FINAL REPORT

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The AAIU initiated an investigation into this occurrence following notification from the IAA on 6 December 2007. In accordance with the provisions of SI 205 of 1997, on 25 February 2009, the Chief Inspector of Air Accidents appointed Mr. Paul Farrell as the Investigator-in-Charge to conclude the Investigation and prepare a Synoptic Report.

Aircraft Type and Registration:	Britten-Norman Islander BN-2A-26, EI-BCE
No. and Type of Engines:	2 x Avco Lycoming O-540-E4C5
Aircraft Serial Number:	519
Year of Manufacture:	1976
Date and Time (UTC):	28 November 2007 @ 16.30 hrs
Location:	Connemara Airport, Inverin , Co. Galway (EICA)
Persons on Board:	Crew - 1 Passengers - Nil
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	Minor
Notification Source:	Irish Aviation Authority (IAA)
Information Source:	Report from the Operator to IAA

SYNOPSIS

The Pilot's Right Hand (RH) brake pedal broke off during brake release prior to ground handling. No passengers were on board and no further damage occurred. The aircraft had accumulated a high number of brake pedal applications and the brake pedal pillar suffered a fatigue fracture. The Manufacturer's data and analysis suggests that this was a one-off event.

FINAL REPORT

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was being towed by a tug to another location on the ramp at Connemara Airport, Inverin, Co. Galway. There were no passengers on board. The Pilot who released the pedals for towing reported that during brake release the RH brake pedal broke off.

The Operator advised the IAA of the event on 28/29 November 2007 but the event was not immediately entered into the Safety Occurrence Tracking System (SOTS). Consequently the AAIU only learned of the event on 6 December 2007.

1.2 Subsequent actions

The Operator replaced the failed components and carried out precautionary inspections on the remainder of the fleet; no adverse findings resulted.

The Operator has also amended the aircraft maintenance programme to impose a 40.000 cycle/ 6 year life on the failed pillar (Part Number BN-45-1891).

1.3 Technical Information

The aircraft was operated predominantly on short sector routes and had accrued 17,155 hours, and 81,287 landings since manufacture. The pedal pillar fractured at the area where taper pins attach the outer pedal assembly to the pillar. The Investigation noted that it is not possible to visually inspect the failure area (without dis-assembly) because the pedal mounting block Part No. (P/No). NB-45-C1895, slides over the failed pillar P/No. NB-45-B-1891, obscuring the pillar from view (**Figure No. 1**).

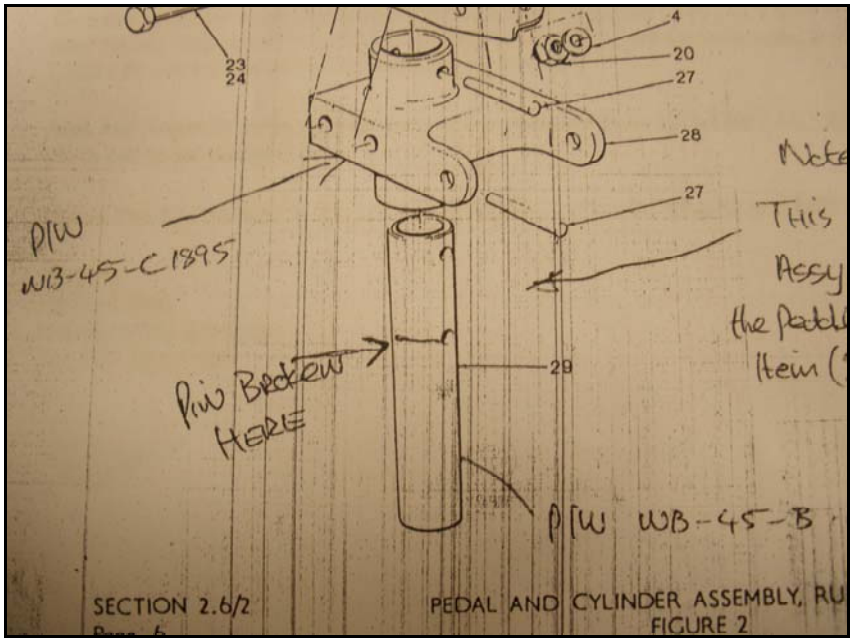

Figure No. 1: Schematic of the pedal mounting block and the failed pillar. (Diagram courtesy of the Operator).

1.4 Metallurgical Investigation

Both the failed RH brake pillar and the intact Left Hand (LH) pillar were removed from the aircraft. The Investigation sent the failed pillar and the intact LH pillar for metallurgical examination by an independent laboratory (**Photo No. 1).** This examination revealed that: -

*The pillar failed due to fatigue[1] cracking, which initiated at a bolt hole (***Photo No. 2***).*

*Burrs[2] from machining were observed around the bolt holes of the failed component (***Photo No. 3***), and the holes of the intact pillar (from the left side of the aircraft); it is likely that failure to remove these burrs facilitated crack initiation.*

Photo No. 1: The intact LH pillar and the failed RH pillar.

[1] "Fatigue", also known as "Metal Fatigue", describes a condition where material is subjected to many cycles of stress reversal or fluctuation (variation in magnitude without reversal), resulting in failure of the material, even though the maximum stress at any cycle may be considerably less than the value at which the failure would occur if the stress were constant. The fatigue process is often characterised into two categories, "high-cycle" and "low-cycle". With "high-cycle" fatigue, the cycle loads are low, strain cycles are largely confined to the elastic range, and the number of cycles before failure is large. With "low-cycle" fatigue, the cycle loads are relatively high, significant amounts of plastic strain are induced during each cycle, and the number of cycles before failure is relatively low. The transition from "low-cycle" to "high-cycle" fatigue occurs between 10,000 and 100,000 cycles, with many authorities defining low cycle fatigue as failure that occurs at less than 50,000 cycles.

[2] "Burrs" is a term used to describe rough edges left on a component after drilling, grinding, etc.

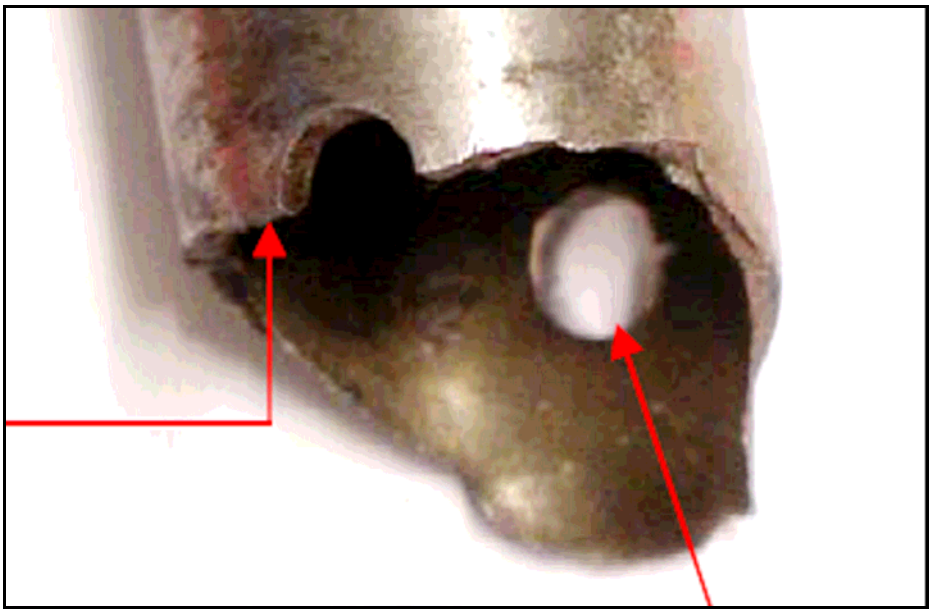

Photo No. 2: Red arrows indicating the locations of failure through the bolt hole, and cracking initiated in the corresponding hole.

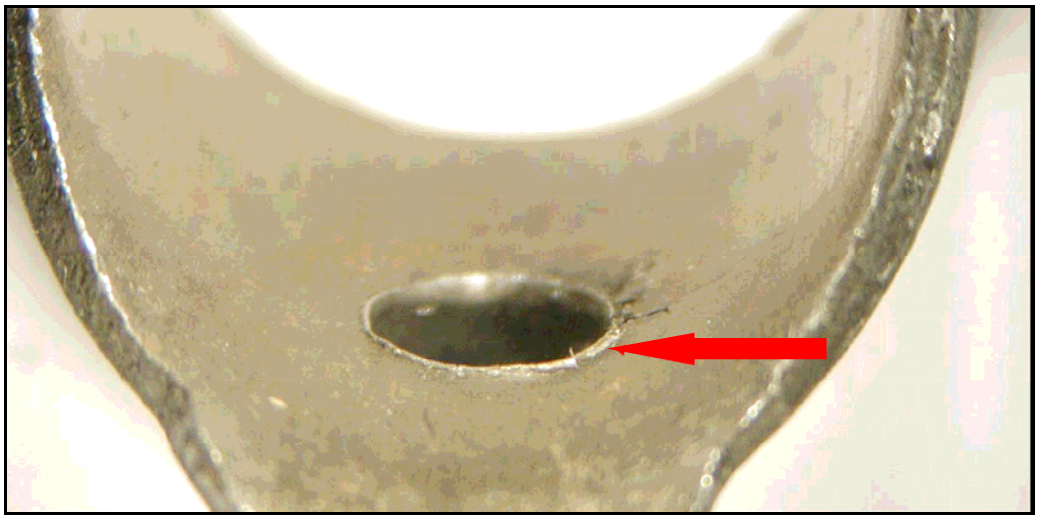

Photo No. 3: Manufacturing burrs indicated by the arrow.

1.5 Manufacturer's Response

In January 2008, the Investigation forwarded a copy of the metallurgical examination report to the Aircraft Manufacturer for consideration. The Manufacturer responded to say that they would review the stress analysis in light of the metallurgist's findings and would keep the investigation informed of the outcome.

In March 2009, the Investigation contacted the Manufacturer to inquire as to the progress of the review. The manufacturer advised that: -

> *"Service Bulletin BN-2/SB 314 Rudder Pedal Assemblies – Inspection, was issued (October 2008) to all operators requesting a one-off inspection of the left and right shaft assemblies to examine the taper pin holes for cracks using borescope equipment. To date no additional failures have been reported.*

The metallurgical examination on the shaft concluded that the shaft had failed through fatigue cracking. This is plausible as the aircraft cycles > 80,000.

A review of the original stress calculations was carried out and the following design changes made: The thickness of the tube has been increased from 0.056 inches to 0.080 inches for new build and "on condition" replacement shafts. This change was made to provide a greater margin on static strength and also improves the fatigue life.

The particular circumstances of this incident (high brake pedal usage on the aircraft) and that no other occurrences of this have been reported, lead us to conclude that this is a one-off incident. We therefore do not intend to take any further action."

2. ANALYSIS

The aircraft had accumulated an unusually high number of landings (81,287) and consequently would have experienced an unusually high number of brake pedal applications. Each brake application constitutes a stress cycle for the purposes of fatigue analysis, and as there could be several brake applications for each landing and also during taxi operations, the stress cycles accumulated by the brake pedal pillar would have been a multiple of the aircraft's landing cycle total.

The pillar failed due to a combination of high-cycle fatigue and manufacturing burrs (which initiated cracking). Information provided by the Operator and the Manufacturer suggests that this was a one-off event. Compliance with the Manufacturer's Service Bulletin (SB) should obviate the possibility of recurrence.

3. CONCLUSIONS

(a) Findings

1. The pillar suffered a fatigue failure, possibly facilitated by the presence of manufacturing burrs.

2. The aircraft had more than 80,000 landings and accordingly the brake pedal pillar would have experienced a high cyclic stress count.

3. The Operator found no problems when the remaining aircraft in the company fleet were inspected.

4. Since the issue of the Manufacturer's Service Bulletin (SB BN-2/SB 314), approved on 1 October 2008, no other operator has advised the Manufacturer of a similar problem.

5. Notwithstanding the Manufacturer's determination that this is a one-off incident, the pillar tube thickness has been increased for new build and "on-condition" replacement pillars.

(b) Probable Cause

1. The pillar suffered a fatigue failure, consistent with the aircraft's high number of landings and consequent high number of brake applications.

(c) Contributory Cause

1. The manufacturing burrs left around the holes in the pillar were likely to have facilitated crack initiation.

4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any Safety Recommendations.

- END -