NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594
DATE

STRUCTURES/FLIGHT CONTROLS

EXAM

NTSB Case No.: ERA13FA273

1.1 ACCIDENT:

1.2 Description

Location:	Manchester, KY
Date:	June 6, 2013
Time:	2315 Eastern Daylight Time
Helicopter:	Bell206L1
	N114AE

1.3 Summary

On June 6, 2013, about 2315 eastern daylight time, a Bell 206 L-1, N114AE, was destroyed when it impacted the ground in an elementary school parking lot while on approach to the company helicopter landing zone near Manchester, Kentucky. Night visual meteorological conditions prevailed; however, reports of patchy fog were reported by numerous eyewitnesses and a company visual flight rules flight plan was filed. The airline transport pilot and two medical personnel were fatally injured. The repositioning flight to the company helipad was conducted under the provisions of Title 14 Code of Federal Regulations Part 91 and had departed from the St. Joseph-London Heliport (5KY9), London, Kentucky about 2259.

1.4 HELICOPTER INFORMATION

According to FAA and company records the helicopter was issued an airworthiness certificate on September 26, 1980 and was registered to Air Evac EMS, Inc on October 31, 2002.. The helicopter was modified with an enhanced power and increased payload which gives it a further designation of an "L-1 Plus."

Helicopter Manufacturer: Bell Helicopter Textron
Helicopter Model Number: 206 L-1
Helicopter Serial Number: 45507
Helicopter Date of Manufacturer: September 26, 1980
Helicopter Total Time in Service: 19971.6 hours
Total Cycles: 7371
Recent Inspection: Event 1 – June 6, 2013
Engine Manufacturer: Allison
Engine Model Number: 250-C30P
Engine Serial Number: CAE 895805
Engine Total Time in Service: 4701.4 hours

1.5 INITIAL EXAMINATION AS RECEIVED

On November 4 – 7, 2013 the investigative group listed below met at Atlanta Air Recovery in Griffin, Georgia to further examine the helicopter wreckage. The wreckage had been in secured storage with access being granted to the recovery facility on two (2) occasions. The first occasion was shortly after the accident to facilitate the removal and shipment of the engine to Rolls-Royce in Indianapolis, Indiana for examination (see Engine Examination Report for further information on the engine exam). The second, and only other, time was on June 15, 2013 at the request of the IIC to take swabs of reddish colored substance for further examination by the Smithsonian Institute – Bird Identification Laboratory, for possible bird DNA. The swab samples indicated the presence of bird DNA; however, the DNA was that of a Least Flycatcher *(Empidonax minimus)* which was about 10.3 grams (0.36 ounces). However, due to the presences of DNA further samples were gathered during this examination and shipped to the Smithsonian Institute – Bird Identification Laboratory for DNA analysis. According to the analysis performed by the Smithsonian Institute, the samples were devoid of DNA and no feather evidence was found during the microscopic examination. The analysis further stated that "some insect parts only" were found.

The wreckage was brought out of storage and placed in the recovery facility's shop to facilitate the examination of the fracture surfaces. The wreckage brought to the shop consisted of the main wreckage, which included the cockpit and cabin section, which had been thermally destroyed during the accident. The wreckage also consisted of the tail rotor section and assembly and the main rotor assembly which included the upper deck section.

1.6 PARTICIPANTS IN THE EXAMINATION

Shawn Etcher
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1.7 SUMMARY OF EXAMINATION FINDINGS

All separations in the structure and flight control hardware were consistent with static overload.

2 DETAILS of the STUDY:

2.1 Tail Boom

The tail boom was separated about 16 inches aft of the fuselage/tailboom intersection. The boom separated in bending, with the direction of bending as if the rotor section moved to the

right and slightly down.

<u>Photo 1</u> View looking aft. There is compression damage on the right side of the boom (the left side in the photo), tension damage on the left side (the right side in the photo), and the two tubes are bent to the right at their fracture points.

<u>Photo 2</u> View looking forward. The vertical plane is about 45 degrees to the left. There is tension damage on the left side. The two tubes are bent to the right at their fracture points. The fractures of the forward section match the fractures of the aft section.

2.2 <u>Tail Rotor Drive Shaft</u>

All components of the segmented tail rotor drive shaft were present. There are 6 sections of the drive shaft. The fracture of the tail boom occurred mid-span of the second section. There are five support bearings where the sections are joined by Thomas couplings. The forward end is attached to a drive spline. The aft end is joined to the tail rotor gear box. The push-pull tubes exposed at the tail boom separation point could be freely moved and actuate the elevator and tail rotor blade incidence. The tail rotor drive shaft could be freely rotated and the tail rotor freely rotated in response.

Photo 3 The boom fracture is mid-span of the number 2 driveshaft section.

<u>Photo 4</u> View looking to the right shows the number 1 hangar bracket bent forward. The bracket is on the forward section of the tail boom.

<u>Photo 5</u> View looking to the left shows the number 2 hangar bracket bent aft. The bracket is on the aft section of the tail boom.

Photo 6 Scoring marks on hangar bracket match the threads and nuts on the drive shaft. The Thomas Coupling remnants are bent forward.

Photo 7 The tail rotor drive shaft was still attached to the spline that transfers power from the engine to the shaft.

2.3 Main Rotor Mast and Transmission

The main rotor blades, hub, mast, transmission and upper deck separated from the helicopter as a unit. The mast was bent in two places. At the upper end, the mast was bent just below imprints left by the mast stops that are attached to the rotor hub. The bend was about 5 degrees. The bend at the lower portion of the mast was below the swash plate. The bend was about 20 degrees and was in plane with the upper bend.

Photo 8 The mast is bent about 20 degrees from vertical using the transmission as the reference. At the upper end, the bend is about 5 degrees back toward vertical.

<u>Photo 9</u> Both stops contacted the mast. This side shows a distinct impression and gouging in the metal.

<u>Photo 10</u> Mast contact at stop.

2.4 Pitch Change Links

Both pitch change links were present. One was still attached to the swash plate and pitch arms although it was fractured in bending overload. The other pitch change link had fractured in bending overload. The lower portion had separated from the helicopter and was found near the tail boom. The lower end pulled out of the swash plate. The fracture at the swash plate appeared consistent with a tension fracture and a bending type fracture on the other side. The small section from the swash plate remained with the lower bearing of the pitch change link. Samples of deposits were taken from both pitch change links to be examined for source.

Photo 11 The pitch change link was fractured. The damage was consistent with a bending overload. The lower portion separated from the swash plate and was found near the tail boom.

<u>Photo 12</u> The lower portion of the pitch change link. A section tore from the swash plate and the section remained with the link. The fracture at the thin portion was consistent with tension overload. The fracture at the thicker, lower portion was also consistent with tension and some bending in the area.

Photo 13 The change link separated in bending overload.

Photo 14 The pitch change link separated in bending overload.

2.5 Collective Lever and Sleeve

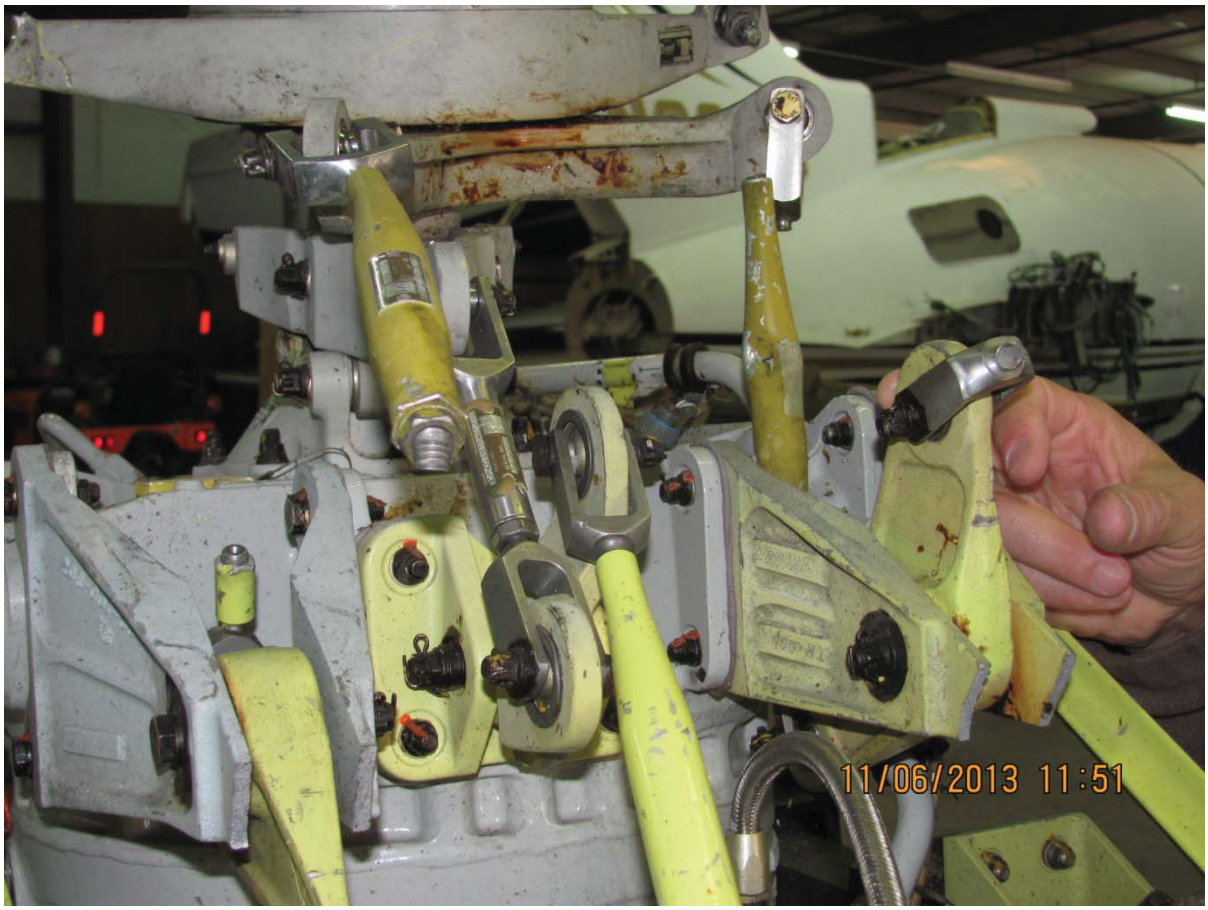
The collective sleeve separated from the collective lever pins and was free to slide. One of the pins was bent slightly upward. The second pin appeared to remain in a normal orientation. The two pin bushings were severely gouged in a downward direction, as if the pins were moving in a downward direction.

2.6 Swash Plate Linkages

The linkages that attach to and move the swash plate were separated in bending overload.

<u>Photo 15</u> The collective lever pivot pins had separated from the bushings and were found above the bushings. However, the right pin or arm was bent slightly upward. The bushing was gouged in a downward direction. The top portion of the gear box casting was damaged by the casting that holds the bushings.

Photo 16 The right bushing was gouged in a downward direction.



<u>Photo 17</u> The linkages that attach to the bell cranks and swash plate were fractured. The fractures were consistent with static bending overload. The transmission was free to rotate by moving the K-flex attach fitting.

Drive shaft

<u>Photo 18</u> The K-flex drive shaft was found in the parking lot, about mid-distance between the fuselage and main rotor blades.

2.7 Upper Deck Structure

The upper deck structure had separated cleanly from the fuselage. All fractures were consistent with static overload.

Photo 19 Forward left quadrant of upper deck.

Photo 20 Forward right quadrant of upper deck.

Photo 21 Aft portion of upper deck.

2.8 Main Rotor Blades

Both main rotor blades remained attached to the hub. One blade remained intact; the other was separated about 149 inches from the mast. The forward portion of the fracture was along a line generally perpendicular to the span and curving inboard toward the aft end. The separated tip was found next to the blade. The blade exhibited a general permanent bending just inboard of the trim tab.

The winglet's forward and aft tips are 157.8 and 172.0 inches aft of the mast. The winglets are 38.94 inches left and right of centreline.

<u>Photo 22</u> One main rotor blade remained intact.

<u>Photo 23</u> The blade was fractured at 149 inches from the mast. A downward bend was located just inboard of the trim tab. The lower surface had a compression wrinkle at the area of the bend, depicted in the photograph.

<u>Photo 24</u> The outboard section that separated had a general upward bending in the first half of the section. The fracture surfaces were consistent with static overload and the bending was consistent with the tip moving in an upward direction.

2.9 Push-pull Tubes in Tail Boom

There are two push-pull tubes in the tail boom. The larger tube controls the elevator deflection. Pulling on the tube deflected the elevator trailing edge down. The smaller tube controls the incident angle of the tail rotor blades. Pulling on the tube deflected the blade angles to decrease the right thrust component from the blades. The tip of the left winglet was damaged but still attached when found on-scene. The tip separated during the transportation to the recovery facility.

Continuity of the tail rotor push-pull rods could be established to the bellcranks at the aft end of the engine compartment. All bellcranks, rod ends, and pedals were found. Although all of the flight control push pull tubes had thermal and/or impact damage. All the bell cranks including the under-seat bell cranks for the tail rotor and elevator control system were located and each had the rod ends attached and found safetied, with the exception of the one rod end on the horizontal tube that attaches to the forward end of the tail rotor pedal assembly bell crank. This rod end could not be located and that same bell crank had the ears melted away but was still attached by the pivot bearing and the short links were still attached to the pedal ends with the bolts and safeties still in place. The cross tube and the bell crank that translates the motion aft was not found. Although the elevator control tubes exhibited thermal and impact damage all rod ends, connection points, and bell cranks for the elevator control system were located and attach bolts were found to be safetied.

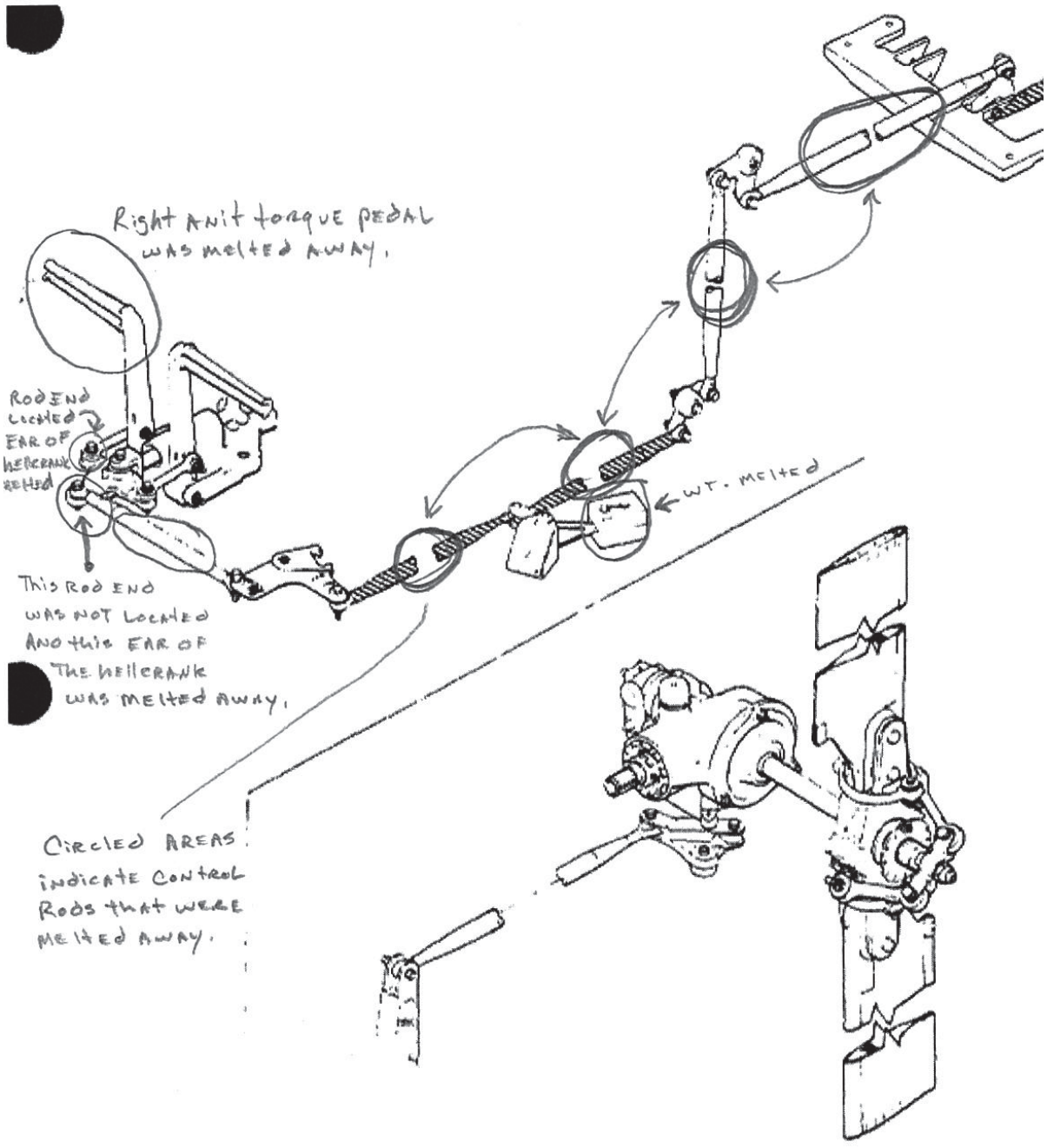


Figure 1: Antitorque Control System

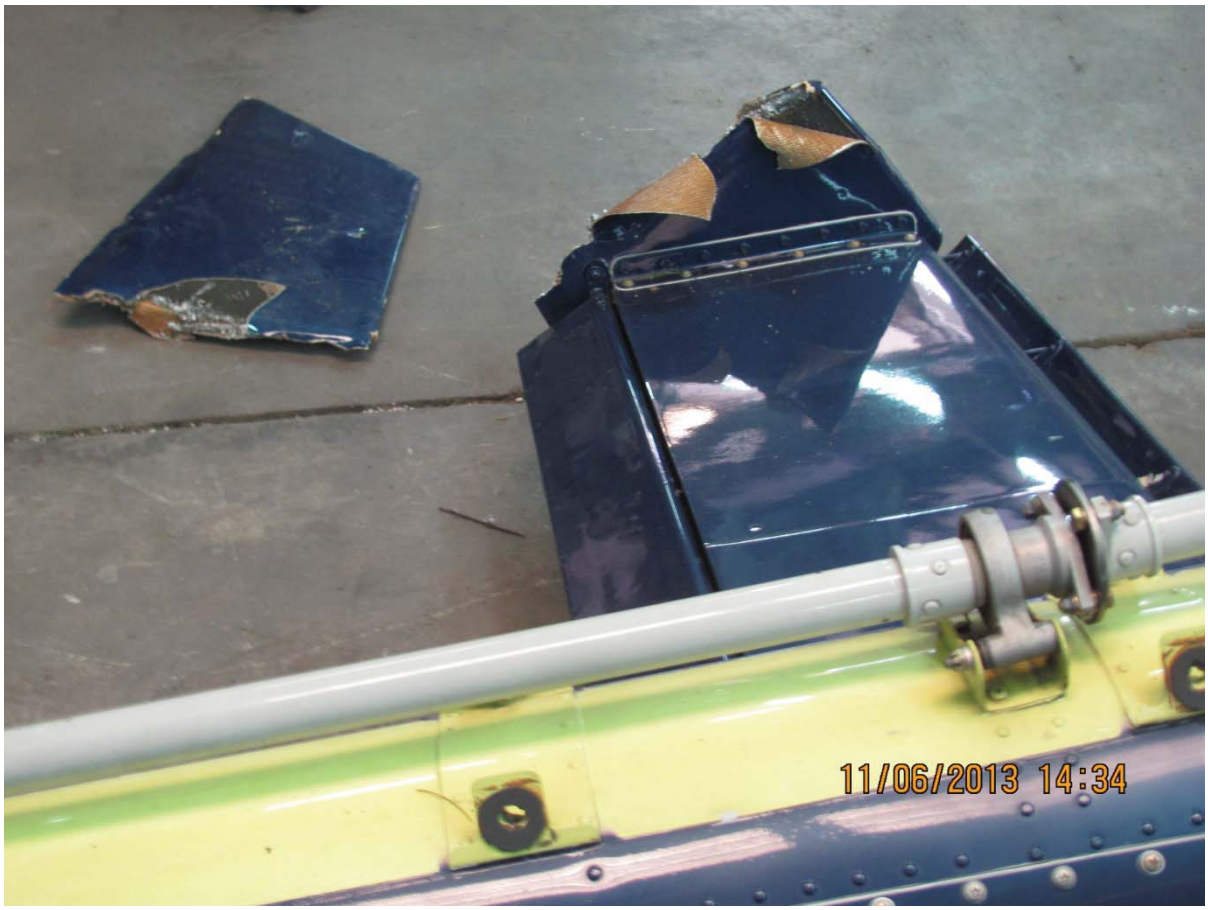


Photo 25 Pulling on the large push-pull tube that was exposed at the fracture of the tail boom deflected the elevator trailing edge down (note, the tube in this photo is the tail rotor drive shaft).

Photo 26 The left winglet was fractured when found on-scene; however, the tip was still attached when found.

<u>Photo 27</u> The tail rotor blade deflected to a more tail right force position when the push-pull tube was deflected aft (push).

Photo 28 The tail rotor blade deflected to a more tail left force position when the push-pull tube was deflected forward (pulled).

2.10 Cyclic and Collective Controls

All control rods, bellcranks, and attach hardware for the cyclic and collective were located. Some of the rods were melted, however, all rod ends were securely attached to their respective attach points. The ears of the rudder pedal bellcrank and link to the bellcrank at the center of the helicopter had been burned off.

Photo 29 Flight controls

Photo 30 Flight controls

Photo 31 Pilot's pedals

Photo 32 Pilot's pedals and other bellcranks

<u>Photo 33</u> Flight control – the empty hole is for the co-pilot pedal controls. The copilot pedals and control links had been removed for the EMS operation.

Photo 34 Flight control

Photo 35 Flight control – Tailrotor control damper weight bell crank assembly

<u>Photo 36</u> Flight control - – Tailrotor control damper weight bell crank assembly

(opposite side of Photo 35)

<u>Photo 37</u> Flight control – Co-pilot side cyclic stick quadrant

Photo 38 Piece of elevator flight control

<u>Photo 39</u> Piece of elevator flight control

<u>Photo 40</u> Piece of elevator flight control

<u>Photo 41</u> Piece of elevator flight control

Photo 42 Tail rotor flight control

Photo 43 Tail rotor flight control

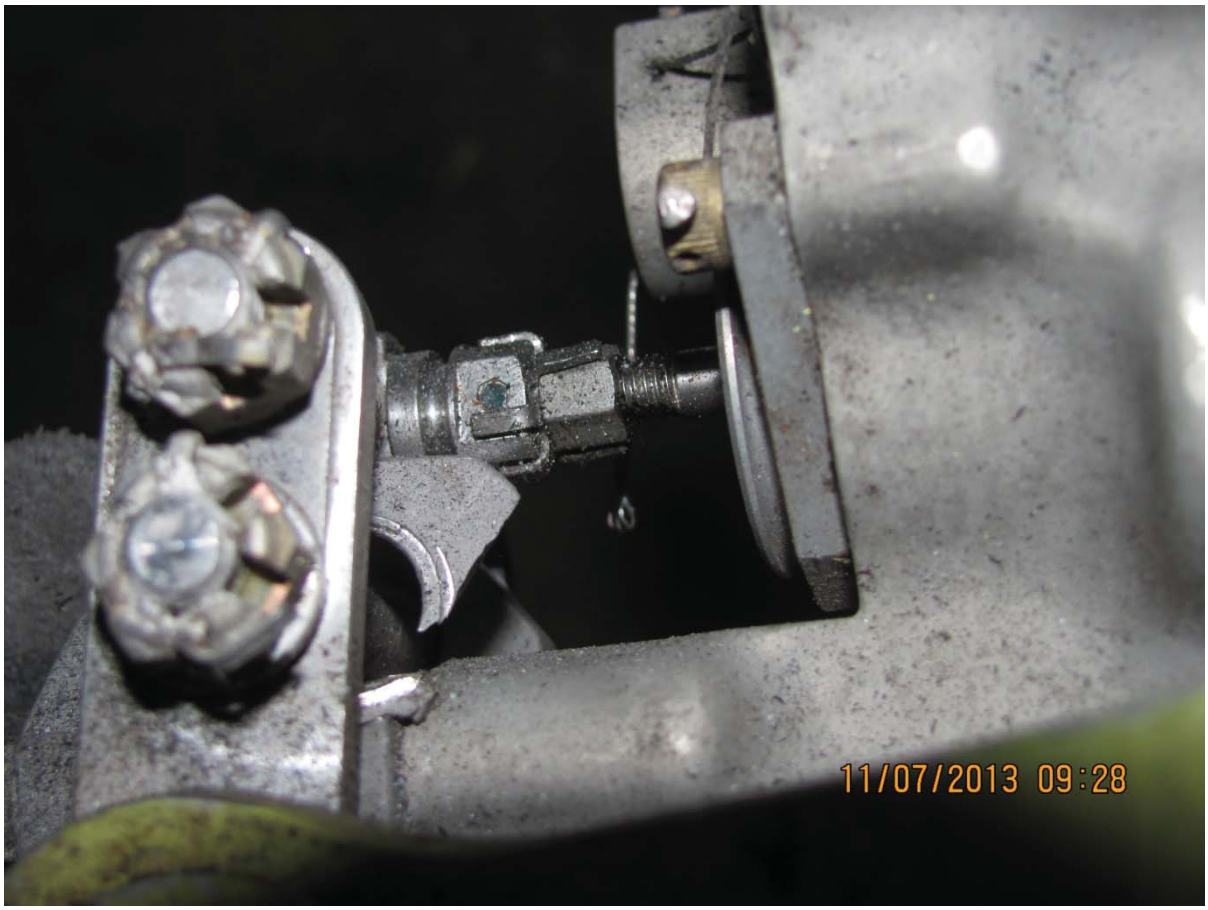
2.11 Hydraulic Servo Actuator.

The three servos had sustained impact damage. However, the attachments and attaching hardware were in place and properly secured. The length of the exposed pistons were:

1 – 3.0 in.
2 – 3 3/8 in.
3 – 3 ¼ in.

The levers were free to move and the servo valve input lever which includes the link assembly trunnion input (Part No. 206-001-556-1) appeared to be functional.

Photo 44 Actuator 1 – Collective Pitch Hydraulic Actuator with Link Assembly Attached



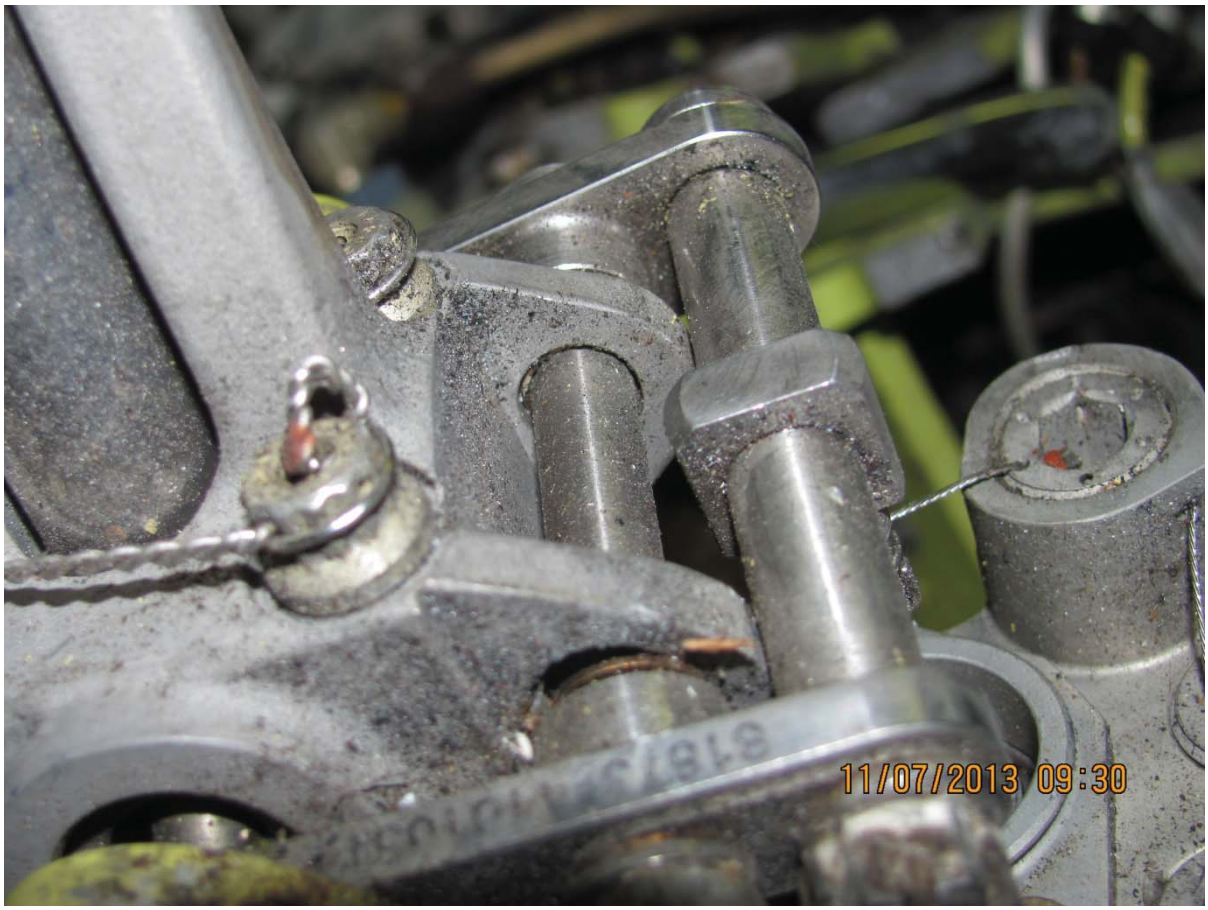
<u>Photo 45</u> Actuator 1 – Collective Pitch Hydraulic Actuator Link Assembly

Trunnion Input

<u>Photo 46</u> Actuator 1 – Collective Pitch Hydraulic Actuator - with Separated Hydraulic Piston

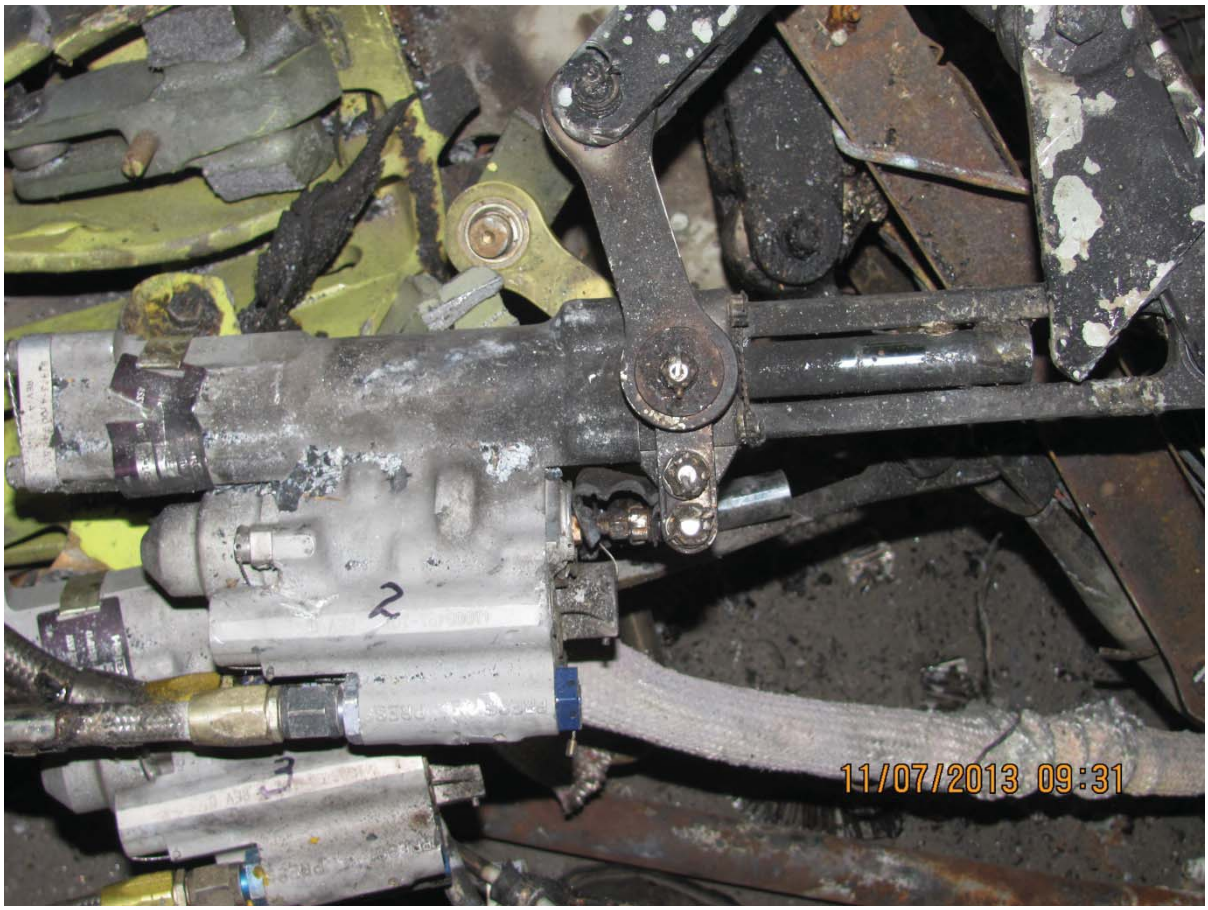
Photo 47 Actuator 1 – Collective Pitch Hydraulic Actuator

<u>Photo 48</u> Actuator 1 - Collective Pitch Hydraulic Actuator



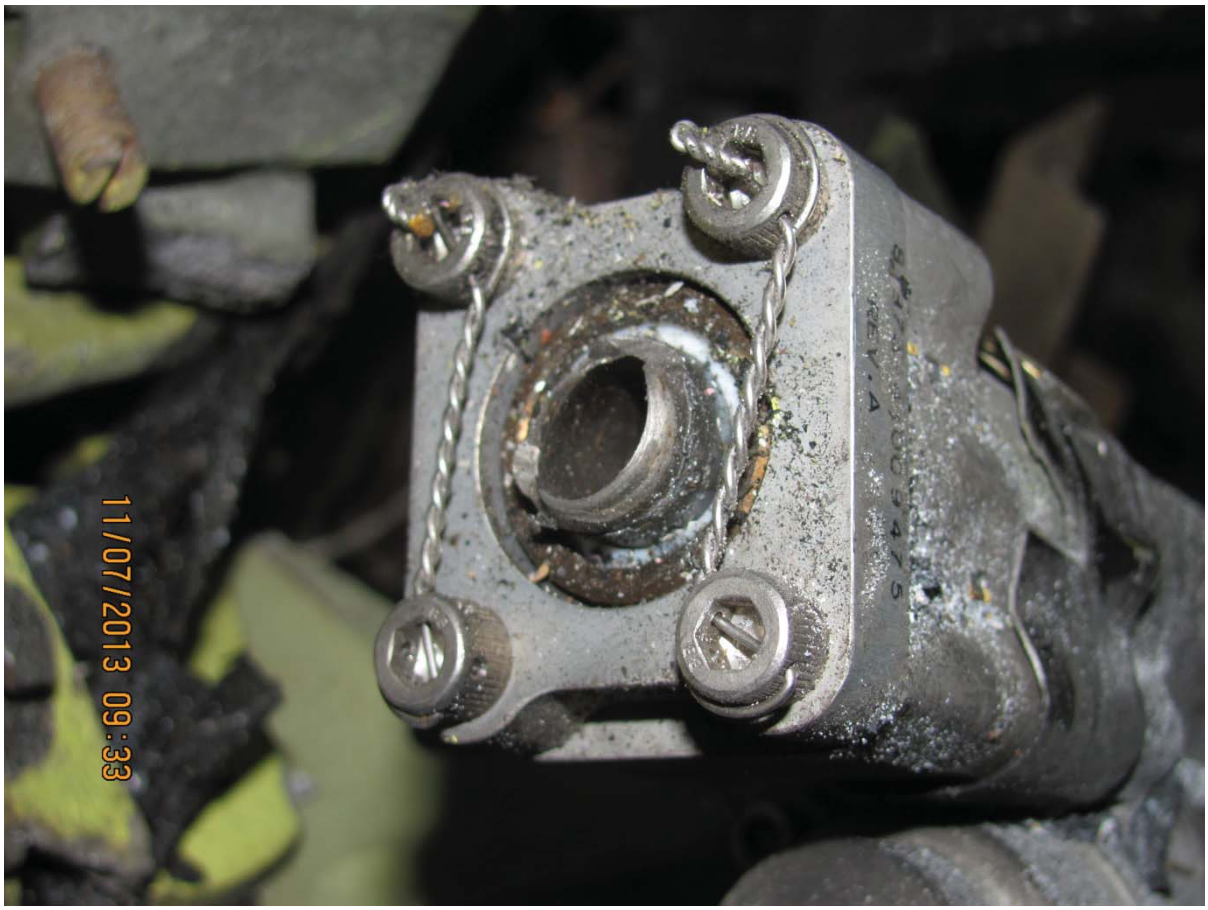
<u>Photo 49</u> Actuator 1 – Collective Pitch Hydraulic Actuator – Trunnion Input

Photo 50 Actuator 1 – Collective Pitch Hydraulic Actuator Trunnion Input



<u>Photo 51</u> Actuator 2 – Cyclic Control Hydraulic Actuator

Photo 52 Actuator 2 – Cyclic Control Hydraulic Actuator – Trunnion Input



<u>Photo 53</u> Actuator 2 – Cyclic Control Hydraulic Actuator

Photo 54 Actuator 2 - Collective Pitch Hydraulic Actuator with Link Assembly

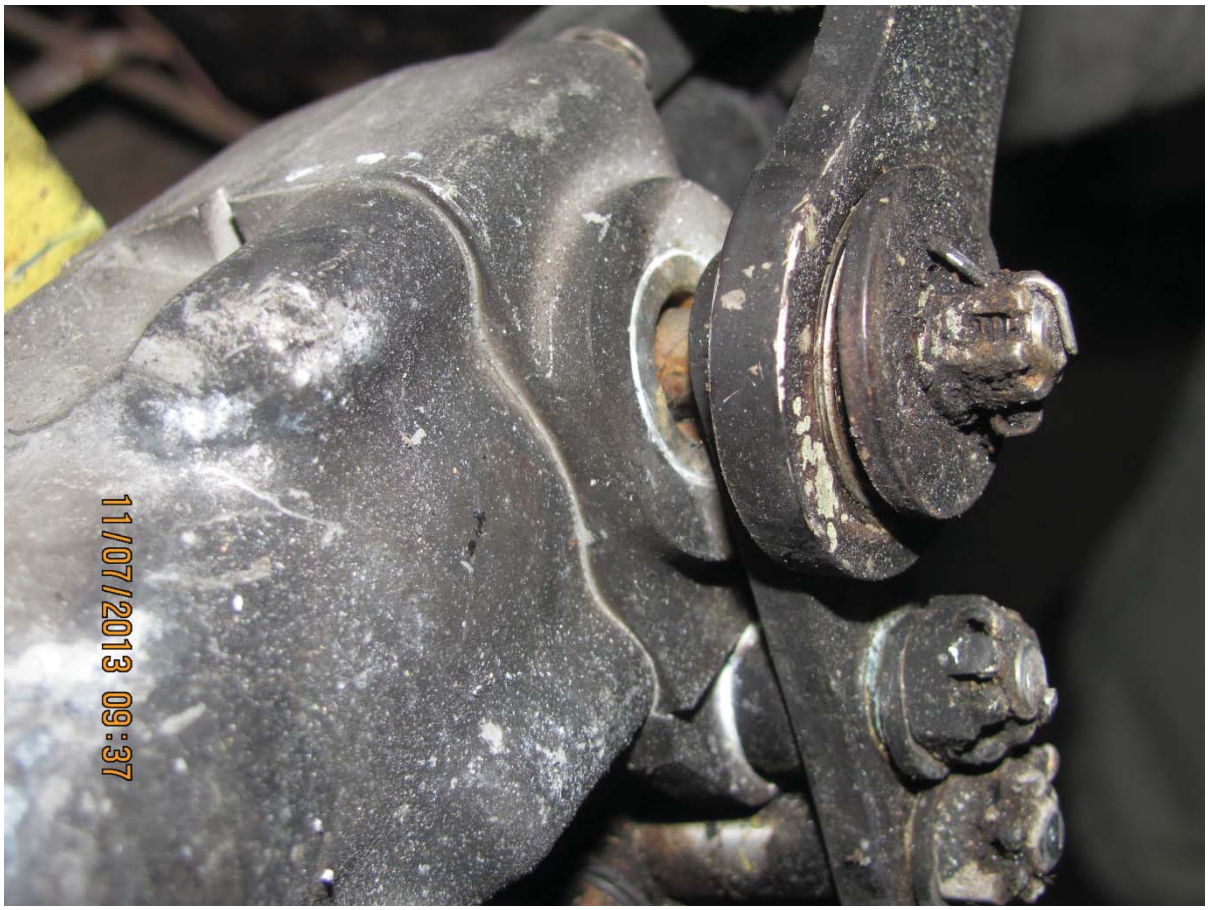
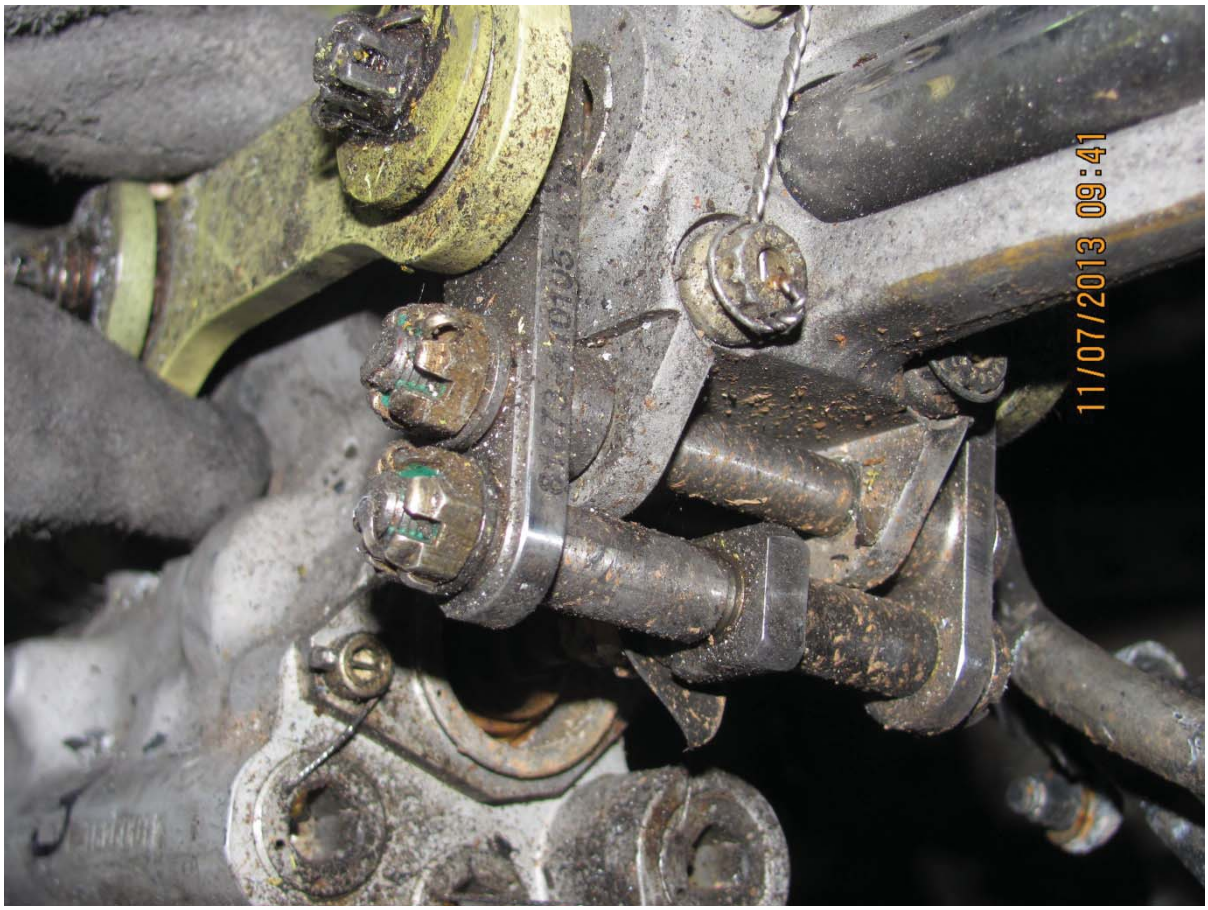


Photo 55 Actuator 2 – Collective Pitch Hydraulic Actuator with Link Assembly

<u>Photo 56</u> Actuator 3 – Collective Pitch Hydraulic Actuator with Link Assembly

Photo 57 Actuator 3 – Collective Pitch Hydraulic Actuator – Trunnion Input



<u>Photo 58</u> Actuator 3 – Collective Pitch with Trunnion Input

<u>Photo 59</u> Actuator 3 – Collective Pitch Hydraulic Actuator with Piston

Photo 60 Actuator 3 – Collective Pitch Hydraulic Actuator with Link Assembly

2.12 FUTURE ACTIVITES

None are planned at this time for this aircraft. The helicopter will be returned to storage at Atlanta Air Recovery in Griffin, Georgia in preparation for the release of the wreckage by the National Transportation Safety Board IIC.