

Date of Accident: March 19, 2017

Location: Minter City, MS

NTSB File No.: ERA17FA131

Aircraft: Air Tractor AT-602

Registration No.: N2049D

Serial No.: 602-1219 (Year of Manufacture 2012)

Owner/Operator: per FAA registry:
Sturdivant Brothers Flying Service Inc.
738 Sturdivant Road
Glendora, MS 38928-2541

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

Report Date: February 5, 2018

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PROPELLER TEARDOWN REPORT

Date of Investigation: June 22, 2017

Location: Dawson Aircraft Inc., Clinton, AR

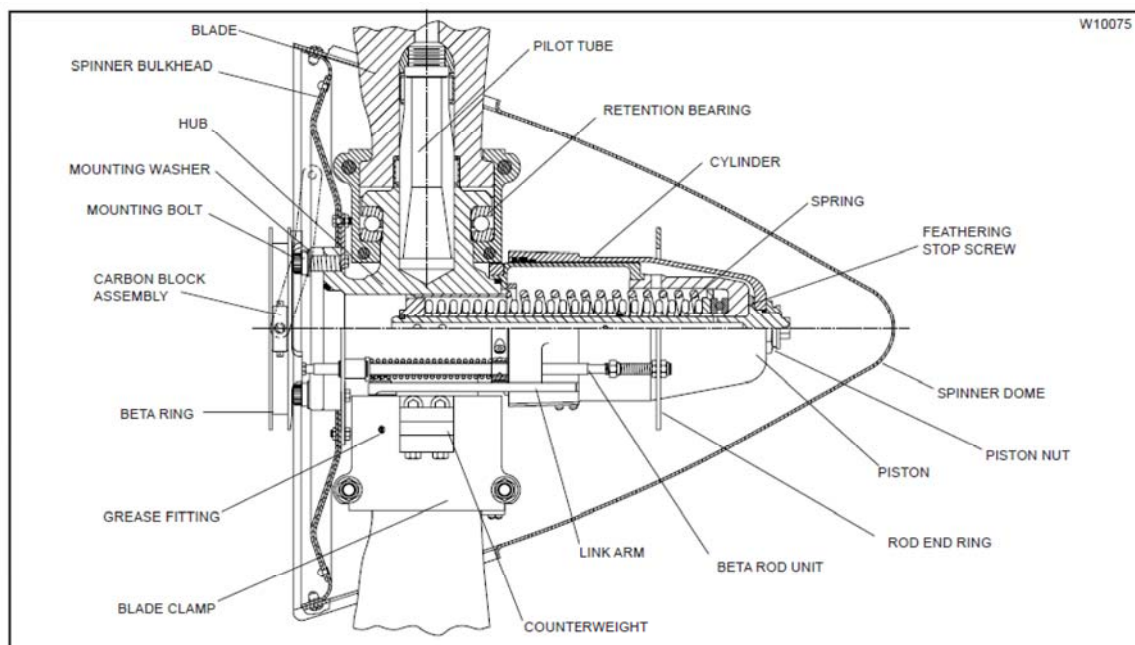
Propeller Model: HC-B5MP-3C with M10876ANS blades

Representatives:	Les Doud	Hartzell Propeller Inc.
	Tim Monville	NTSB Investigator in Charge
	Leslie Ederer	Pratt & Whitney Canada ASI

General Comments: The propeller examined is a 111.2-inch diameter, 5-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 and a feathering spring provide moments and force towards the high pitch 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 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. 95 or 1442 and Aircraft TCDS A19SW for settings referenced below (Angles referenced at the 42-inch radius):

Reverse:	-11.0 ± 0.5 degrees
Low Pitch:	16.5 ± 0.1 degrees
Feather:	79.0 ± 0.5 degrees
Counterweight:	Positive



Propeller Assembly S/N: EVA3219

Service History: The propeller was assembled and inspected as new at Hartzell Propeller on 10/9/12. The propeller logbooks were not available at the time of this examination therefore the service history is unknown. There was a decal on the piston suggesting the last service was performed by Mid-America Specialized Services.

	<u>S/N</u>	<u>Date of Manufacture</u>	<u>TTSN</u>	<u>TSO</u>
Hub/Factory	D4001A	10/9/12	UNK	UNK
Blade 1	L29161	10/2/12	UNK	UNK
Blade 2	K91312	8/12/09	UNK	UNK
Blade 3	L22094	2/23/12	UNK	UNK
Blade 4	L22101	2/23/12	UNK	UNK
Blade 5	L29163	10/2/12	UNK	UNK

Blade Orientation: The blades were identified as 1-2-3-4-5 counterclockwise as viewed from the rear of the propeller (in sequence of rotation). The hub serial number was between the #5 and #1 blades.

“As Received” Condition: The engine Reduction Gear Box (RGB) fractured from the engine during the impact sequence with the propeller still attached to the propeller shaft. It was recovered to Dawson’s and presented for examination as shown in Photo #1. All five blades remained attached to the propeller assembly. All blades were bent aft in varying degrees and exhibited leading edge bends characteristic of tree strikes. One blade was fractured approximately 10.5” from the tip. The spinner dome was dented and buckled in some areas but roughly maintained its shape. There was a counterweight impression formed in the dome. The propeller assembly is shown in Photo #2 after removal of the spinner dome. The piston was extended approximately 2.42” from the beta rod guide collar to a flight idle/low pitch stop position and jammed in that position by blade/clamp rotation beyond the reverse angle. The feathering spring was holding tension against three immovable/bent link arms. All blades were retained by the clamps and all clamps were intact with no fractured bolts. One blade (#5) showed slippage towards low pitch of approximately 10 degrees. One link arm (#1) had pulled from and fractured the piston attachment point; hole deformation was towards high pitch. The #4 link arm was detached from the link screw on the clamp. The #1 counterweight appears to have rotated more than 90° lower than the reverse range and punctured the spinner bulkhead.

Spinner Dome: The spinner dome was dented and torn. There was a counterweight impression in the spinner dome at the blade #5 position with a counterweight angle of approximately 23 deg. (Photo #3). This is approximately equivalent to a blade angle of 11°.

Spinner Bulkhead: The spinner bulkhead remained attached to the propeller but the dome attachment flange was bent. The bulkhead appeared to be punctured by the #1 counterweight on the lead edge side of the blade.

Propeller Cycling: Propeller cycling was not possible due to impact damage. The hydraulic unit was jammed in a low pitch position.

Engine/Propeller Mounting: The propeller mounting flange was intact and appeared undamaged.

Blade/Clamp Slippage and Rotation:

Blade	Blade/clamp Angle As-Received	Blade Slip in Clamp?	Rotation of clamp on bearings possible?
1	Rotated and jammed beyond reverse, counterweight angle approximately -45°	No	Yes
2	Rotated and jammed beyond reverse, counterweight angle approximately -60°	No	Yes
3	Rotated and jammed beyond reverse, counterweight angle approximately -60°	No	Yes
4	The #4 link arm was pulled from the link screw, the counterweight was approximately $+35^{\circ}$ and the blade/clamp was free to rotate	No	Yes
5	Jammed at approximately $+23^{\circ}$ counterweight angle	Yes, approximately $5-10^{\circ}$ towards low pitch	Yes

Pitch Stops:

Reverse and Low Pitch Stop: The reverse stop sleeve was not removed or examined. All three low pitch stop nuts were present.

Feather Stop Screws: All four screws appeared intact and undamaged. The adjacent stop screw marks in the piston showed normal contact signatures.

Beta Rods & Ring: All three beta rods remained attached to the beta ring. The beta rod return springs remained in place. The beta rod support ring was intact and appeared undamaged with the attachment nuts in place. The beta ring was intact and appeared undamaged. The beta arm and carbon block were intact and appeared undamaged at approximately the low pitch/flight idle position.

Piston: The piston was intact except for the #1 link arm attachment point; the link pin hole deformation was in the direction of high pitch. The piston appeared rotated on cylinder; one of two guide rods was bent opposite this rotation. There was scuff/scrape on the forward end of the piston between blades #1 and #5. There was a measureable amount of oil in the piston/prop shaft cavity that drained when the feathering spring was released and piston removed. The piston showed internal impact marks at several locations (see Photo #4):

1. 3.4" from the bottom edge, approximately equivalent to 50° blade angle
2. 2.07" from the bottom edge, approximately equivalent to 10° blade angle

3. Several marks in the range 1.87-1.93", approximately equivalent to 4-6° blade angle
4. Scuff marks starting at 2.88" extending to the forward break corner (feather end) of the piston stroke

Link Arms: All five link arms remained on the propeller assembly (see Photo #5). The #2, #3 and #5 link arms remained attached to the link pins and screws. The #1 link arm pulled from the piston and fractured the link pin attachment. The #4 link arm separated from the clamp link screw.

Link Arm	Link Arm Condition
1	Link screw hole stretched, arm appeared normal length
2	Bent in compression, link screw hole stretched
3	Bent in compression, link screw hole damaged
4	Bent in compression, link screw hole stretched
5	Normal length, link screw hole stretched

Cylinder: The cylinder appeared undamaged but had some rub marks at approximately 2.31 to 2.9" from the top of the beta rod guide collar (see Photo #6). The marks closely match the positions of the piston O-ring and phenolic rub strip grooves. The piston displacement needed to make these marks is approximately equivalent to a blade angle of 10°. The forward spring cup/retainer hardware remained in place and appeared undamaged.

Feathering Spring Assembly: The feathering spring was intact and remained in the hydraulic unit and thus not inspected. The feathering spring appeared to be attached to the pitch change rod as the rod snapped to the feather position when released by the piston nut.

Pitch Change Rod: The pitch change rod was not removed or inspected. It was loaded by the feathering spring and snapped from the low pitch/extended position to feather when released from the piston.

Clamps and Counterweights: (Photo #7) There was adequate and clean grease in the blade bearings and clamp interior surfaces.

Clamp Pos.	Clamp S/N	Clamp Condition	Counterweight Condition
1	F27199	Intact	Scoring by contact with adjacent component
2	F27198	Intact	Scoring by contact with adjacent component
3	F27176	Intact	Scoring by contact with adjacent component
4	F27197	Intact, link screw bent opposite low pitch	Scoring by contact with adjacent component
5	F27177	Intact, link screw bent opposite high pitch	Not remarkable

Hub Unit: (Photo #8) The #5 pilot tube fractured, all others were intact. The four other blades were easily removed from their clamps and pilot tubes. Blade arm #5 had blade

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impact marks in the trail/face quadrant, lead/camber quadrant and rotational scoring on both the blade butt and hub arm surfaces (Photos #9 and #10). The cylinder mounting was intact and beta/piston guide ring was in place with contact damage from the link arms and screws. The propeller mounting flange was intact and appeared undamaged. All the mounting hardware was intact with safety wiring.

Blade Properties: See Photos #11 through #14

Blade # 1

Camber side	Not remarkable
Face side	Not remarkable
Bend	Aft
Twist	Leading edge up at tip
Lead edge damage	Tree strike waves/bends
Trail edge damage	Dents
Blade bearings	Intact
Butt/shank impact marks	Pilot tube shoulder arm impact mark in face/trail quadrant
De-Ice boot	NA

Blade # 2

Camber side	Caked mud/sap-like substance
Face side	Not remarkable
Bend	Aft
Twist	Not remarkable
Lead edge damage	Tree strike waves/bends, accelerated abrasion
Trail edge damage	Not remarkable
Blade bearings	Intact
Butt/shank impact marks	Pilot tube shoulder impact mark in trail edge quadrant
De-Ice boot	NA

Blade # 3

Camber side	Not remarkable
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down at tip
Lead edge damage	Tree strike waves/bends
Trail edge damage	Partially fractured ~31" from butt, tree strike shape/bend
Blade bearings	Intact
Butt/shank impact marks	Pilot tube shoulder impact mark around circumference
De-Ice boot	NA

Blade # 4

Camber side	Caked mud/sap-like substance
Face side	Not remarkable
Bend	Aft
Twist	Leading edge up
Lead edge damage	Tree strike waves/bends, accelerated abrasion
Trail edge damage	Partially fractured ~31" from butt, tree strike shape/bend
Blade bearings	Intact
Butt/shank impact marks	Pilot tube shoulder impact mark around circumference
De-Ice boot	NA

Blade # 5 – Blade portion fractured 39.5" from butt (~10.5" from tip) and piece not recovered

Camber side	Score mark in mid-blade from trail edge, caked mud/sap-like substance
Face side	Not remarkable
Bend	Aft
Twist	Leading edge down at tip
Lead edge damage	Tree strike wave/bend shape near fracture
Trail edge damage	Waviness near tip
Blade bearings	Intact
Butt/shank impact marks	Two impact crescents and rotational score marks
De-Ice boot	NA

Photo #1 – Propeller assembly as-received



Photo #2 – As-received with spinner dome removed



Photo #3 – Counterweight impression angle at blade #5

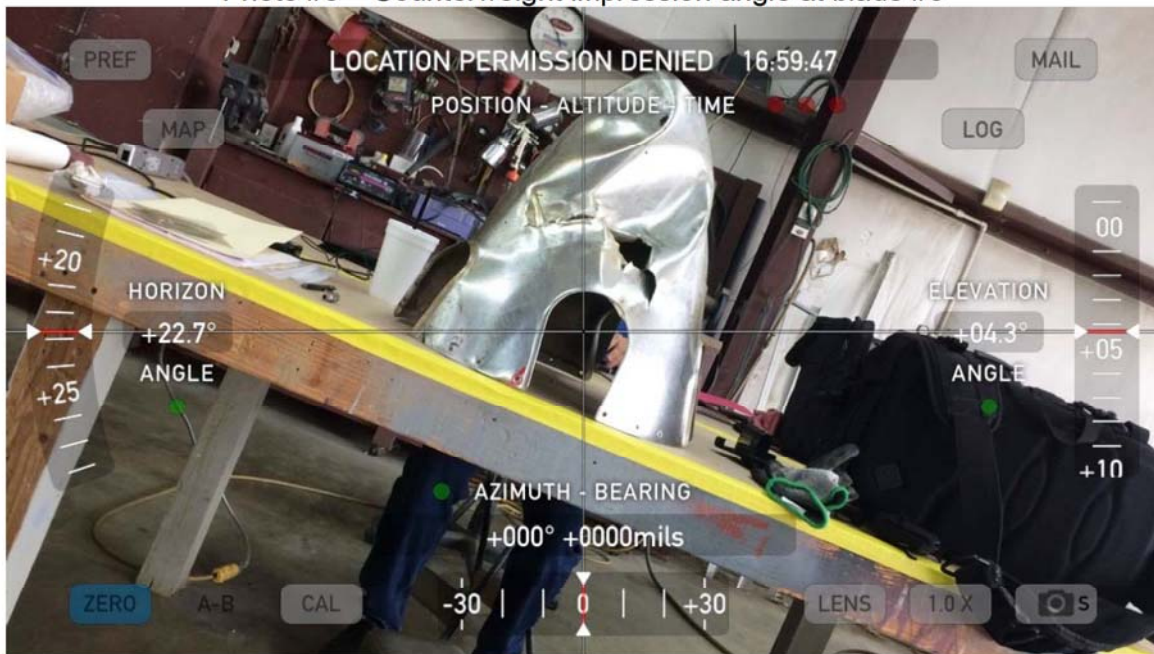


Photo #4 – Internal piston marks



Photo #5 – Link arms



Photo #6 – Cylinder mark measurements



Photo #7 – Clamps

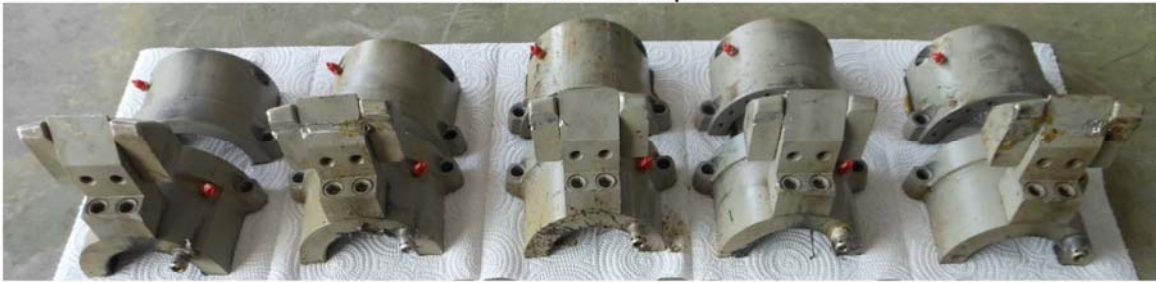


Photo #8 – Hub unit



Photo #9 – Hub arm #5 impact crescent



Photo #10 – Blade butt #5 impact marks



Photo #11 – Blades camber side (#1-#5 right to left)



Photo #12 – Blades face side (#1-#5 left to right)



Photo #13 – (Blade leading edge view, blade #5 in foreground)



Photo #14 – Blade #2 leading edge, typical tree strike wave/bends



PHOTOGRAPHIC SUMMARY

NOTE: The following is a list of the original and unedited digital photographs taken by the author. 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 are permitted.

<u>Picture File Name</u>	<u>Description</u>
DSCN5603.JPG	Engine gearbox second stage planetary to prop shaft connection A
DSCN5604.JPG	Engine gearbox second stage planetary to prop shaft connection B
DSCN5605.JPG	Engine gearbox second stage planetary to prop shaft connection C
DSCN5606.JPG	Prop beta arm as-received
DSCN5607.JPG	Prop as-received A
DSCN5608.JPG	Prop as-received B
DSCN5609.JPG	Prop as-received C
DSCN5610.JPG	Prop as-received D
DSCN5611.JPG	Prop as-received E
DSCN5612.JPG	Prop as-received F
DSCN5613.JPG	Prop as-received G
DSCN5614.JPG	Prop as-received H
DSCN5615.JPG	Prop as-received I
DSCN5616.JPG	Prop as-received J
DSCN5617.JPG	Prop as-received K
DSCN5618.JPG	Prop spinner dome removed, components numbered A
DSCN5619.JPG	Prop spinner dome removed, components numbered B
DSCN5620.JPG	Prop spinner dome removed, components numbered C
DSCN5621.JPG	Prop spinner dome removed, components numbered D
DSCN5622.JPG	Prop spinner dome removed, components numbered E
DSCN5623.JPG	Prop spinner dome removed, components numbered F
DSCN5624.JPG	Prop spinner dome removed, components numbered G
DSCN5625.JPG	Blade #1 slip indicator
DSCN5626.JPG	Blade #2 slip indicator
DSCN5627.JPG	Blade #3 slip indicator
DSCN5628.JPG	Blade #4 slip indicator
DSCN5629.JPG	Blade #5 slip indicator
DSCN5630.JPG	Piston extension measurement A
DSCN5631.JPG	Piston extension measurement B
DSCN5632.JPG	Piston extension measurement C
DSCN5633.JPG	Spinner bulkhead puncture A
DSCN5634.JPG	Spinner bulkhead puncture B
DSCN5635.JPG	Spinner bulkhead puncture C
DSCN5636.JPG	Blades and clamps as-removed
DSCN5637.JPG	Blade butt #5 as-removed
DSCN5638.JPG	Blades and clamps #2, #3, #4 as-removed

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DSCN5639.JPG	Hub unit final stage of disassembly
DSCN5640.JPG	Feather stop screws
DSCN5641.JPG	Blade arm #2
DSCN5642.JPG	Blade arm #3
DSCN5643.JPG	Blade arm #4
DSCN5644.JPG	Blade arm #5 A
DSCN5645.JPG	Blade arm #5 B
DSCN5646.JPG	Blade arm #5 C
DSCN5647.JPG	Blade arm #1 A
DSCN5648.JPG	Blade arm #1 B
DSCN5649.JPG	Prop S/N A
DSCN5650.JPG	Prop S/N B
DSCN5651.JPG	Misc. air tool adaptor - not related
DSCN5652.JPG	Piston ID mark A
DSCN5653.JPG	Piston ID mark B
DSCN5654.JPG	Piston ID mark C
DSCN5655.JPG	Piston ID mark D
DSCN5656.JPG	Piston ID mark E
DSCN5657.JPG	Piston ID mark F
DSCN5658.JPG	Piston #1 link arm attach point fracture
DSCN5659.JPG	Piston decal with name of repair station
DSCN5660.JPG	Link arms A
DSCN5661.JPG	Link arms B
DSCN5662.JPG	Link arm #5 comparison A
DSCN5663.JPG	Link arm #5 comparison B
DSCN5664.JPG	Link arm #4 comparison
DSCN5665.JPG	Link arm #3 comparison
DSCN5666.JPG	Link arm #2 comparison
DSCN5667.JPG	Link arm #1 comparison
DSCN5668.JPG	Clamps A
DSCN5669.JPG	Clamps B
DSCN5670.JPG	Clamps C
DSCN5671.JPG	Clamp #5 and #4 counterweight arm/slugs
DSCN5672.JPG	Clamp #1, #2, and #3 counterweight arm/slugs
DSCN5673.JPG	Prop mounting and beta ring A
DSCN5674.JPG	Prop mounting and beta ring B
DSCN5675.JPG	Blade arm #5 impact marks A
DSCN5676.JPG	Blade arm #5 impact marks B
DSCN5677.JPG	Cylinder rub marks A
DSCN5678.JPG	Cylinder rub marks B
DSCN5679.JPG	Cylinder rub marks C
DSCN5680.JPG	Cylinder rub marks D
DSCN5681.JPG	Cylinder rub marks E
DSCN5682.JPG	Cylinder rub marks F
DSCN5683.JPG	Cylinder rub marks G
DSCN5684.JPG	Cylinder rub marks H
DSCN5685.JPG	Blades camber tip area
DSCN5686.JPG	Blades #1 and #2 camber tip area
DSCN5687.JPG	Blades #3 and #4 camber tip area
DSCN5688.JPG	Blades #4 and #5 camber tip area

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DSCN5689.JPG	Blades camber lead edge view
DSCN5690.JPG	Blades camber trial edge view
DSCN5691.JPG	Blade butt #1
DSCN5692.JPG	Blade butt #2
DSCN5693.JPG	Blade butt #3
DSCN5694.JPG	Blade butt #4
DSCN5695.JPG	Blade butt #5
DSCN5696.JPG	Blade #2 camber lead edge abrasion/chordwise mud/sap A
DSCN5697.JPG	Blade #2 camber lead edge abrasion/chordwise mud/sap B
DSCN5698.JPG	Blade #4 camber lead edge mud and blade #3 trail edge fracture
DSCN5699.JPG	Blade #3 tip camber lead edge tree strike
DSCN5700.JPG	Blades face side shank view
DSCN5701.JPG	Blades face side tip view
DSCN5702.JPG	Blades face side trail edge view
DSCN5703.JPG	Blades face side lead edge view
DSCN5704.JPG	Blades #2 and #3 lead and trail edge bends A
DSCN5705.JPG	Blades #2 and #3 lead and trail edge bends B
DSCN5706.JPG	Blades #2 and #3 lead and trail edge bends
DSCN5707.JPG	Blade #4 lead edge
DSCN5708.JPG	Blade #1 lead edge bends
DSCN5709.JPG	Blade #5 fracture surface
DSCN5710.JPG	Blade #5 fracture area/lead edge bend
DSCN5711.JPG	Blades #3 and #4 trail edge fractures/bends
DSCN5712.JPG	Blades face side trail/shank view