NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

January 27, 2017

HELICOPTER SPECIALIST'S FACTUAL REPORT

NTSB No: CEN15LA395

A. ACCIDENT

Operator:	Roberts Ranch and Investments, LLC
Aircraft:	Bell Helicopter 429, Registration N428AR
Location:	Port O'Connor, Texas
Date:	August 22, 2015
Time:	Unknown time

B. GROUP

No group was formed.

LIST OF ACRONYMS

AD	airworthiness directive
ASB	alert service bulletin
ATT	aircraft total time
EAD	emergency airworthiness directive
FAA	Federal Aviation Administration
NTSB	National Transportation Safety Board
PCL	pitch change link
P/N	part number
S/N	serial number
TX	Texas
XA81	Midstream Port O'Connor Heliport

C. SUMMARY

On August 22, 2015, at an unknown time, a Bell Helicopter 429, N429AR, experienced a tail rotor pitch change link failure during flight and landed uneventfully at the Midstream Port O'Connor Heliport (XA81), Port O'Connor, Texas (TX). The pilot and three passengers were not injured. The helicopter sustained substantial damaged. The helicopter was registered to and operated by Roberts Ranch and Investments, LLC, under the provisions of 14 *Code of Federal Regulations* Part 91. Visual meteorological conditions prevailed for the flight, which was not operated on a flight plan.

The pilot reported feeling a faint bump and vibration. The helicopter approached XA81 and the pilot brought the helicopter to a hover over the helipad, at which time the pilot reported an uncommanded slow right yaw. Upon pushing the left pedal to its limit, the pilot reported the right yaw ceased, while at the same time he landed the helicopter without incident. A post-landing inspection of the helicopter revealed one of the four tail rotor pitch change links (PCL) was fractured. While no further damage was sustained to any helicopter components, the fractured tail rotor PCL had an adverse effect on the helicopter's flight characteristics and required replacement, meeting the definition of substantial damage. The four tail rotor PCLs, the pitch horn associated with the fractured PCL, grounding cables, and attaching hardware were submitted by the operator for further examination.

On September 2, 2015, representatives from the Federal Aviation Administration (FAA) and Bell Helicopter convened at Bell Helicopter facilities in Hurst, TX to examine the fractured tail rotor PCL, the pitch horn associated with the fractured PCL, and the remaining three tail rotor PCLs. The examination revealed evidence of fatigue on the fractured PCL, with evidence of pitting corrosion observed collocated with the fatigue fracture origins.

C. DETAILS OF THE INVESTIGATION

1.0 HELICOPTER INFORMATION

The Bell Helicopter 429 helicopter has a four-bladed main rotor system that provides helicopter lift and thrust, and a four-bladed stacked teetering tail rotor system that provides main rotor anti-torque and directional control. The helicopter is equipped with two Pratt and Whitney Canada PW207D turboshaft engines. The helicopter is type certificated under FAA type certificate data sheet No. R00003RD.

1.1 TAIL ROTOR PCL INFORMATION

The tail rotor PCL assembly comprises a single-piece forged aluminum body with two circular ends (also known as the "banjo end"), each containing a spherical bearing (also known as a "mono-ball bearing"). One end of the tail rotor PCL is attached to the pitch change crosshead; the other PCL end is attached to its respective tail rotor blade pitch change horn. A total of four PCLs are installed on the four-bladed tail rotor of the Bell Helicopter 429: two short-length PCLs, identified as "inboard" PCLs, and two long-length PCLs, identified as the "outboard" PCLs, are used to accommodate the stacked rotor blade configuration. A photograph provided by the operator showed the fractured PCL remained attached to the crosshead and the spherical bearing and remnant circular end remained attached to the tail rotor blade pitch horn (**Photo 1**).

Photo 1. Photo of the fractured tail rotor PCL still installed on N429AR. (photo courtesy of Bell Helicopter)

2.0 TECHNICAL INVESTIGATION FINDINGS

On September 2, 2015, representatives from the FAA and Bell Helicopter convened at Bell Helicopter facilities in Hurst, TX to examine the fractured tail rotor PCL, the pitch horn associated with the fractured PCL, and the remaining three tail rotor PCLs (**Photo 2**). The fractured PCL, one of the two inboard PCLs, was identified as serial number (S/N) TE-0168 (**Photo 3**). The remaining three PCLs were identified as S/N TE-0363 (inboard PCL), TE-0076 (outboard PCL), and TE-0088 (outboard PCL).

Photo 2. The tail rotor directional control components received at Bell Helicopter facilities. (photo courtesy of Bell Helicopter)

Photo 3. The tail rotor PCLs identified by S/N. (photo courtesy of Bell Helicopter)

2.1 TAIL ROTOR PCL S/N TE-0168 EXAMINATION FINDINGS

Tail rotor PCL S/N TE-0168 exhibited fractures through two areas of the pitch horn-side circular end (housing the spherical bearing), with the two fractures about 180 degrees opposed to each other (**Photo 4**). The primary fracture surface exhibited fatigue through the bulk of the cross-section of the circular end (**Photo 5**). The secondary fracture surface exhibited evidence of fatigue through about half of the cross-section, with the remaining cross-section exhibiting signatures consistent with overload. Both fatigue fractures initiated on the same chamfer on the circular end of the link; the chamfer is used to stake the bearing into PCL circular end. Evidence of pitting corrosion was observed at the fatigue fracture origins of the fracture surfaces. The depth of the pitting corrosion at the primary fracture, in an area that did not sustain mechanical damage, was about 0.005 inches (**Photo 6**). The depth of pitting corrosion at the secondary fracture was about 0.007 inches (**Photo 7**).

Material composition analysis of the PCL revealed no anomalous findings. The hardness and conductivity of the aluminum PCL met engineering drawing requirements. Microstructure and chemical analysis via scanning electron microscope showed results typical of the aluminum alloy specified in the engineering drawing. A yellow-colored substance, chemically analyzed to be consistent with epoxy polyamide primer, was observed on the inner diameter surfaces of [fractured] circular end. Both the separated circular end and the pitch change horn bushing exhibited evidence of mechanical contact wear. The blade pitch horn-side spherical bearing exhibited wear through a portion of its outer ring and wear on the surface of the spherical ball (**Photo 8**). Examination of the crosshead-side of the PCL revealed evidence of corrosion on the staking chamfer (**Photo 9**). Removal of the crosshead-side spherical bearing revealed evidence of fretting and wear on both the bearing outer ring and adjacent to the staking chamfer (**Photo 10**).

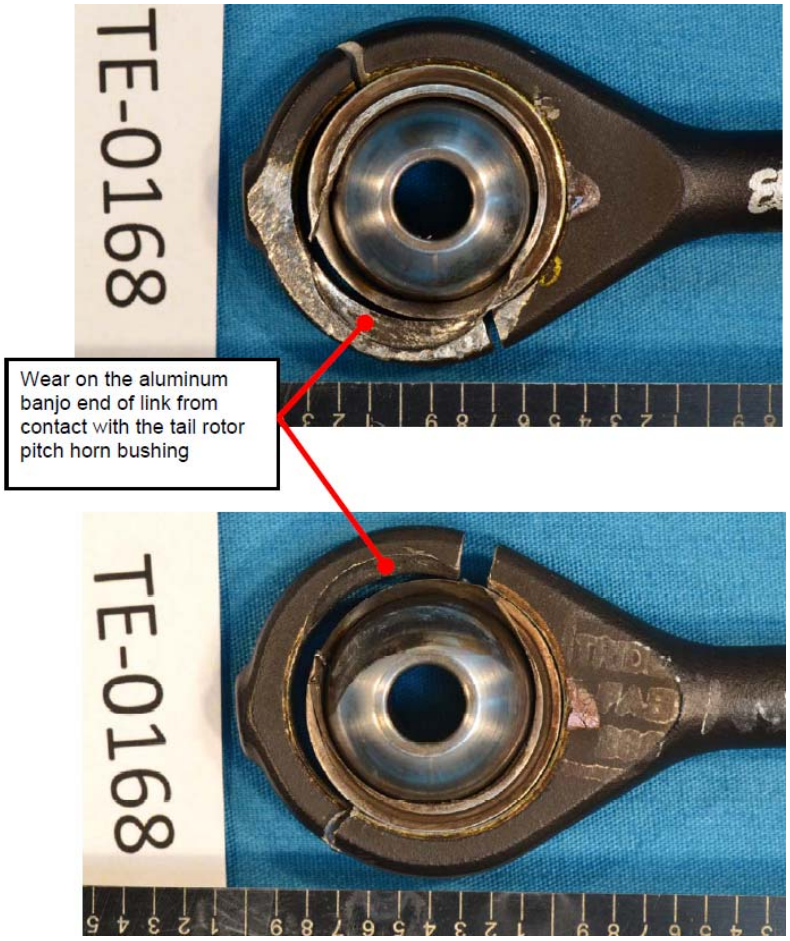

Photo 4. The fractures observed on the pitch horn-side circular end of PCL S/N TE-0168.
(photo courtesy of Bell Helicopter)

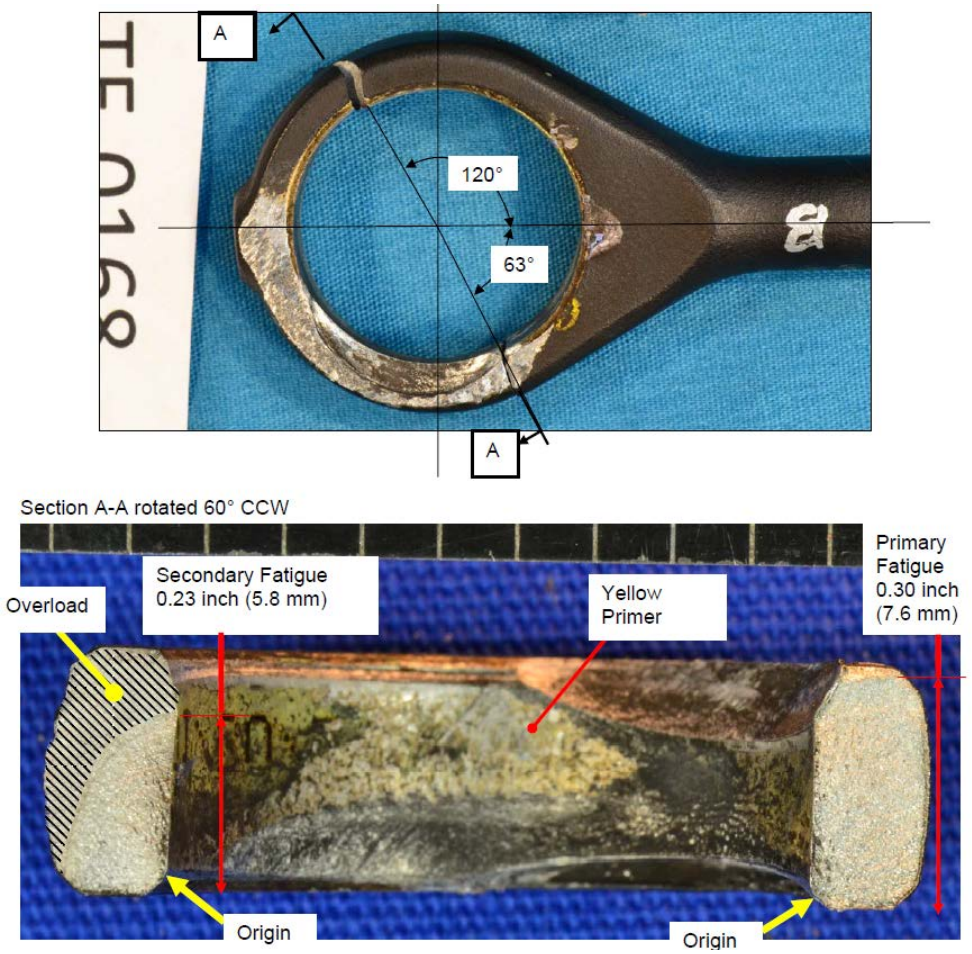

Photo 5. Cross-section view of the pitch horn-side circular end fracture of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

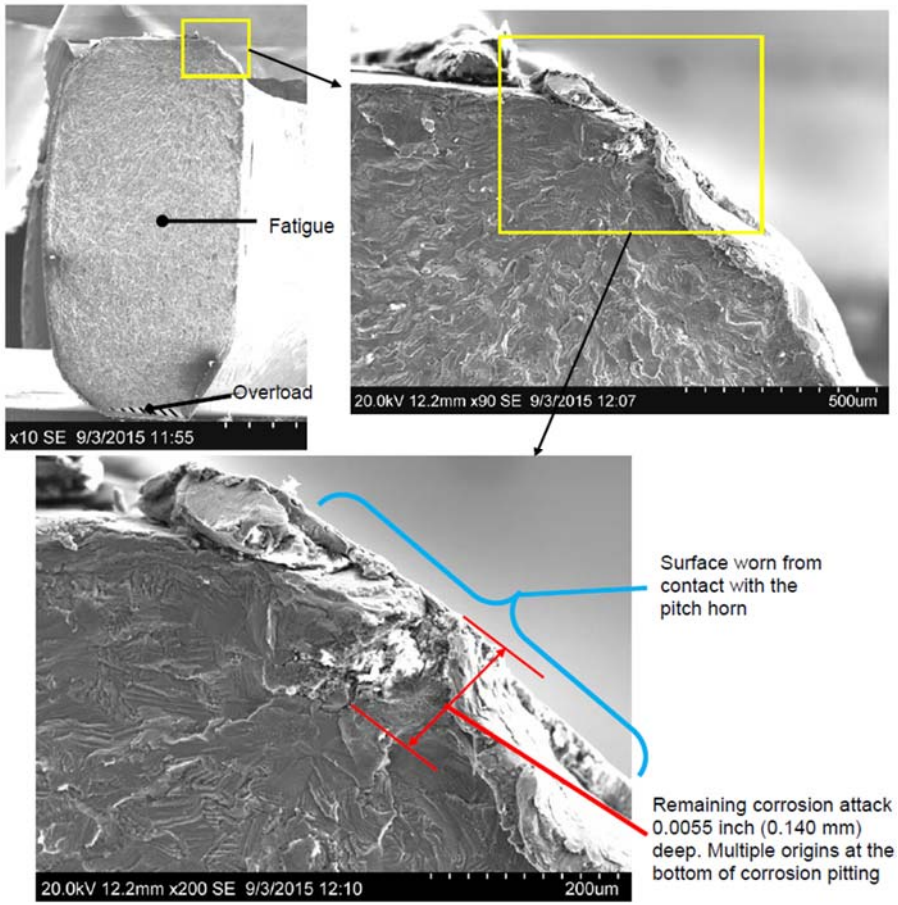

Photo 6. Corrosion observed at the primary fatigue origin of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

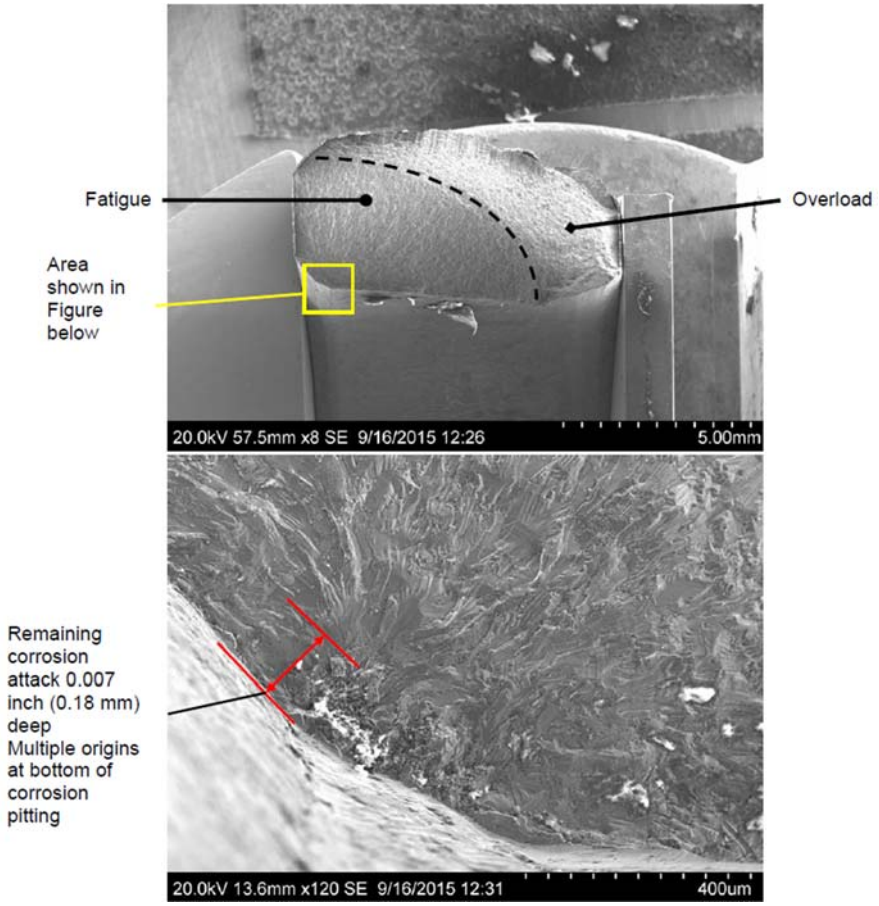

Photo 7. Corrosion observed at the secondary fatigue origin of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

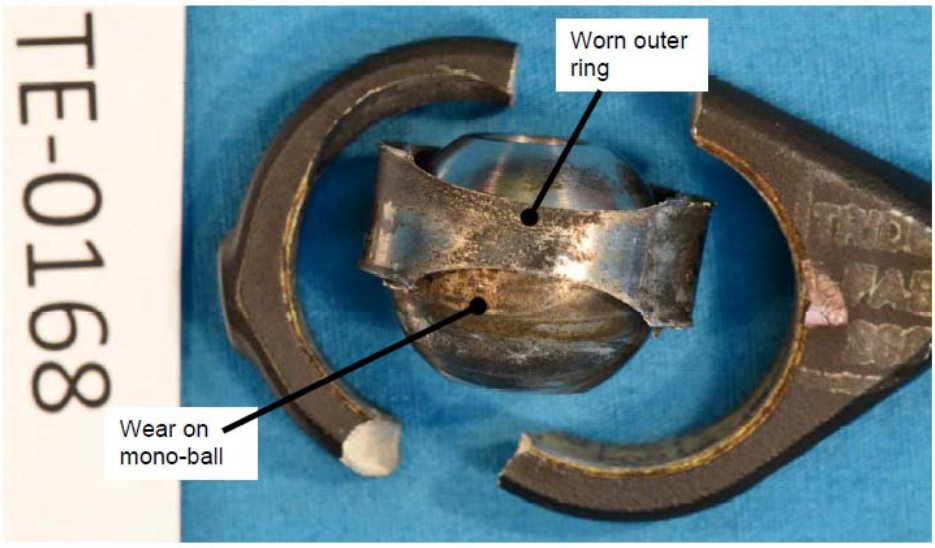

Photo 8. Mechanical contact wear observed on the spherical ball and outer ring of the pitch horn-side spherical bearing of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

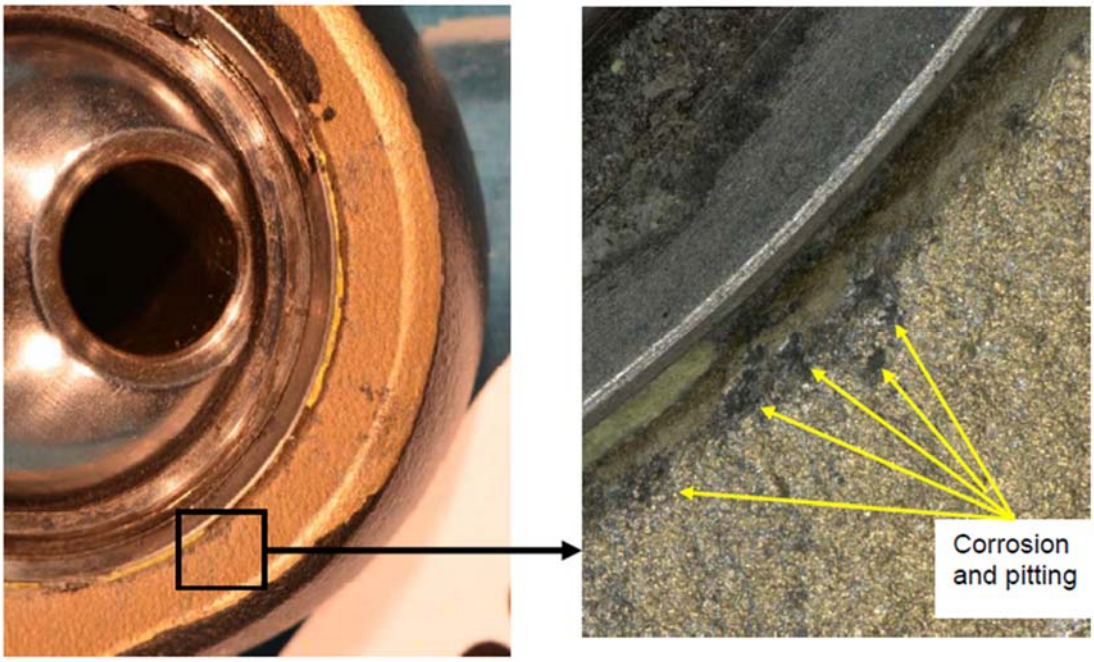

Photo 9. Corrosion and pitting observed on the chamfer of the crosshead-side spherical bearing of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

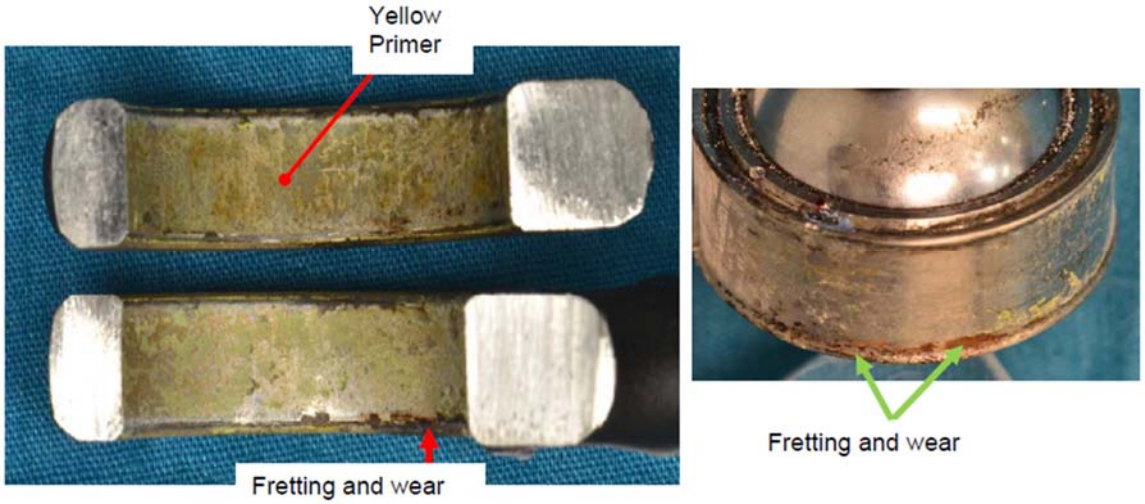

Photo 10. Fretting and wear observed on the chamfer and spherical bearing outer ring of the crosshead-side of PCL S/N TE-0168. (photo courtesy of Bell Helicopter)

An axial and radial bearing play inspection of the crosshead-side spherical bearing revealed it to be within the limits published in the Bell Helicopter 429 maintenance manual No. BHT-429-MM-1, Chapter 67-00-00 (**Table 1**); the published limits were 0.005 inches of radial play and 0.010 inches of axial play. Removal of the crosshead end spherical bearing revealed evidence of corrosion and fretting on the inner diameter surfaces of the [crosshead] circular end. Though the pitch horn-side spherical bearing suffered mechanical damage, an axial and radial bearing play inspection of the pitch horn-side spherical bearing was performed and its results recorded.

Table 1. Axial and radial play inspection results of tail rotor PCL S/N TE-0168.

Bearing Location	Axial Play	Radial Play
Crosshead-side bearing	*0.001 inches*	*<0.001 inches*
Pitch horn-side bearing	*0.100 inches*	*0.025 inches*

2.2 REMAINING TAIL ROTOR PCL FINDINGS

Visual examination of the remaining tail rotor PCLs revealed all PCLs exhibited evidence of corrosion on the bearing staking chamfer surfaces. Axial and radial bearing play inspection of the spherical bearings revealed all but one spherical bearing were within 429 maintenance manual limits (0.005 inches radial, 0.010 inches axial); the spherical bearing installed on the pitch horn-side of PCL S/N TE-0076 exhibited about 0.014 inches of axial play. The results of the axial and radial bearing play inspection are seen in **Table 2**.

Table 2. Axial and radial play inspection results of the remaining tail rotor PCLs.

PCL S/N	Bearing Location	Axial Play	Radial Play
TE-0363	*Crosshead-side bearing*	*0.001-0.002 inches*	*0.001 inches*
TE-0363	*Pitch horn-side bearing*	*0.006-0.007 inches*	*0.001 inches*
TE-0076	*Crosshead-side bearing*	*0.001 inches*	*<0.001 inches*
TE-0076	*Pitch horn-side bearing*	*0.014 inches*	*0.003 inches*
TE-0088	*Crosshead-side bearing*	*0.001 inches*	*<0.001 inches*
TE-0088	*Pitch horn-side bearing*	*0.006-0.007 inches*	*0.001-0.002 inches*

3.0 TAIL ROTOR PCL MAINTENANCE HISTORY

According to maintenance records, tail rotor PCL S/N TE-0168 was installed on N429AR on February 6, 2015 at aircraft total time (ATT) 1,062.9 flight hours.

On February 18, 2015, Bell Helicopter released alert service bulletin (ASB) No. 429-15-16 which introduced a 50-hour recurrent inspection of the inboard and outboard tail rotor PCLs for axial and radial bearing play. FAA emergency airworthiness directive (EAD) No. 2015-16-51, released on August 2, 2015, required inspecting each inboard and outboard tail rotor PCL for axial and radial bearing play. The EAD also set a recurrent inspection at an interval of 50 flight hours. According to the helicopter log sheet for N429AR, EAD No. 15-16-51 was complied with on August 15, 2015 at ATT 1,235.3 flight hours. FAA airworthiness directive (AD) No. 2015-22-02, dated November 12, 2015, superseded EAD No. 2015-16-51.

Attachment 1 contains the maintenance records for tail rotor PCL installation on N429AR and compliance with EAD No. 15-16-51.

4.0 CORRECTIVE ACTIONS

On December 7, 2015, Bell Helicopter released ASB No. 429-15-26 which introduced an inspection of tail rotor PCLs, P/Ns 429-012-112-101 and -103, for corrosion and application of sealant between the spherical bearing and its housing. The ASB also introduced a 50-hour recurrent inspection of this sealant. FAA AD No. 2016-02-06, dated February 6, 2016, required inspection of tail rotor PCLs, P/Ns 429-012-112-101, -101FM, -103, and -103FM, for corrosion. The AD also required application of sealant between the spherical bearing and its housing, and a recurrent inspection of this sealant at a 50-hour interval.

Chihoon Shin
Aerospace Engineer – Helicopters