Date of Accident: April 28, 2017

Location: Amarillo, TX (Amarillo International Airport KAMA)

NTSB File No.: CEN17FA168

Aircraft: PC-12 (Modified to /45 Configuration)

Registration No.: N933DC

Serial No.: 105 (Year of Manufacture 1994)

Owner/Operator: Per FAA Registry:
Rico Aviation LLC
2322 Lakeville
Amarillo, TX 79109-1510

Written by: Les Doud
Hartzell Propeller Air Safety Investigator

Date: May 23, 2017

Contents:

ACCIDENT SYNOPSIS

The following is excerpted from the NTSB Preliminary Report:

"On April 28, 2017, about 2348 central daylight time, a Pilatus PC-12 airplane, N933DC, impacted terrain near Rick Husband Amarillo International Airport (AMA), Amarillo, Texas. The airline transport pilot and two flight crew were fatally injured. The airplane was destroyed. The airplane was registered to and operated by Rico Aviation LLC, under the provisions of 14 Code of Federal Regulations Part 135 as an air ambulance flight. Instrument meteorological conditions prevailed at the time of the accident and the flight was operated on an instrument flight rules (IFR) flight plan. The flight was originating at the time of the accident and was enroute to Clovis Municipal Airport (CVN), Clovis, New Mexico.

At 2248, the flight request was received from a medical center in Clovis to retrieve and transfer a patient to Lubbock, Texas. The flight was accepted by the Rico Aviation crew at 2334.

A review of preliminary Federal Aviation Administration (FAA) air traffic control information revealed that about 2332 the pilot received an IFR clearance and about 2344 he taxied to runway 4 at intersection A. About 2345 the airport tower controller cleared the airplane for takeoff on course, which was a right turn. About 2346 the same controller instructed the pilot to reset his transponder and then transferred communications to the departure controller. About 2347 the pilot reported at 6,000 ft. MSL and the departure controller radar identified the airplane. About 2348 the controller advised the pilot that he was no longer receiving the transponder, but the pilot did not respond. The controller made 3 more transmissions to the pilot without response. The airport tower controller observed a fireball and reported a crash.

Surveillance video from a nearby business recorded the accident airplane in a steep descent at a high rate of speed followed by an explosion.

The airplane impacted a pasture (Photo #1) adjacent to several stationary train cars about 1 nautical mile south of AMA and a post impact fire ensued. The wreckage debris path was generally oriented southwest. All major structural components of the airplane were located within the wreckage.

Photo #1 – Accident Site Viewed from the south (NTSB Photo)

The pilot, age 57, held an airline transport pilot certificate with a rating for airplane multi-engine land; a commercial pilot certificate with ratings for airplane single engine land, airplane single engine sea airplane multi-engine sea, rotorcraft-gyroplane; a flight engineer certificate for turbojet powered aircraft; a flight instructor certificate for airplane single engine and multi-engine, instrument airplane, and rotorcraft-gyroplane; an advanced and instrument ground instructor certificate; a powerplant mechanic certificate; and a repairman experimental aircraft builder certificate.

On the medical certificate application, dated January 19, 2017, the pilot reported that his total flight experience included 5,800 hours and 80 hours in last six months. This pilot was issued a second-class medical certificate with the limitation "must have available glasses for near vision."

According to FAA and maintenance records, the airplane was manufactured in 1994. Its most recent annual and 100-hour inspections were completed March 2, 2017, at 4,407.5 hours total time.

At 2353, the AMA automated weather observation recorded wind from 360° at 21 knots gusting to 28 knots, 10 statute miles visibility, broken clouds at 700 ft. above ground level (AGL), overcast cloud layer at 1,200 ft. AGL, temperature 45° F, dew point 45°F, altimeter setting 29.78 inches of mercury. Remarks: peak wind from 360° at 32 knots at 2346, lightning distant west, rain began at 2314 and ended at 2325, variable ceiling from 500 to 900 ft. AGL.

A preliminary review of the weather data revealed wind shear beginning about 6000 ft. MSL along with a temperature inversion at the same altitude.

SUMMARY AND ANALYSIS OF PROPELLER FINDINGS

The aircraft impacted relatively rock-free, pasture soil in a steep, nose-down attitude. The topsoil was dark and relatively soft, extending to a depth of approximately 3-4 ft. The subsoil started at approximately 4 ft. depth and was relatively hard clay. The depth of the impact crater appeared to be no more than approximately 5 ft. All critical parts from the propeller assembly were recovered from the crash site, either on the surface or in the impact crater and taken to a hangar at Amarillo International Airport for further examination. The recovered propeller components were examined to search for blade angle information and/or indications of power and rotation at impact.

Chordwise/rotational scoring on the blades, blade damage, blade retention pocket damage and beta rod bending all suggest rotation at impact. The propeller hub fractured during the impact sequence and all four blades separated from the assembly. Hub fragments remained attached to two blades and were removed to recover the preload plates. Preload plate #2 had discernable impact marks near the hub parting line that equated to a blade angle range of approximately 28-34°.

Two blades were fractured suggesting rotation under power; blade #2 tip and blade #4 was fractured at mid-blade. Damage suggesting a positive angle of attack at initial impact included blade #2 forcible rotation to high pitch, blade S-bending and twisting towards high pitch.

Damage on all four counterweight bosses indicated the counterweight fractured from the blade at impact and attachment hole deformation was opposite rotation.

A blade angle in the normal range of operation suggests the propeller was rotating at the governed 1700 RPM. With blade angles of 28-34°, the rated 1200 Hp is reached in the approximate airspeed range of 130 -230 KTAS respectively. Considering terrain and impact angle, these approximate conditions are consistent with the impact damage observed on the recovered propeller components.

CONCLUSIONS

Preload plate impact marks and blade damage indicated the propeller was operating under high power in the normal range of operation at time of impact such that blade impact angles of attack were initially positive. Preload plate #2 markings indicated a blade angle in the range of approximately 28-34° at impact. There were no discrepancies noted that would prevent or degrade normal propeller operation prior to impact. All damage was consistent with high impact forces.

PROPELLER TEARDOWN REPORT

Date of Investigation: May 1-3, 2017

Location: Amarillo International Airport (KAMA) hangar on Baker St. adjacent to airport fire department and airport maintenance facility buildings

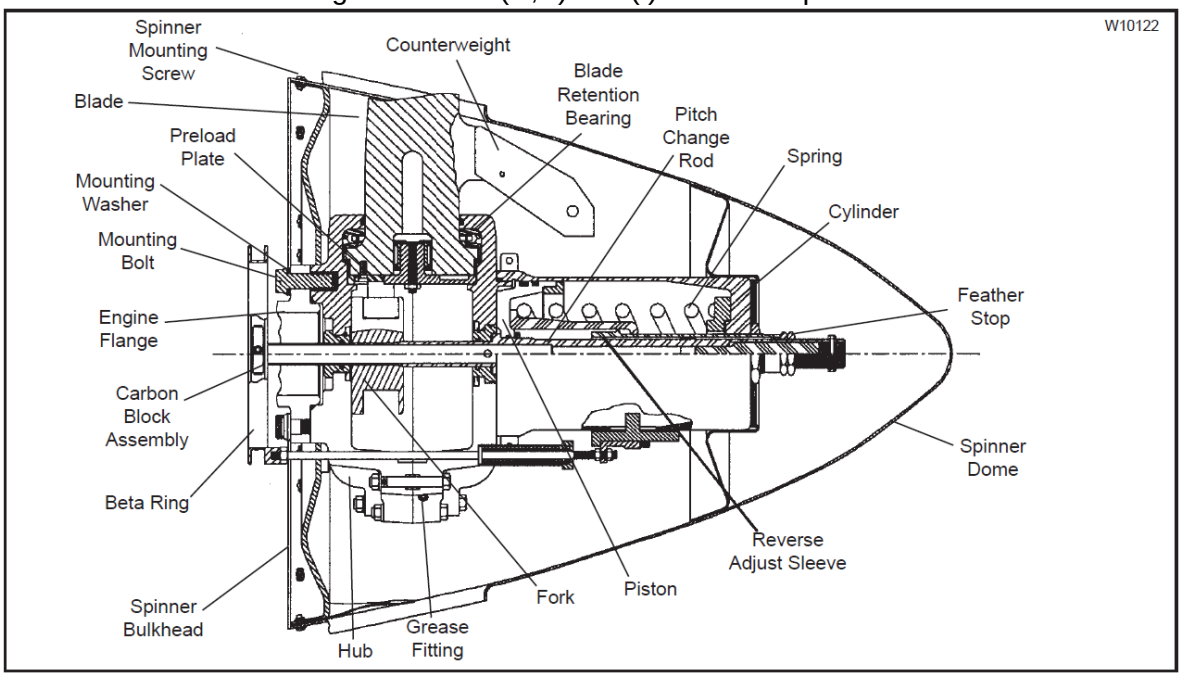
Propeller Model: HC-E4A-3D with E10477K blades

Representatives:

Les Doud	Hartzell Propeller Air Safety Investigator
Josh Lindberg	NTSB Investigator in Charge
Todd Fox	NTSB Sr. Investigator
Michael Hicks	NTSB Air Safety Investigator
Jeff Davis	Pratt & Whitney Canada Air Safety Investigator
Markus Kohler	Pilatus Air Safety Investigator
Ryan Deinhardt	Pilatus Air Safety Investigator
Mark Biron	Pilatus Air Safety Investigator

General Comments: The PC-12 propeller examined is a 105-inch diameter, 4-blade single-acting, hydraulically operated constant speed model with feathering and reversing pitch capability. Oil pressure from the propeller governor is used to move the blades to the low pitch (blade angle) direction. A feathering spring force and blade counterweight twisting moments are used to move the blades to the high pitch/feather 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. The propeller utilizes an aluminum hub with aluminum blades. Rotation is clockwise as viewed from the rear. A cross sectional view of the propeller model is shown in Figure 1. Additional basic information is available in Hartzell Manual 149.

Figure 1 – HC-(D,E)4A-3( ) Series Propeller



Installation Data: Refer to Hartzell Installation Data Sheet No. 735 and Type Certificate Data Sheet A78EU for propeller configuration including angle settings below:

(Angles referenced at the 42-inch radius)

Reverse:	-17.5 ± 0.5 degrees
Low Pitch:	19.0 ± 0.2 degrees
Feather:	79.6 ± 0.5 degrees

Propeller Assembly Serial Number: HJ325

Service History: The propeller was last inspected on March 2, 2017 by Greenpoint with a TTSN of 4407.5. The propeller was last overhauled on February 24, 2016 by New England Propeller with a TTSN of 4174.2. The blade serial numbers listed below were installed as new replacements by Warner Propeller and Governor Co. on March 28, 2007.

Item	S/N	Date of Manufacture	TTSN	TSO
Hub/Factory	A28728	10/5/94	4407.5	196
Blade 1	K53527	3/1/07	2359.7	196
Blade 2	K53530	3/1/07	2359.7	196
Blade 3	K53528	3/1/07	2359.7	196
Blade 4	K53534	3/1/07	2359.7	196

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

NOTE: Because of hub fragmentation and blade separations, the blade S/N sequence above may not match maintenance records. The best effort was made to establish the blade S/N sequence based on hub fracture surfaces and blade shank damage. Regardless, the blade S/N sequence has no influence on the findings in this report.

As Received: The propeller assembly fragmented during the impact sequence. All four blades separated and were found at the crash site; two in the impact crater, one blade shank just forward of the impact crater and its corresponding tip section approximately 100 yards forward and to the right of the flight path, and another blade approximately 50 yards to the right of the flight path (see Photo #2). Approximately 90% of the hub fragments were recovered; either still attached to a blade shank or in the impact crater. The aft wall/mounting flange of the propeller hub fractured and remained attached to the engine propeller shaft. The cylinder, piston and feathering spring fractured from the propeller assembly as a unit and was found in the impact crater. The pitch change rod aft of the piston and pitch change fork were not found. All four counterweights fractured; two were found near the impact crater and two were not recovered. Other fragments such as bearing races, ball bearings, preload plate fragments, spinner bulkhead and de-ice slip ring fragments were found in the impact crater.

The propeller components were recovered to a hangar at Amarillo International Airport for further examination. The blades and hub fragments were loosely assembled as shown in Photo #3. Three blades exhibited S-bending and one blade had forward/thrust direction bending.

Spinner Dome: Only approximately 5% of the spinner dome was recovered; it appears the dome was crushed, torn and fragmented during the impact sequence. The dome fragments were recovered in or near the impact crater.

Spinner Bulkhead: The spinner bulkhead fractured from the propeller assembly and was torn, bent and fragmented. Approximately 60% of the spinner bulkhead and de-ice slip ring were recovered in the impact crater. The de-ice brush block was recovered in the impact crater.

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

Engine/Propeller Mounting: The propeller fractured from the engine propeller shaft flange. The back wall of the propeller hub remained attached to the engine flange. It appeared all the threaded inserts and mounting bolts were still attached to the propeller shaft flange.

Hydraulic Unit & Pitch Change Mechanisms: The hydraulic unit (cylinder, piston, feathering spring and pitch change rod) fractured from the propeller assembly and was found in the impact crater in the condition shown in Photo #4. The remaining portion of the pitch change rod appeared to be in the extended position with approximately 2.44" between the reverse stop sleeve and feather stop nuts.

> **Cylinder:** The cylinder fractured from the propeller assembly and was found in the impact crafter. A portion of the cylinder aft of the piston tore from the cylinder and was found separately from the hydraulic unit. The cylinder base clamp was not recovered.
>
> **Piston:** The piston was jammed in the cylinder and no attempt was made to remove it. The piston aft side and exposed OD was dented and dinged.
>
> **Pitch Change Rod:** The pitch change rod aft of the piston was fractured and not recovered. The pitch change rod forward of the piston appeared intact. There was no attempt to remove the remaining portion of the pitch change rod.
>
> **Fork:** The fork was not recovered and assumed to be in the impact crater.
>
> **Feathering Spring/Guides:** The feathering spring, spring guides and retaining cup remained compressed in the cylinder. For safety reasons no attempt was made to remove them.
>
> **Beta Rods/Beta Ring:** The beta ring was not recovered and assumed to be in the impact crater. The beta rods and spring tubes remained in the hub fragments and appeared bent opposite rotation. Only a fragment of the beta yoke and one yoke tappet was recovered from the impact crater.
>
> **Pitch Stops:** The visible portions of the pitch stops (reverse sleeve and feather nuts) were intact and appeared undamaged.

Hub Assembly: See Photo #5. The hub assembly fragmented into three main pieces; a forward and aft portion around blade #1 that was found at the deepest level of the impact crater, a forward and aft portion around blade #2 found approximately 100 yards to the right of the flight path, and forward and aft portions between blades #3 and #4 found in the impact crafter and

was not attached to any blades. The aft/mounting wall of the propeller hub remained attached to the propeller shaft flange. The cylinder attachment boss threads were fractured from the hub.

Preload Plates: Preload plates #1 and #2 were still retained in their respective hub fragments and were mostly intact. Only fragments of preload plates #3 and #4 were found. All had lip damage/deformation consistent with impact forces and the corresponding hub pocket damage. Preload plate #2 had two discernable fork bumper impact marks near the hub split line corresponding to a blade angle range of 28-34° (see Photo #6). Preload plate #2 knob slot also had a knob bracket impact mark at the high pitch end of travel.

NOTE: For this propeller model, when the blade knob is aligned with the hub parting line, the blade angle at the reference station is approximately 33° (knob -3° + 36° - difference between blade Set-up Station and the 42" reference radius = 33°).

Preload Plate	Condition
1	Stain marks at ~20.5° and ~40.5° forward of parting line, lip sheared/damaged, trail edge sidewall dented
2	Hex shape bumper dents at and 8.5° aft of parting line. Lip damaged and sheared, trail edge sidewall fracture. Knob dent at high pitch end of slot
3	Fractured/fragmented, center plug remained in shank
4	Fractured/fragmented, pieces recovered in impact crater

Propeller Blade Properties: See Photos #7 through #14

Blade #1 – Found in impact crater, buried approximately 5 ft. below surface.

Camber side	Leading edge abrasion, sooted last 10-12"
Face side	Not remarkable
Bend	Forward/thrust direction
Twist	Not remarkable
Lead edge damage	Leading edge abrasion, otherwise not remarkable
Trail edge damage	Not remarkable
Knob/Bracket condition	Intact and attached, appears undamaged
Counterweight	Fractured, holes damaged opposite rotation
Blade bearings	Intact with ball imprints
Butt/shank impact marks	None remarkable
De-Ice boot	Intact

Blade #2 – Found approximately 50 yards right of flight path/impact crater. Approximately 3" of tip fractured; fractured tip was recovered.

Camber side	Random scoring near tip
Face side	Abrasion near tip lead edge, chordwise/rotation marks near shank
Bend	S-bend
Twist	Leading edge up, localized leading edge down near tip
Lead edge damage	Localized bending near tip, otherwise not remarkable
Trail edge damage	Torn and gouged, fractures near tip
Knob/Bracket condition	Pitch change knob bracket fractured from the blade butt and was not recovered. Dowel pin hole and attaching screws deformed opposite high pitch.
Counterweight	Fractured, holes damaged opposite rotation
Blade bearings	Blade side races only, ball imprints
Butt/shank impact marks	Gouged by the pitch change knob bracket.
De-Ice boot	Torn near shank and ~4 from end on camber side

Blade #3 – Found in impact crater near surface.

Camber side	Sooted near tip and mid blade adjacent to de-ice boot
Face side	Sooting and heat damage to paint
Bend	S-bend
Twist	Leading edge up/untwisted
Lead edge damage	Abrasion camber side ~0.5"
Trail edge damage	Torn and gouged, spanwise scoring near shank
Knob/Bracket condition	Intact and attached with one attaching screw head fractured in tension
Counterweight	Fractured, holes damaged opposite rotation
Blade bearings	All bearing races missing/not recovered, retention ring missing.
Butt/shank impact marks	30% of the bearing shoulder was fractured from the leading edge side.
De-Ice boot	Heat damaged, charred, bubbled.

Blade #4 – Jagged fracture 22-26" from tip, fracture surface appears to show forward/thrust direction bending. Shank found just outside and beyond impact crater. Tip section found approximately 100 yards forward and to the right of the impact crater.

Camber side	Chordwise/rotational abrasion last 14", random gouges near shank, sooted near tip
Face side	Chordwise/rotational scorning/abrasion near shank
Bend	S-bend
Twist	Leading edge up/untwisted
Lead edge damage	Dents outboard of de-ice boot
Trail edge damage	Torn and gouged, wavy bends
Knob/Bracket condition	The cam follower bearing was fractured and not recovered. The bracket was attached with both screws but lifted/bent off blade surface.
Counterweight	Fractured, holes damaged opposite rotation
Blade bearings	All bearing races missing/not recovered, retention ring missing.
Butt/shank impact marks	Compression/deformation on the leading edge side in the shape of the preload plate slot
De-Ice boot	Torn, chunked and heat damaged.

Photo #2 – Propeller Components In-Situ

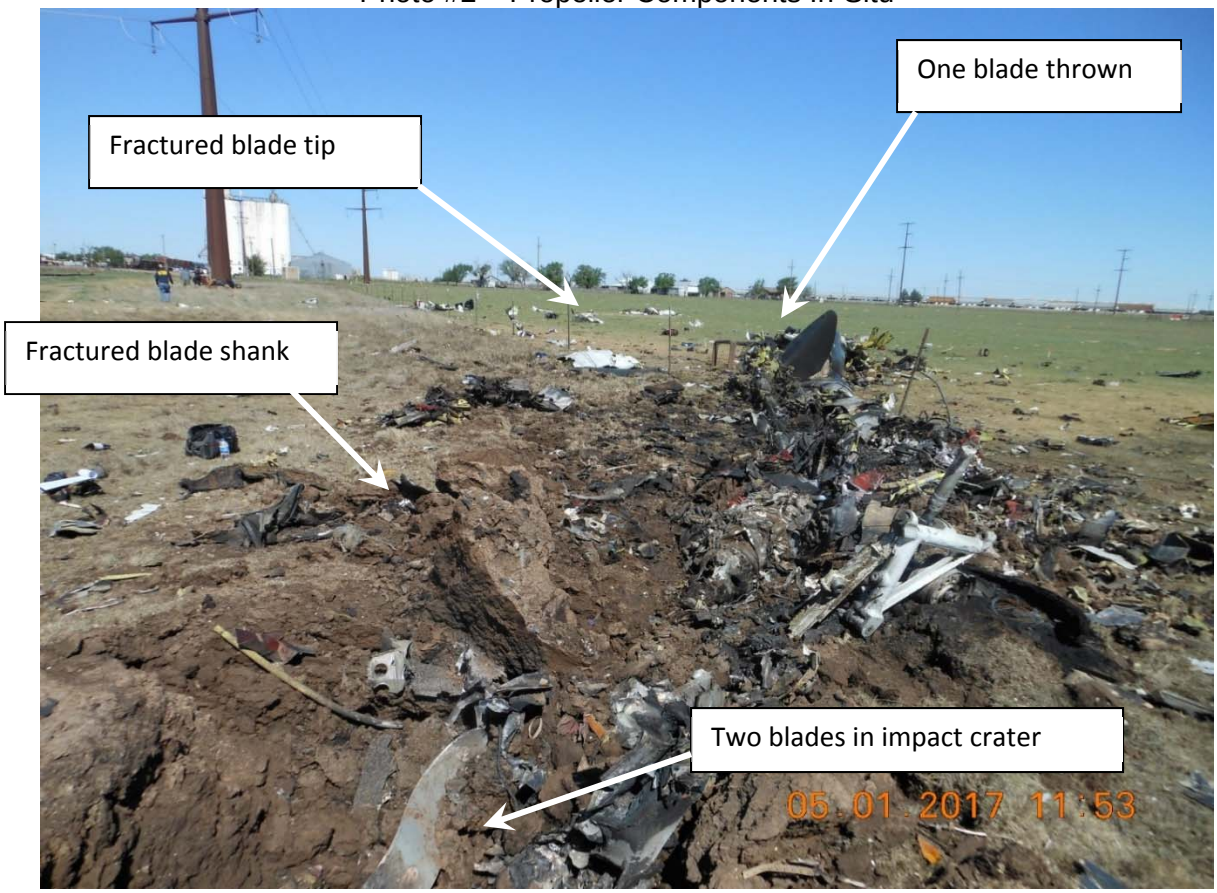


Photo #3 – Main propeller components as-recovered

Photo #4 – Hydraulic Unit as recovered

Photo #5 – Fractured hub fragments

Photo #6 – Preload plate #2

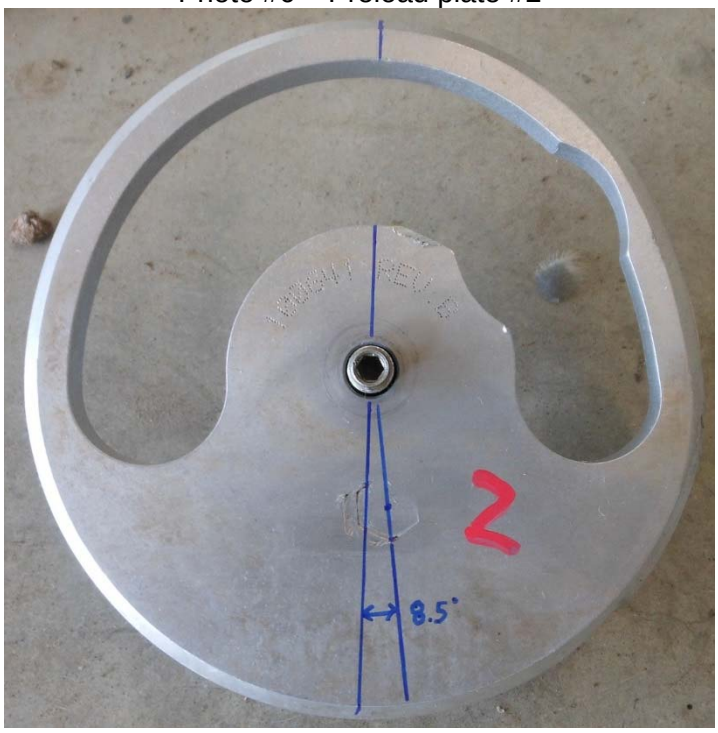


Photo #7 – Blades camber side shank view

Photo #8 – Blades camber side tip view

Photo #9 – Blades leading edge view

Photo #10 – Blades trailing edge view

Photo #11 – Blades face side

Photo #12 – Blades #2-#4 S-bend characteristics trailing edge view

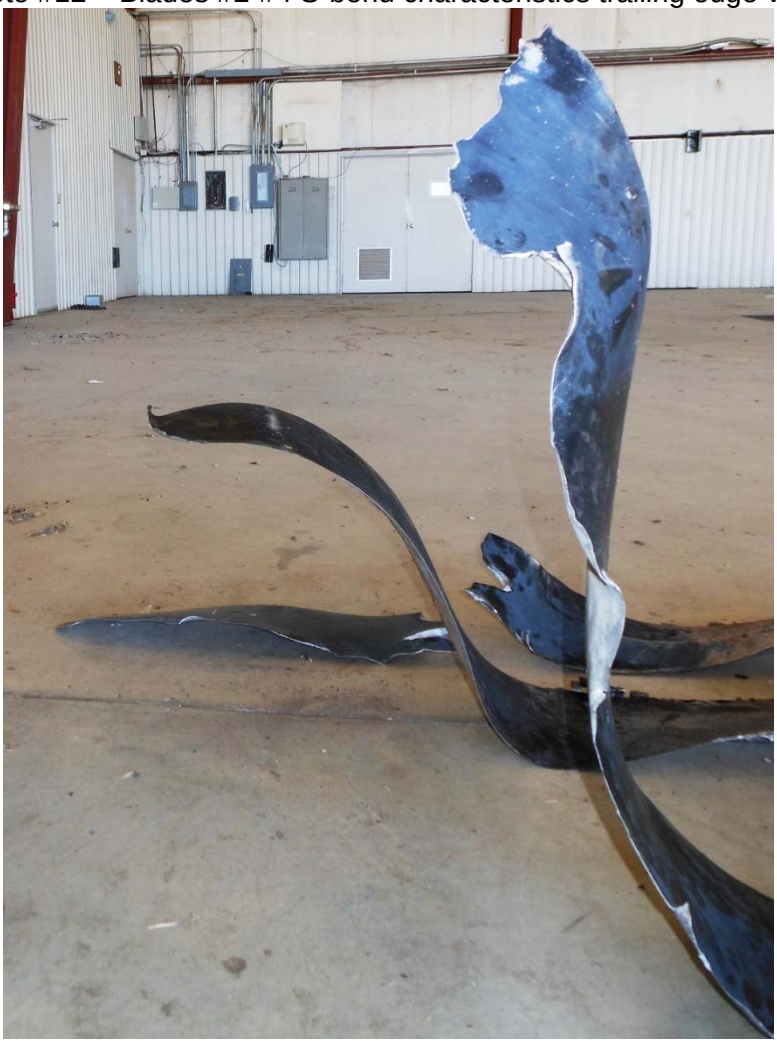


Photo #13 – Blade #4 fracture

Photo #14 – Blade #4 chordwise/rotational scoring on camber side

PHOTOGRAPHIC SUMMARY

NOTE: The following is a list of the original and unedited digital photographs taken during this investigation. The photographs are available in digital format (CD, memory stick/card, FTP). 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 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 were made.

Picture File Name	Description
DSCN5274.JPG	Blade 2 in-situ A
DSCN5275.JPG	Blade 2 in-situ B
DSCN5276.JPG	Blade 4 tip in-situ A
DSCN5277.JPG	Blade 3 in-situ/impact crater A
DSCN5278.JPG	Blade 3 in-situ/impact crater B
DSCN5279.JPG	Impact crater
DSCN5280.JPG	Crash scene direction of flight
DSCN5281.JPG	Blade impression made in dirt at impact crater
DSCN5282.JPG	Hydraulic unit as recovered from impact crater
DSCN5283.JPG	Blade 1 as recovered from impact crater
DSCN5284.JPG	Excavated impact crater after all blades found A
DSCN5285.JPG	Excavated impact crater after all blades found B
DSCN5286.JPG	Prop components dug from crater, previously not visible
DSCN5287.JPG	Estimated reassembly A
DSCN5288.JPG	Estimated reassembly B
DSCN5289.JPG	Estimated reassembly C
DSCN5290.JPG	Estimated reassembly D
DSCN5291.JPG	Estimated reassembly E
DSCN5292.JPG	Propeller S/N
DSCN5293.JPG	Hub unit S/N A
DSCN5294.JPG	Hub unit S/N B
DSCN5295.JPG	Hub unit S/N C
DSCN5296.JPG	Hydraulic unit A
DSCN5297.JPG	Hydraulic unit B
DSCN5298.JPG	Pitch change rod extension measurement
DSCN5299.JPG	Final estimated reassembly
DSCN5300.JPG	Hub unit fragment surrounding blade 1
DSCN5301.JPG	Hub unit fragment surrounding blade 2
DSCN5302.JPG	Blades camber side shank view
DSCN5303.JPG	Blades camber side tip view
DSCN5304.JPG	Blades camber side leading edge view
DSCN5305.JPG	Blades camber side trailing edge view
DSCN5306.JPG	Blade 2 tip fracture A
DSCN5307.JPG	Blade 2 tip fracture B
DSCN5308.JPG	Blade 4 mid blade fracture A

DSCN5309.JPG	Blade 4 mid blade fracture B
DSCN5310.JPG	Blade 4 fracture surface shank side
DSCN5311.JPG	Blade 4 fracture surface tip side
DSCN5312.JPG	Blade 4 fracture leading edge view
DSCN5313.JPG	Blade 4 fracture camber side view
DSCN5314.JPG	Blade 4 camber tip chordwise/rotational abrasion
DSCN5315.JPG	Blade 3 camber side tip area
DSCN5316.JPG	Blade 2 camber side tip area
DSCN5317.JPG	Blade 1 camber side tip area
DSCN5318.JPG	Blades face side shank view
DSCN5319.JPG	Blades face side tip view
DSCN5320.JPG	Blades 3 and 4 face side
DSCN5321.JPG	Blade 4 fractured tip face side
DSCN5322.JPG	Blade 4 fractured shank face side
DSCN5323.JPG	Blades 3 and 4 face side shank view
DSCN5324.JPG	Blade 2 face side
DSCN5325.JPG	Blade 2 tip fracture face side A
DSCN5326.JPG	Blade 2 tip fracture face side B
DSCN5327.JPG	Blade 1 face side tip
DSCN5328.JPG	Blade 1 shank
DSCN5329.JPG	Blade 2 shank
DSCN5330.JPG	Blade 3 shank
DSCN5331.JPG	Blade 4 shank
DSCN5332.JPG	Blade 4 preload plate fragments
DSCN5333.JPG	Blade 3 preload plate fragments
DSCN5334.JPG	Blade 2 preload plate
DSCN5335.JPG	Blade 1 preload plate
DSCN5336.JPG	Hub fragments A
DSCN5337.JPG	Hub fragments B
DSCN5338.JPG	Hub fragments C
DSCN5339.JPG	Spinner bulkhead and de-ice slip ring fragments
DSCN5340.JPG	Counterweights
DSCN5341.JPG	Bearings and misc. parts
DSCN5342.JPG	Spinner dome fragments
DSCN5343.JPG	Hardware bags
DSCN5344.JPG	Hydraulic unit C
DSCN5345.JPG	Hydraulic unit D with cylinder fragment
DSCN5346.JPG	Low pitch collar and block
DSCN5347.JPG	Blade 2 tip fracture and trailing edge damage
DSCN5348.JPG	Blade 3 S-bend
DSCN5349.JPG	Blade 2 S-bend characteristics
DSCN5350.JPG	Engine compressor to accessory housing connection torsional/compression A
DSCN5351.JPG	Engine compressor to accessory housing connection torsional/compression B
DSCN5352.JPG	Engine 1st stage compressor blade damage A
DSCN5353.JPG	Engine 1st stage compressor blade damage B
DSCN5354.JPG	Engine turbine damage
DSCN5355.JPG	Propeller mounting flange/hub fragment mounted to prop shaft flange A
DSCN5356.JPG	Propeller mounting flange/hub fragment mounted to prop shaft flange B
DSCN5357.JPG	Prop assembly components overall

DSCN5358.JPG	Blade 1 hub fragments
DSCN5359.JPG	Blade 2 hub fragments
DSCN5360.JPG	Hub unit S/N B
DSCN5361.JPG	Blade 3-4 hub fragments external
DSCN5362.JPG	Blade 3-4 hub fragments internal
DSCN5363.JPG	Preload plate 1 marked A
DSCN5364.JPG	Preload plate 1 marked B
DSCN5365.JPG	Preload plate 2 marked
DSCN5366.JPG	Preload plate 2 knob impact mark a high pitch end
DSCN5367.JPG	Logbook 1
DSCN5368.JPG	Logbook 2
DSCN5369.JPG	Logbook 3
DSCN5370.JPG	Logbook 4
DSCN5371.JPG	Logbook 5
DSCN5372.JPG	Logbook 6
DSCN5373.JPG	Logbook 7
DSCN5374.JPG	Logbook 8
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DSCN5402.JPG	Logbook 36
DSCN5403.JPG	Logbook 37
DSCN5404.JPG	Logbook 38
DSCN5405.JPG	Logbook 39
DSCN5406.JPG	Logbook 40

DSCN5407.JPG	Logbook 41
DSCN5408.JPG	Logbook 42
DSCN5409.JPG	Logbook 43