

WPR22FA197

Hartzell Propeller Air Safety Investigator Exam Notes

Accident

NTSB File No.: WPR22FA197

Accident Date: June 3, 2022

Location: Oceanside, CA

Aircraft: Cessna C-208B

Aircraft Registration: N7581F

Aircraft Total Time: Recorded A/C TT on 6/2/2022 was 13379.9

Propeller TSN: Unknown

Propeller Examination

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

Exam Date: June 7, 2022

Participants: Les Doud – Hartzell Propeller Air Safety Investigator
Zoe Keliher – NTSB Investigator in Charge
Jay Eller – Honeywell Air Safety Investigator
Allison Engel – Honeywell Air Safety Investigator
Luis Rodriguez – Honeywell Project Engineer

Propeller Description

Propeller Model and S/N

Model: HC-B4TN-5QL / LT10891N

Assembly S/N: CDA5366

Date of Manufacture: 5/11/2011

Blades S/Ns (numbered clockwise ALF with S/N between #1 and #4). These blade S/Ns were installed sometime after the original propeller build as part of a blade replacement program; DOM for all blades was 9/28/12. A decal on the piston suggested the last, major propeller work (overhaul or repair) was performed by Intercontinental Jet Service in Tulsa, OK. According to a logbook entry, a 100-hour inspection was conducted on 6/2/22 at a TSO of 2719 hours. TTSN is unknown at this time.

#1 – L29169

#2 – L29171

#3 – L29175

#4 – L29172

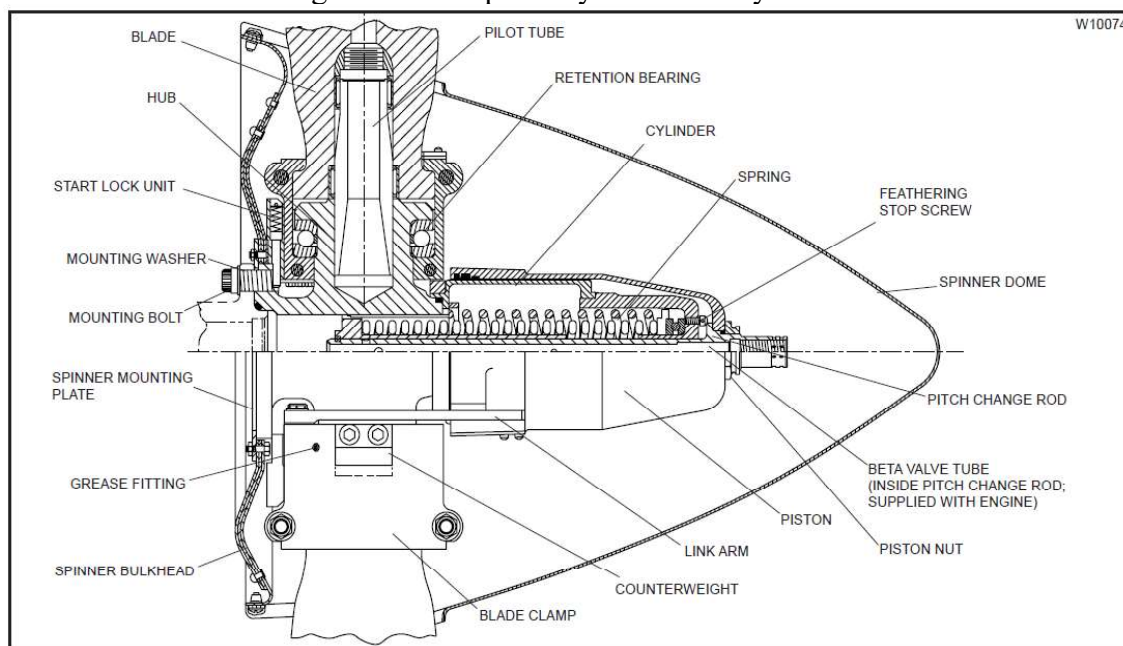
The propeller on the accident airplane is a 109.5” diameter, 4-blade, single-acting, hydraulically operated constant speed model with feathering and reverse pitch capability. Oil pressure from the propeller governor is used to move the blades to the low pitch (blade angle) direction. A force from a feathering 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 aluminum blades. The hub and blade retention clamps are steel. 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. 3093 and STC SA10841SC for additional installation data. (Blade angles referenced at the 42-inch station)

Reverse:	-11.5 ± 0.5 degrees
Start Lock	-1.4 ± 0.1 degrees
Flight Idle Pitch:	5.0 ± 1.0 degrees (STC SA10841SC)
Feather:	81.2 ± 0.5 degrees

Figure #1 – Propeller system cutaway sketch



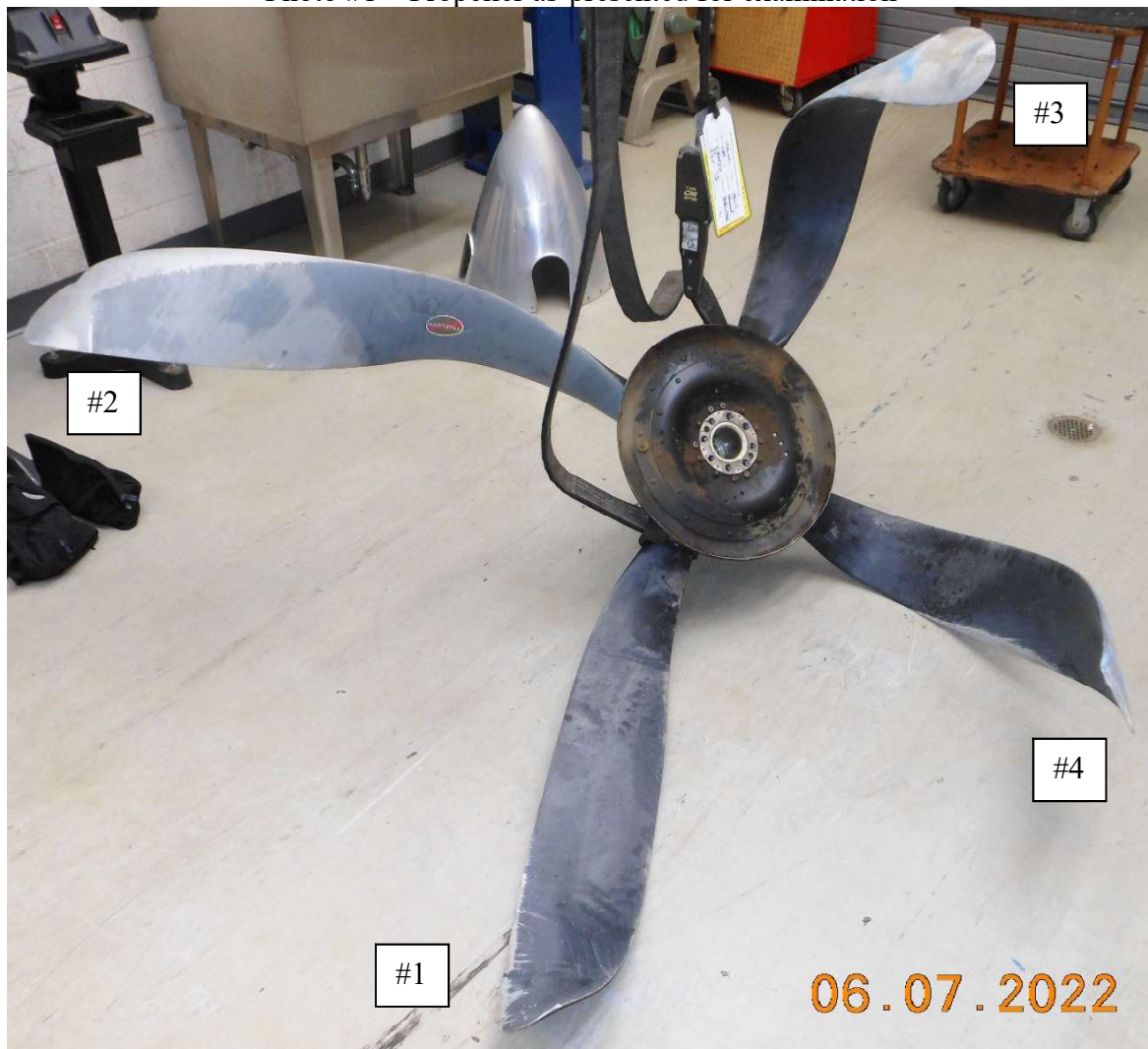
Propeller Examination

The propeller was presented for examination in the Honeywell Product Integrity Lab on June 7, 2022 as shown in Photo #1. On-scene photos show the forward fuselage/nacelle resting on Blade #2 and Blade #3 in contact with the ground (Photo #2). According to the Honeywell ASI the propeller remained attached to the engine propeller shaft flange with all eight bolts secure and lockwired. The propeller was removed from the engine by the Honeywell ASI on June 6 at Air Transport. All four blades remained attached to the propeller assembly with no blade fractures. Blades #1, #3 and #4 presented in a low pitch position, Blade #2 was rotated beyond low pitch such that it appeared facing partially backwards. The spinner dome was relatively undamaged and only exhibited some longitudinal scoring on the nose with no discernable counterweight impact marks. The spinner bulkhead appeared undamaged with no counterweight impact marks. Blade #1 link screw was bent opposite low pitch and the link arm was detached. The start lock plates on the #1, #3 and #4 clamps were fractured and not recovered. The #2 start lock plate was on the start lock pin. All the start locks brackets and plungers were intact and functional with finger force. The blade slip indicators (Photo #3) indicated Blade #1 had no slippage, #2 had slipped approximately 130° to low pitch, #3 slipped 5° to high pitch, and #4 slipped

approximately 47° to low pitch. Blades #1, #3 and #4 were bent aft in varying degrees. Blade #2 was mostly bent forward/thrust direction but exhibited S-bend characteristics. Blades #2, #3 and #4 had remarkable bending opposite rotation. All blades exhibited chordwise/rotational scoring primarily on the camber side outboard of the mid-blade region.

There were no apparent oil leaks emanating from the hydraulic unit components. No attempt was made to cycle the propeller with air pressure. The mounting flange surface was undamaged.

Photo #1 – Propeller as-presented for examination



This piston nut was removed to release the feathering spring tension. The link arms were disconnected from the piston and the piston was removed; piston travel was smooth during removal. The internal ceiling of the piston and the feather stop screws (Photo #4) were not damaged indicating the propeller was not feathered at impact. With the link arms detached from the piston all four blade/clamp assemblies rotated smoothly by hand force. The link arms were bent in compression in varying degrees (Photo #5). The feathering spring assembly was intact and loaded with the forward and aft spring retainers in-place (Photo #6).

Photo #2 – Propeller in-situ (photo provided by Honeywell ASI)



Photo #3 - Blade slip indicators

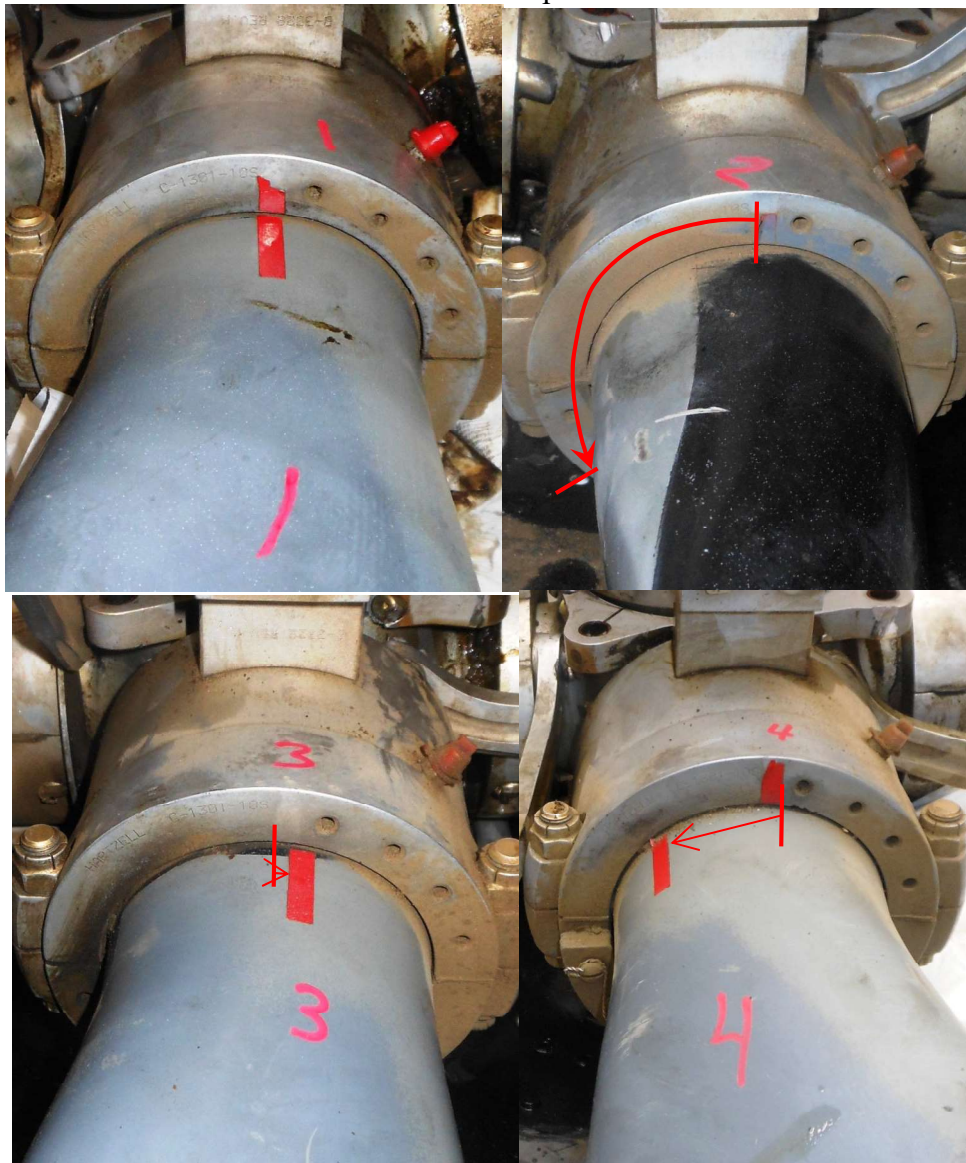


Photo #4 – Feather stop screws

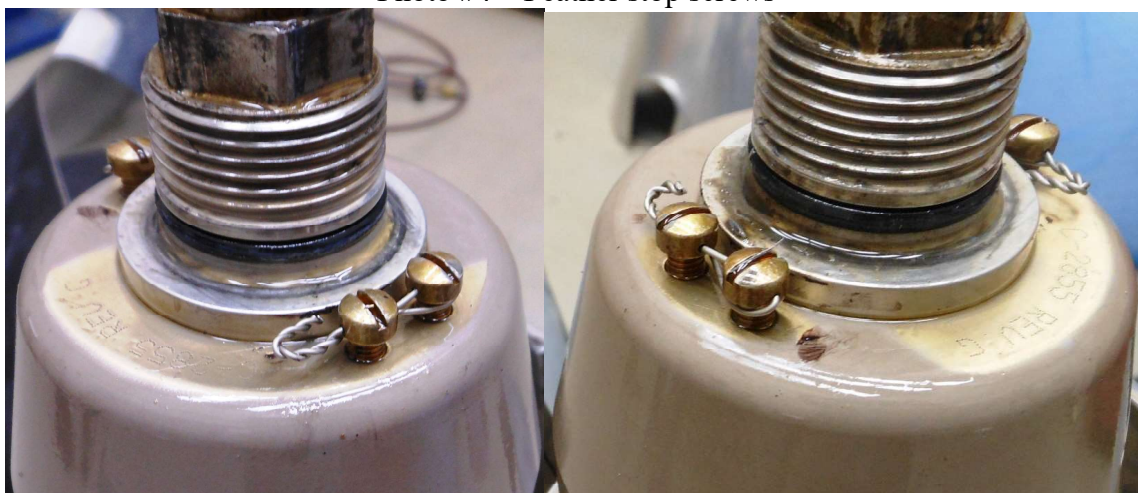


Photo #5 - Link arms



Photo #6 - Feathering spring assembly/pitch change rod



There were four marks on the internal surface of the piston (Photo #7) that may suggest a blade angle at impact. There were distinctive scuff marks on the cylinder at ~1.87" from the top corner (Photo #8). These marks translated to a blade angle with corresponding confidence levels are summarized below in Table #1.

Table #1 - Summary of Piston/Cylinder Signatures

Internal Marks from Bottom Piston Edge	Approximate Equivalent Blade Angle	Pre-impact Confidence Level / Why?
1.4"	-13.6°	Low – Mark is lower than reverse stop, impact sequence mark
2.2" machine mark?	14°	Low – This mark was very defined, narrow, and continuous around the circumference and resembled a machine mark
2.35" machine mark?	18.5°	Low – This mark was very defined, narrow, and continuous around the circumference and resembled a machine mark
1.85" crease	3°	Medium – Near flight idle blade angle
1.87" scuff mark from top corner	3.5°	Medium – Near flight idle blade angle

Photo #7 - Piston internal surface marks

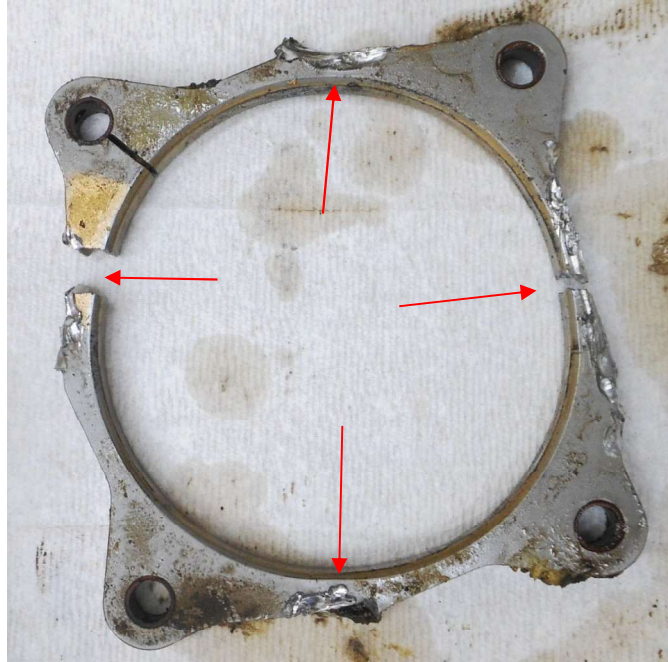


Photo #8 - Cylinder surface scuff marks



The guide rod collar was gouged in all four positions and fractured at two positions (Photo #9) by the link arm/screws forceful rotation to low pitch during the impact sequence. The hub was intact with no visible fractures. All four pilot tubes and bearing assemblies were intact. Blade #4 was the only blade that had a hub-to-butt impact crescent. It was in the approximately pure-aft direction suggesting the blade was at low/flat pitch position when it was made.

Photo #9 - Guide collar gouges and fractures

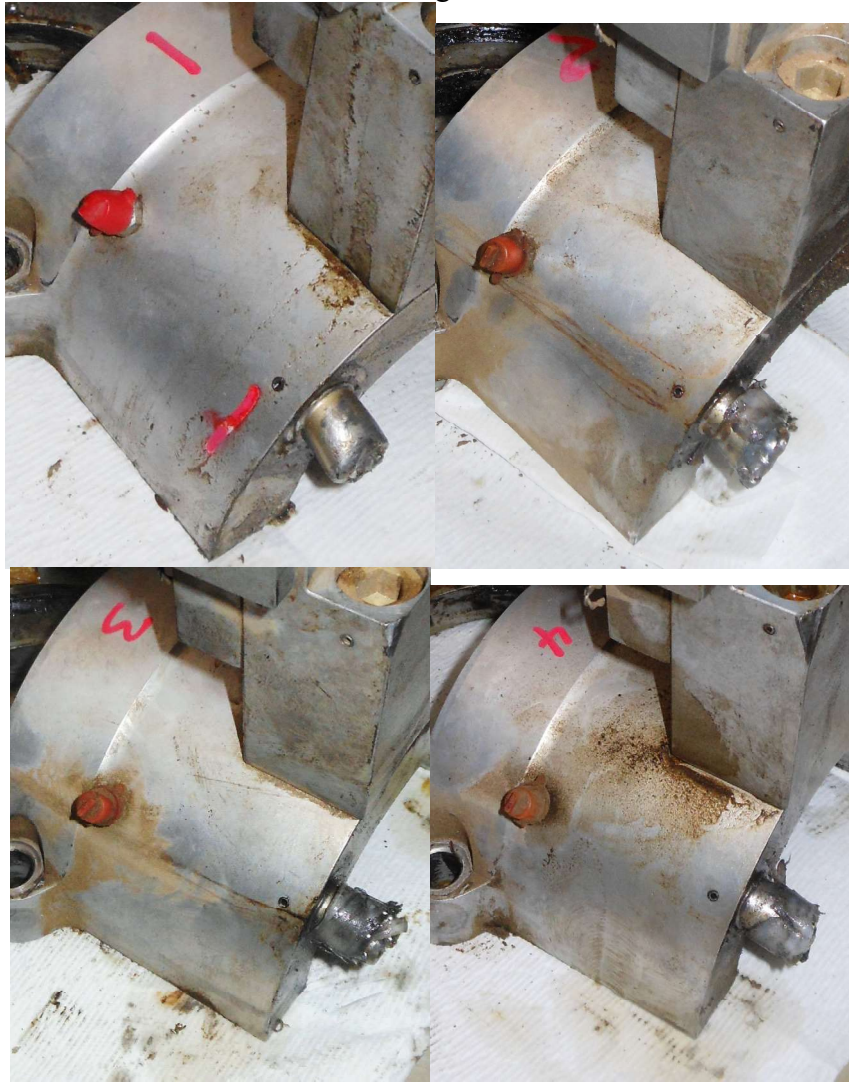


All four clamps and counterweights appeared intact (Photo #10). The counterweight slugs exhibited some scoring marks. The start lock plates on #1, #3 and #4 fractured from the clamps and were not recovered. All four clamp link screws were bent opposite low pitch and partially fractured at the cotter pin holes (Photo #11).

Photo #10 - Clamps



Photo #11 Montage - Link screws



All four blades had chordwise/rotational scoring on the camber-side (Photo #14). Blade #2 had some face-side chordwise/rotational scoring, but as seen in the on-scene photos this could have been caused by dragging after rotation stopped (Photo #2). Blades #3 and #4 hit an airframe component at some point during the impact sequence by evidence of the blue paint transfer (Photo #14).

Blades were predominately bent aft (Photo #12). Blades #2, #3 and #4 had remarkable bending opposite rotation (Photo #13). All four blades were twisted toward low pitch. Blades #2 and #4 had some remarkable bends in the leading edge with material deformation toward low pitch (Photos #15 and #16). Blade #1 also had a remarkable leading edge wave bend in the mid-blade region with material deformation toward low pitch (Photo #17).

Photo #12 – Blades 1-2-3-4 left to right



Photo #13 – Blades face side, 1-2-3-4 left to right



Photo #14 - Blade camber side tip area



Photo #15 - Blade #2 leading edge bend & chordwise scoring



Photo #16 - Blade #4 leading edge gouge/bend & chordwise scoring



Photo #17 - Blade #1 leading edge wave bend



Conclusions

There were no visible discrepancies noted that would prevent or degrade normal propeller operation prior to impact. All visible damage was consistent with high impact forces while rotating at low power at or near the flight idle blade angle. Signatures that indicate rotation at low power are:

1. All blades exhibited chordwise/rotational scoring and leading edge gouging isolated to the camber side with some exhibiting material deformation toward low pitch (rotation with power).
2. Predominately aft bending with compound twisting and remarkable bending opposite rotation (low power).
3. Measureable slip in the clamps toward low pitch (low power).
4. The counterweights did not over-rotate sufficiently to contact the spinner bulkhead (low power).
5. All four pilot tubes were intact and minimal blade-to-hub contact marks (low power).
6. All damage indicates only forceful rotation of the blades towards low pitch (low power):
 - a. All three clamp link screws were bent and/or fractured opposite low pitch.
 - b. Link arms bent in compression
 - c. Guide collar gouged/fractured by the link arm/screws.

Leslie A.
Doud

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Hartzell Propeller Inc.

