

AVIATION OCCURRENCE REPORT

HYDRAULIC SYSTEM FAILURE

**CANADIAN AIRLINES INTERNATIONAL LTD.
BOEING 737-242C C-GNDC
WINNIPEG, MANITOBA
19 AUGUST 1994**

REPORT NUMBER A94C0166

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

Canadian Airlines flight 431 was on approach to land at The Pas, Manitoba, when the aircraft A-system hydraulic pressure dropped to zero. The crew conducted a missed approach and, after consultation with company maintenance control, they elected to return to land at Winnipeg. The crew declared an emergency and requested priority handling. Winnipeg airport emergency response services were placed on standby. The aircraft landed safely. The runway was closed until the aircraft could be towed to the terminal and until spilled hydraulic fluid was washed from the surface of the runway. There were no injuries.

Other Factual Information

Company maintenance personnel determined that the A-system hydraulic fluid depleted when the end cap failed on a hydraulic transfer cylinder that was installed in the left main landing gear wheel well.

The failed transfer cylinder (Boeing Assembly No. 69-54600-2, Serial No. 585) was removed from the aircraft. The failed components of the end cap and the internal shuttle mechanism were removed from the cylinder. Both end caps installed on this hydraulic transfer cylinder were made of an aluminium alloy material. The failed end cap displayed evidence of a multi-surfaced fracture that emanated from an internal groove and proceeded around the circumference of the cap material. The failed end cap components and shuttle assembly were forwarded to the TSB Engineering Laboratory Branch for analysis.

The hydraulic transfer cylinder end caps are the subject of Boeing Service Bulletin (S.B. 737-32-1099), issued 14 September 1979, which recommended replacement of aluminium end caps with higher strength stainless steel end caps. On 10 January 1985, Canadian Airlines International created an engineering order (E.O. 3200-01033) that referenced the service bulletin and mandated replacement of the aluminium hydraulic transfer cylinder end caps at the next cylinder shop visit. The engineering order did not specify action to be taken regarding aluminium end caps installed on cylinder assemblies that were in inventory ready for installation on company aircraft. Following installation, the hydraulic transfer cylinders are maintained as "on-condition" units and are not required to be removed or overhauled in accordance with any specified time-frame.

The data plate on the failed unit indicated that the transfer cylinder was a ...-2 model. Company records indicated that the hydraulic transfer cylinder was a ...-1 model. The data plate serial number (585) was consistently displayed in all records for the component. This hydraulic transfer cylinder was installed from inventory stock on the occurrence aircraft on 30 July 1985. The cap failed approximately nine years and one month after installation, after 44,149.22 hours in service.

The material composition of the failed end cap was consistent with the standard aluminium alloy (AA 7075 heat treated to a T-73 condition) used in the original end cap construction. The mode of failure was determined to be low-cycle fatigue; the fracture propagated under normal service loads from fatigue-generated pre-cracks originating at the top edge of a ring groove in the internal diameter of the end cap. No stress concentrations other than those caused by the geometry of the groove were detected.

Analysis

Boeing Service Bulletin 737-32-1099 recommended replacement of aluminium hydraulic transfer cylinder end caps with stronger stainless steel end caps. Canadian Airlines International responded to this recommendation by issuing engineering order E.O. 3200-01033. The engineering order required replacement of hydraulic transfer cylinder end caps at the next cylinder shop visit, but it did not specify replacement of end caps on in-stock assemblies. The requirements of

E.O. 3200-01033 were in effect when the serial number 585 hydraulic transfer cylinder was installed. However, because the in-stock cylinders were not modified and because the unit had not subsequently required a cylinder shop visit, the aluminium end caps were not replaced with stainless steel end caps.

The following Engineering Branch report was completed:

LP 126/94 - Hydraulic End Cap Analysis.

Findings

1. One of two aluminium end caps installed on a hydraulic transfer cylinder (P/N 69-54600-2) failed because of low-cycle fatigue under normal service loads.
2. The material composition of the failed end cap was consistent with the standard aluminium alloy designated AA 7075, heat treated to a T-73 condition.
3. Boeing service bulletin 737-32-1099, issued 14 September 1979, recommended replacement of hydraulic transfer cylinder aluminum end caps with higher strength stainless steel end caps.
4. Canadian Airlines International E.O. 3200-01033, dated 10 January 1985, did not direct replacement of end caps installed on existing cylinder assemblies in the company inventory.
5. The aluminium end caps had not been replaced with stainless steel caps when the subject hydraulic transfer cylinder was installed on the occurrence aircraft.
6. The hydraulic transfer cylinder was maintained as an "on-condition" item and had not been subjected to a cylinder shop visit and subsequent end cap replacement.

Causes and Contributing Factors

The aluminium alloy end cap failed because of low cycle fatigue under normal service loads.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Gerald E. Bennett, Zita Brunet, the Hon. Wilfred R. DuPont and Hugh MacNeil, authorized the release of this report on 28 February 1995.