AIRWORTHINESS BULLETIN

Control Cable Terminal - Retirement

AWB 27-001 **Issue** : 4
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1. Applicability

All aircraft flight control cable terminal fittings made from stainless steel specification SAE-AISI 303 Se, including, but not limited to, standard terminal stud part numbers AN669 and MS21260 and MS20668 eye end terminals.

2. Purpose

The objective of this airworthiness bulletin (AWB) is to urge operators and maintainers to consider replacing all control cables having terminal fittings manufactured from stainless steel SAE-AISI 303Se before reaching 15 years time in service. In addition, operators and maintainers should consider inspecting control cable terminals which have rubber sleeves or tape etc. wrapped around the terminal, irrespective of total time in service, as described in section 4 of this AWB.

3. Background

Reports of flight control cable terminal fitting separation failures continue to be received in Australia, New Zealand and the United States. Failure of a flight control cable terminal can result in loss of control.

Investigations have revealed that the failed terminals had been in service for approximately 15 years or more, were manufactured from SAE-AISI 303Se stainless steel and identified by standard terminal fitting part numbers AN669, MS21260 and MS20668.

It should be noted that these terminal fittings have been incorporated into flight control cable assemblies which can then be identified by different manufacturers part numbers in the aircraft Illustrated Parts Catalogue (IPC).

Figure 1 - Separation at threaded end of terminal

Terminal fitting separation as described in this Airworthiness Bulletin is due to chloride stress-corrosion cracking (CSCC) a form of intergranular cracking which does not provide clear visual clues to the full extent of the internal structural damage and can originate from within the terminal (See Figure 4.).

This means that even very small corrosion pits, cracks or rust deposits on the surface of the terminal fitting may be indications that the terminal could be very close to failure.

Figure 2 - Separation at swaged end of terminal

Reported failures in Australia include a terminal fitting in a wing and another in the cabin, behind the instrument panel. Such locations are relatively easy to inspect and generally considered to be free of water, battery gasses and engine exhaust fumes, factors which can contribute to corrosion problems.

Periodic inspections to monitor growing rust and/or pitting deposits on the terminal surface are not considered adequate to determine the continuing serviceability of the terminal. In-flight failures indicate that, not only is the initial pitting /cracking generally difficult to detect, but the extent of the associated sub-surface corrosion is extremely difficult to assess and the rate of crack propagation is unpredictable.

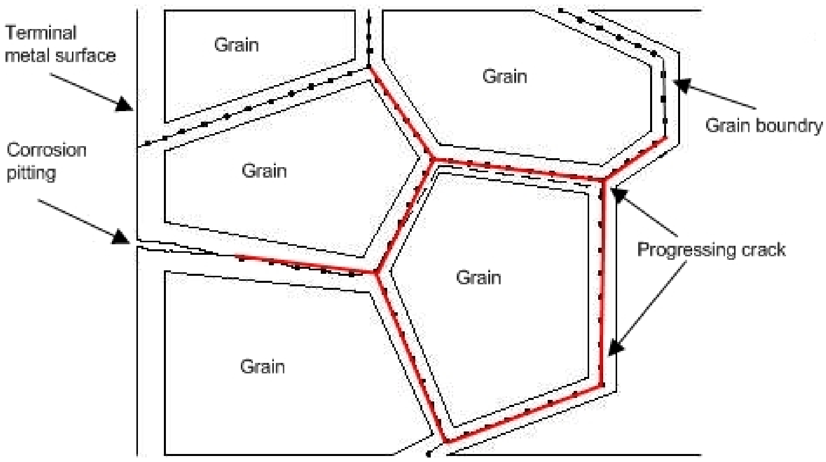

Figure 3 - Intergranular Corrosion Cracking

Adapted from: Corrosion DOE-HDBK-1015/1-93 SPECIALIZED CORROSION Rev. 0 CH-02 Page 33 Figure 14 Intergranular Corrosion Cracking.

While the sketch above (Figure 3.) shows surface pitting as evidence of intergranular corrosion, a corroded terminal may also show small rust deposits.

A formal investigation by the New Zealand Civil Aviation Authority into a report of stainless steel control cable terminal corrosion, discovered evidence of chloride stress corrosion cracking (CSCC) originating from the inside of the terminal. Since such cracking can originate from within the terminal, external surface clues such as pitting or cracking may not provide an adequate basis for determining serviceability. This introduces the possibility that a terminal may be close to failure and may even fail with little or no surface indication.

Figure 4. Internal corrosion - flight control terminal sleeve.

The crack shown in Fig. 4 originates from the cable wires (on the left of the picture) swaged in the terminal sleeve. The corrosion has not yet reached the outside surface of the terminal sleeve.

4. Additional Causes of Corrosion

Corrosion has now been found under the rubber sleeves used for aircraft manufacturer's part number identification, as shown in Figure 5 & 6 below. During an inspection which detected corrosion on one section of a terminal, the maintainer found additional corrosion at the edge and under the rubber sleeve, when the sleeve was pulled back. Four flap control cable terminals were affected. They had been in service for approximately 13 years.

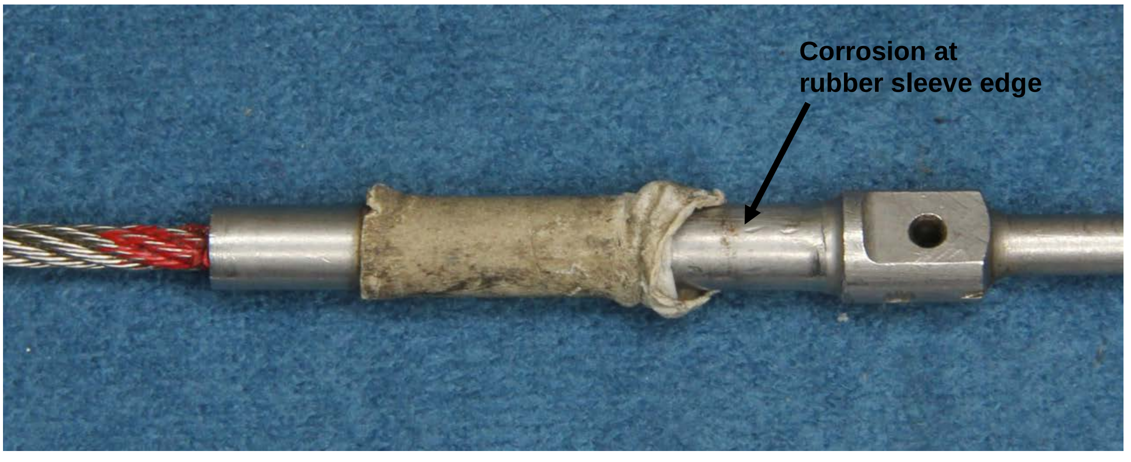

Figure 5 - Control cable terminal covered in rubber sleeve (source ATSB).

Figure 6 - Control cable terminal shown in figure 5, with rubber sleeve removed (source ATSB).

Stainless steel's resistance to corrosion is primarily attributed to the existence of a thin chromic oxide film which develops in the presence of oxygen in the atmosphere. Stainless steel must be in continual contact with oxygen in order to develop and maintain the integrity of the film. A breakdown in an area of the oxide film due to lack of oxygen can allow localised corrosion cells to form. The presence of the rubber sleeves over the terminals prevented the chromic oxide film to form, allowing corrosion to develop.

5. References

(i) FAA Special Airworthiness Information Bulletin (SAIB) CE-02-05 R2 "…..cracking and corrosion problems currently being experienced with terminals made from SAE AIAI 303 Se stainless steel".

(ii) FAA SAIB CE-11-01 Stabilizers - Horizontal Stabiliser - Turnbuckle (Piper Aircraft Inc.)

(iii) National Transport Safety Board (NTSB) recommendations A-01-06 through A-01-008.

(iv) U.S. Department of Energy DOE-HDBK-1015/1-93 SPECIALIZED CORROSION

(v) FAA AC 43-13-1B chapter 7, section 8, paragraph 7.149d

(vi) NTSB Materials Laboratory Factual Report No. 10-108

(vii) ASM Handbook Committee 1975, *Failure Analysis and Prevention*, Metals Handbook, 8th edn, Metals Park, Ohio

6. Recommendations

CASA strongly recommends that operators consider the following:

a. Visually inspect flight control cable terminals, irrespective of the total time in service, for the presence of any rubber sleeves, tape or any other material/substance (other than lockwire) that may prevent the chromic oxide film from forming. Such material should be removed and the terminal cleaned and inspected for corrosion. Any sign of corrosion is cause for rejection.

b. Retire all flight control cables made from stainless steel (SAE-AISI 303Se) including, but not limited to, standard flight control cable terminal part numbers AN669, MS21260 and MS20668, before reaching 15 years time since installation.

c. Where required by aircraft maintenance documentation, flight control cables should be periodically inspected in accordance with the manufacturer's data and FAA AC 43-13-1B chapter 7, section 8, paragraph 7.149d.

7. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

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