blade angle and RPM.

Figure #2 – Propeller Servo Pressure Estimates



Conclusions

All visible damage was consistent with impact into terrain while turning under power at a low blade angle; the propeller was not feathered. All damage was due to high impact forces. There were no visible discrepancies on the propeller components examined that would prevent normal operation. Blade damage suggests the power level was relatively low and the propeller was generating drag at impact. Analysis suggests the propeller became uncontrolled and self-actuated to the beta/reverse position by aerodynamic forces.

Les Doud
Air Safety Investigator
Hartzell Propeller Inc.

¹ PROP Code is the Hartzell Propeller Proprietary propeller design and analysis software that can calculate propeller performance for any given propeller model and flight condition.