

FINAL REPORT

AAIU Synoptic Report No: 2004-019

AAIU File No: 2003/0015

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In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Accidents, on 1 April 2003 appointed Mr. Frank Russell as the Investigator-in-Charge to carry out a Field Investigation into this occurrence and prepare a Synoptic Report.

Aircraft Type and Registration:	Bell 206B, EI-BHI
No. and Type of Engines:	1 x Allison 250-C20
Aircraft Serial Number:	906
Year of Manufacture:	1972
Date and Time (UTC):	31 March 2003 @ 1810 hrs
Location:	Weston Airport, Co Kildare
Type of Flight:	Licence Proficiency Check (LPC)
Persons on Board:	Crew - 2 Passengers - Nil
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	Rear portion of right hand skid severed
Commander's Licence:	JAR ATPL (H)
Commander's Age:	Male, 51 years
Commander's Flying Experience:	6,200 hours of which 3,500 were on type
Information Source:	Accident/Incident Report Form submitted by the Commander, AAIU additional enquiries.

1. History of Flight

- 1.1** The Commander, who is an Irish Aviation Authority (IAA) Authorized Flight Examiner, was carrying out an annual Licence Proficiency Check (LPC) on a qualified pilot (the Pilot Flying) in compliance with JAR-FCL 2 (Flight Crew Licensing-Helicopters). During one of the required exercises, which included a simulated tail rotor failure - specifically "left stuck pedal," a manoeuvre under normal emergencies, the aircraft contacted the ground.

For this manoeuvre, the Commander recalled, it is required to bring the helicopter to a very low hover and, as collective is applied, touch down should be straight ahead, level skids and no forward motion. The Commander, who felt that there may have been some slight forward speed but with relatively mild ground contact, was therefore quite surprised that part of the right rear skid broke off on landing in those circumstances.

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2. Engineering Report

2.1 Installation History

The skid manufacturer is a separate company to the helicopter manufacturer but wholly owned by the same parent company, Textron Inc. The skid, which fractured, had been supplied by this manufacturer on 2 August 1999 and installed by the then owner's maintenance contractor on 23 August 1999. A Maintenance Manual was provided with the landing gear at the time of sale and the vendor states that it was the owner's responsibility to maintain it with the aircraft documentation. The helicopter had then a total of 2788 hours flown. The helicopter was re-registered to its present owner on 23 October 2002. At the time of the incident, the helicopter had flown 268 hours since the installation of the skid.

2.2 Technical Analysis

The fracture (**Appendix A**) was examined by an Irish metallurgist who reported the following:

- *The aluminium tube of the skid suffered severe exfoliation corrosion at/adjacent to the holes in the tube, through which fixing of the plates was made.*
- *This extended around more than 40% of the circumference, and would have weakened the tube significantly.*
- *High strength aluminium alloys are prone to this type of corrosion, particularly in marine environments. Attack occurs at locations where a part is machined such that the transverse grain structure is exposed, as at machined holes.*
- *It would appear that the holes in the tube were not adequately protected to prevent the attack.*

The manufacturer of the Skid Tube said that there had been two previous cases of skid tube cracking on 206 B helicopters reported to them and both were related to corrosion on the abraded underside of the tube. They were interested in examining the 14" piece of fractured tube and this was forwarded to them for analysis of the fracture. The manufacturer examined the piece of tube and reported as follows:

In addition to the exfoliation corrosion reported by AAIU, there was evidence of two other types of corrosion on the Skid Tube.

Galvanic Corrosion: *Accelerated corrosion resulting from the aluminium in contact with steel and exposed to a wet saline environment. In such situations the aluminium is more rapidly corroded than it would be in the absence of the dissimilar metal.*

Stress Corrosion: *Time-dependent cracking under the combined influence of sustained tensile stress and a corrosive environment. Higher-strength alloys such as the 7075-T6 material used in the 206 Skid Tubes are susceptible to stress-corrosion cracking.*

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The Skid Tube portion had mud on and around both Skid Shoes, which suggests that the helicopter was operated in a wet environment. There was also evidence of mud on a small area inside the tube adjacent to the fracture location. This interior tube moisture indicates that the tube was cracked in this location prior to failure. There were stress corrosion cracks in three locations and the longest was 2.5" long. The stress corrosion cracks ran in the longitudinal direction. In addition to the stress-corrosion crack locations, there were three other locations, which showed corrosion in the form of blisters or bulging of the protective coating. The most significant exfoliation corrosion was adjacent to one of the skid shoes, which are steel components. This location indicates that the exfoliation was precipitated and accelerated by galvanic corrosion.

The manufacturer also made the following observation:

"The corrosion inspection requirements for the subject Skid Tubes are established to ensure that any corrosion problems are periodically treated so that the tube will remain airworthy. Because helicopters often operate in harsh environments, these inspection requirements are relatively frequent (100 hours or 6 months whichever comes first). There was no indication on the skid tube sample that any corrosion or crack repair had ever been made."

They drew the attention of the Investigation to the FAA approved corrosion inspection and repair requirements of the current Instructions for Continued Airworthiness (ICA) Report No. AA-01143, an extract of which appears in **Appendix B**. Revision A of this document was issued by the skid manufacturer on 25 March 2003. The introduction to this 22 page document states:

"These instructions are provided with each Skid Tube. Any airworthiness or flight safety revisions will be immediately sent to all affected Skid Tube owners."

The above ICA superseded the original "Inspection and Maintenance Instructions No. AA-96145, which was provided with the Skid Tube when supplied to the original owner in 1999. These Maintenance Instructions had the same corrosion inspection requirements as the present ICA.

2.3 Manufacturer's Conclusions

The manufacturer concluded that if the FAA approved corrosion inspection requirements for the Skid Tube had been adhered to, the initial corrosion would have been repaired prior to the occurrence of any stress-corrosion cracking or exfoliation corrosion. They stated that, *"In the absence of stress-corrosion cracking or exfoliation corrosion, the Skid Tube failure would not have occurred."*

2.4 Aircraft Servicing

The helicopter received major servicing at a contractor's premises in November 2002. This included a 1200hr (24 month) inspection. As part of this inspection a 100hr and an annual inspection were also included. A general corrosion inspection in accordance with Corrosion Control Guide (CCSD-PSE-87-001) was carried out. Inspection of the landing gear in accordance with the instructions in the Maintenance Manual for a 100hr and Annual Inspection was carried out. This included an examination of the *"skid tubes for damage and doublers for corrosion, debonding, and loose rivets"*. Neither the new owner of the helicopter nor the contractor, were aware of the skid manufacturer's specific Instructions for Continued Airworthiness.

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2.5 Aircraft Ownership

The Investigation notes that the IAA registered the helicopter in the name of its present owner on 23 October 2002, Certificate of Registration No. 3853. The IAA approved Flight Manual for EI-BHI states, *inter alia*, that:

“The registered owner shall ensure that a subscription service is in place for all flight manual amendments and that the manual reflects the latest revision status including all applicable supplements.”

The subscription service would normally be supplied by the aircraft manufacturer or its authorized agent(s). The investigation contacted the manufacturer to ascertain the name/address of the owner of EI-BHI to whom they were sending amendments etc. In reply, they gave the name of the owner who was registered with them prior to October 2002. They did not have the name of the present owner on file nor were they aware of a change of ownership.

The same manufacturers database is used for the continued supply of maintenance documents, Service Bulletins and Servicing Letters to the *registered* owner.

3 AAIU COMMENTS

- (a) The skid was inspected in November 2002 in accordance with the Maintenance Manual Instructions. Following the incident in March 2003, the Investigation found evidence of blistering and flaking under protective coatings adjacent to the fracture. The independent metallurgist also drew attention to the difficulty in adequately protecting the machined holes during skid manufacture. In this scenario of rapid corrosion advancement, particularly in a saline environment, the instructions of the manufacturer's 22 page ICA need to be strictly followed.
- (b) Helicopter operations, particularly operations involving knowledge and safe performance of emergency manoeuvres, involve a great deal of skill and pilot co-ordination. In parallel with these requirements is the obvious need for the pilot(s) to be secure in the knowledge that he/she is operating an airworthy aircraft.

In this unusual event, involving the failure and departure of portion of the rear RH skid, the crew were fortunate that the aircraft maintained its equilibrium on landing. It is clear from the engineering analysis of the evidence, that the incident that occurred could have had a less than benign outcome on a different occasion.

- (c) When change of ownership of aircraft occurs through re-registration with the IAA, the new owner may not be personally aware of the requirement to notify the aircraft manufacturer of the change of ownership, so that he /she may avail of their service to supply ongoing operational and maintenance documentation. The Investigation notes that this is *not* the first occasion on which a time lapse has arisen in the notification of change of ownership to the manufacturer. The non-availability of updated instructions for continued airworthiness, for instance, can lead to serious flight safety implications.

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4. Safety Recommendation

On 6 February 2004 the AAIU issued an *Interim Safety Recommendation* to the IAA concerning matters arising from the investigation. This Safety Recommendation has now been finalised as follows:

It is recommended that:

- 4.1** The IAA advise operators of Bell 206 helicopters of the necessity to carry out Skid Tube Inspection and Repair Requirements every 100 hours or 6 months whichever comes first, as per the Manufacturers instructions. **(SR No. 37 of 2004)**

The IAA accepted this Safety Recommendation.

It is also recommended that:

- 4.2** The IAA add an additional explanatory sentence to the Certificate of Registration document advising owners of the requirement to update the aircraft manufacturer in timely fashion with their relevant details. **(SR No. 38 of 2004)**

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APPENDIX A



Photograph of skid fracture caused by a combination of exfoliation, galvanic and stress corrosion (*Photo by Tony Horan*)

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APPENDIX B

The SKID TUBES shall receive a 100-hour or a 6-month inspection whichever comes first.

NOTE

Particular care should be taken to inspect in the areas of the fasteners in the Skid Tubes and all attaching components.

NOTE

The indications of corrosion are 1) corrosion deposits (a white or gray powder on aluminum), 2) pits in the aluminum surface, 3) blisters, bulging, or flaking of protective coatings.

Inspect the skid tubes for scratches, nicks, dents, and corrosion. Refer to Table 1 for damage and repair limits and to Figures 1 and 2 for damage and repair zones.

TABLE 1 (Excerpt) - DAMAGE AND REPAIR LIMITS

Description of Damage	Dimensions of Damage	Zone 1 Repairs Required	Zone 2 Repairs Required
Corrosion (after cleanup)	Exceeding .025 deep & not exceeding one quarter of the circumference by 3.0 in length	Yes	Replace
	If less see Section 3.2 Step 2	Yes	Yes
Cracks (after cleanup hole)	Less than 1.0 diameter	Yes	Yes
(see Section 3.2)	Exceeding 1.0 diameter but less than 2.0 diameter	Yes	Replace
	Exceeding 2.0 diameter	Replace	Replace

Deburr all holes and remove scratches, scuffs, nicks or corrosion by sanding and polishing. Do not exceed the damage limits listed in Table 1 after completion of repair procedure.

NOTE

The repair of cracks must include the removal of 1/2 inch of extra material on each end of the crack not to exceed the limits of Table 1. After cleanup, dye penetrant should be used to ensure the crack has been completely removed.

Repair slight damage or light corrosion as follows:

- Remove scratches, scuffs, nicks or corrosion by sanding or polishing.
- Apply one coat of Epoxy Polyamide Primer per MIL-PRF-23377 or equivalent to the affected skid tube area.
- Paint the reworked area to match the rest of the tube and apply two coats of wingwalk to appropriate areas.

The ICA replaced the previous Inspection and Maintenance Instructions, Report No. AA-96145 which were provided with the subject Skid Tube. The previous Inspection and Maintenance Instructions had the same 100 hr or 6 month requirement and similar corrosion inspection requirements.