Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Aircraft Tubular Steel Structures - Inspection

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1. Effectivity

All aircraft that utilise tubular steel structure that is or forms part of the primary (or secondary) structure of the aircraft.

2. Purpose

To provide information to aircraft engineers and operators regarding detecting internal corrosion and fatigue cracking failures in typical aircraft tubular structures during periodic inspections.

3. Background

Maintenance programs for aircraft which have welded steel tubular primary structure frequently do not include a requirement to periodically inspect the interior surfaces of the tubular structure for corrosion; neither do they require the fabric covering to be removed from sections of the structure not accessible from inspection panels, to inspect the structural tubing for corrosion and cracks.

Internal Structural Corrosion

An operator who was concerned about the possibility of corrosion on the inside surfaces of the steel tubular structure of his aircraft, contracted the services of a Non Destructive Testing (NDT) specialist to conduct radiographic inspections of the suspect frames. The results of the inspection showed heavy corrosion on the inside walls of several sections the fuselage tubing, (Fig.1). The internal corrosion was not detectable using the inspection procedures in the aircraft maintenance manual (see Flight Safety Australia Article, *Internal corruption, a story of steel tubes and hidden rust*).

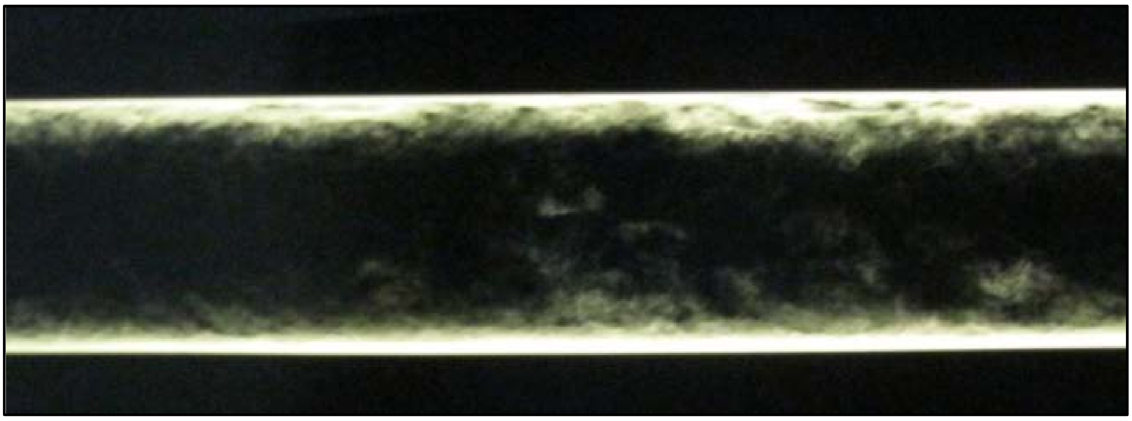


Figure 1 - A radiographic image of a steel tube in the aircraft primary structure showing indications of major internal corrosion and thinning of the wall structure.

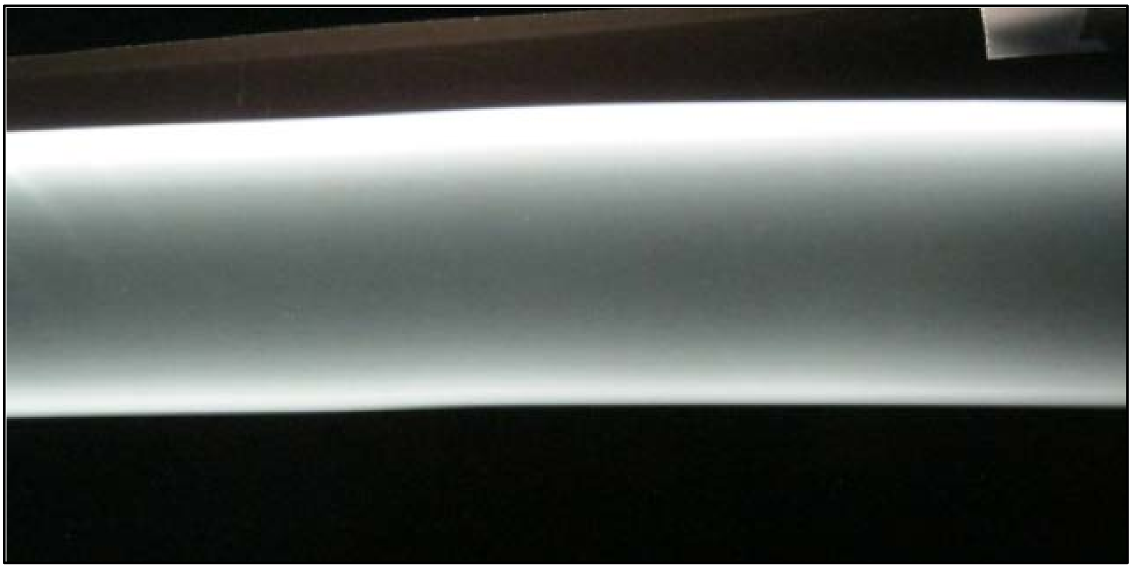


Figure 2 - Comparison. A radiographic image of a structural steel tube with no corrosion.

Corrosion reduces the wall thickness and therefore the strength of the structure. Even minor corrosion pitting provides stress raisers for fatigue crack initiation. If corrosion is detected early enough, localised areas of light corrosion can sometimes be treated. Badly affected tubes are typically cut out and new tubes of the original material specification spliced into the structure. Unfortunately, in some cases, where periodic inspections of the interior of the structure have not previously been carried out, the discovery of extensive corrosion has required the replacement of the entire tubular structure.

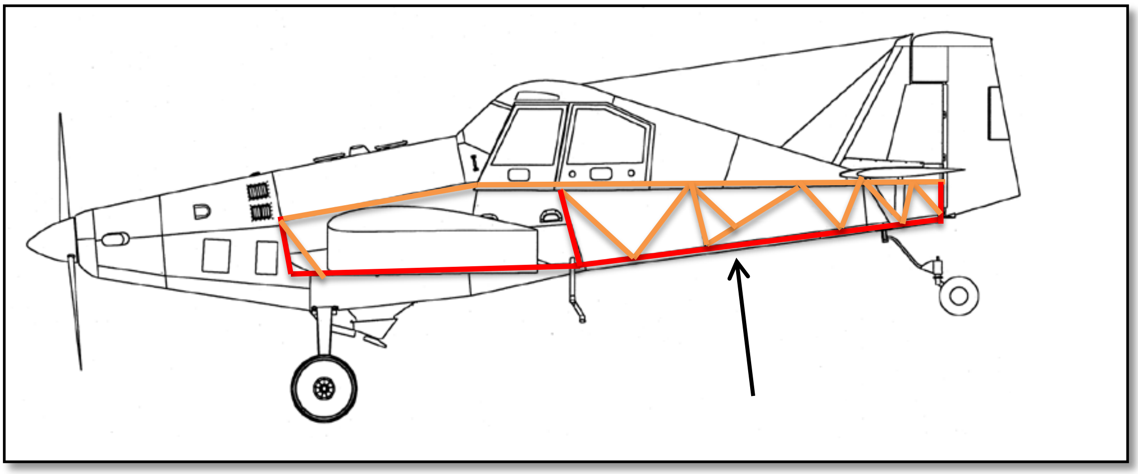


Figure 3 - Areas of corrosion suspected and detected in the lower longeron area (red) using radiographic NDT methods.

Although steel tubular structure may corrode at any location, the interior of lower longerons and lower ends of tubes are prime areas for internal corrosion, because moisture and contaminants tend to collect in these areas.

Evidence of severe corrosion in the form of loose corrosion flakes inside structural tubing can sometimes be heard when an element of the structure, (being removed from the aircraft during repair or rebuild) is tipped one way and then the other, or rotated from vertical through 180 degrees. Magnets inserted into tubes through bolt holes, etc., may locate rust flakes, indicating corrosion.

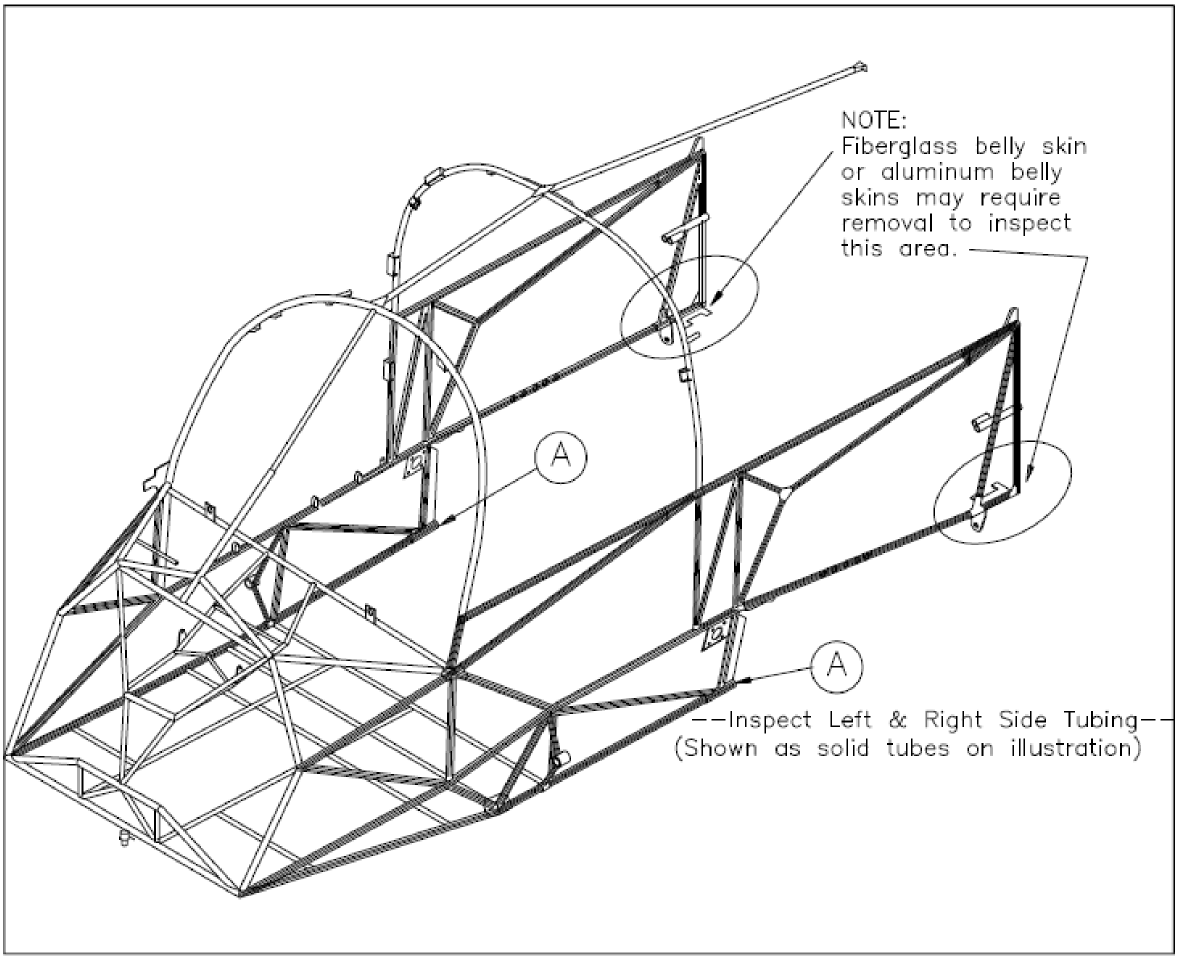


Figure 4 - Mooney M20 Series cabin section. Example of primary steel tubular structure to be periodically inspected externally and internally for corrosion in accordance with SB M20-208 B, mandated by AD/M20/32.

The inspection techniques detailed in Mooney International SB M20-208B INSPECTION OF TUBULAR STRUCTURE includes a visual inspection of the tubes and tube joints for external corrosion, using an awl, screwdriver or punch to probe suspect areas of tubing and the use of ultrasonic testing to determine wall tube thickness where corrosion is found.

Fatigue Cracking

Defect reports submitted to CASA reflect world wide experience which continues to confirm that welded steel tubular structures will fatigue and crack in areas of concentrated stress and which are typically covered with fabric and not readily accessible for a visual inspection.

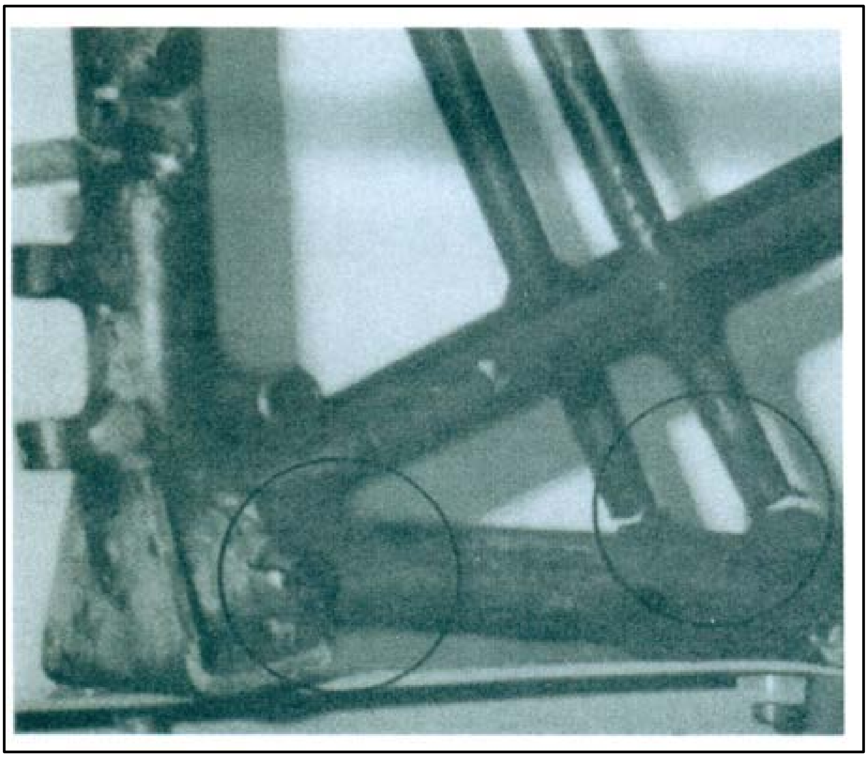
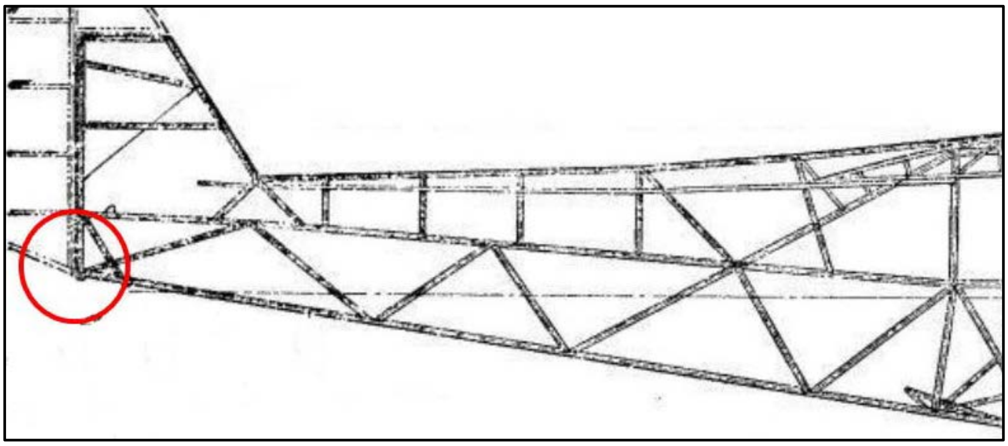


Figure 5a - (above) Typical fractured or separated tubes and cracks at tail wheel attachment fittings and Figure 5b (below) the general location of the failures



The Piper PA18 is a typical example. Fuselage tube cracking and tube separation occurs in the fuselage longerons, bracket joints and cross braces of any aircraft constructed from welded steel tubular structure (Fig. 6 below).

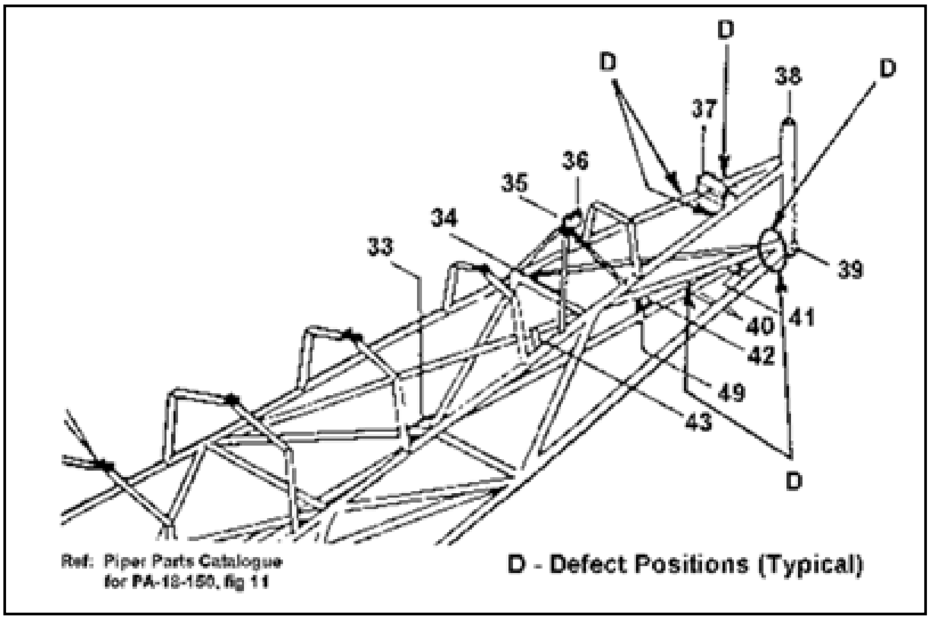


Figure 6 - Piper PA18. Typical fatigue cracking sites in the aft fuselage.

Where existing removable inspection panels do allow adequate external inspection of the tubular structure, consideration should be given to the installation of additional removable inspection panels in the fabric for external inspections, and using radiographic, ultrasonic and other NDTs to detect the extent of cracking, and corrosion on the internal walls of welded tubular aircraft structures.

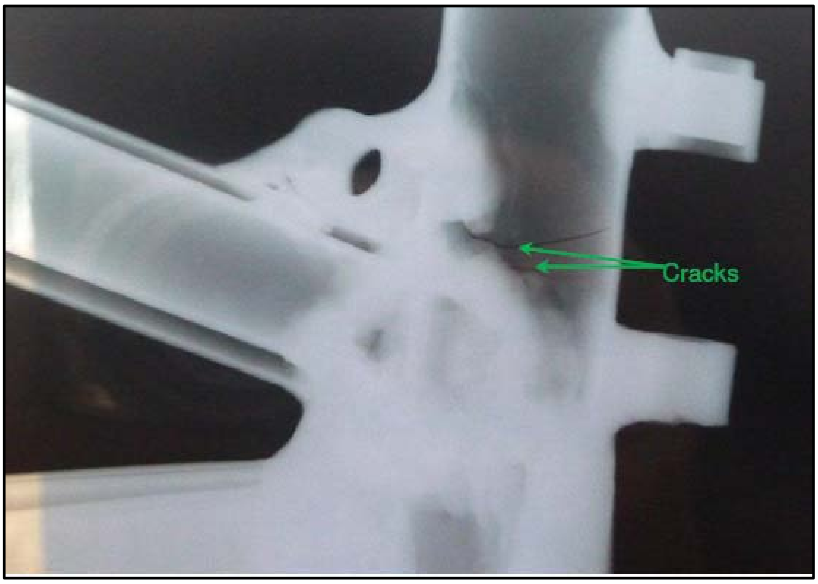


Figure 7 - Sample image of areas covered by fabric and showing cracks found during a radiographic inspection.

Regulation 42V of the Civil Aviation Regulations requires that all aircraft maintenance is to be performed in accordance with approved data. This includes those aeroplanes maintained under CASA Schedule 5.

4. Recommendations

CASA recommends that:

a) Aircraft operators should ensure that the maintenance program for an aircraft constructed from welded tubular steel structure includes a requirement to periodically inspect all external and internal surfaces of the tubular structure. Any approved maintenance program which does not include a periodic inspection that will detect corrosion in the structure may be considered inadequate.

b) If an appropriate inspection technique or NDT procedure is not available in the existing approved data for the applicable aircraft, such data may need to be developed by an NDT specialist in conjunction with a CASR 21M Delegate.

c) Where corrosion or fatigue cracking is detected, any decision about the need for any additional inspections and the extent of repairs should be based on the manufacturer's damage criteria and tolerances found in the aircraft's approved data. In cases where the damage detected is not addressed by existing manufacturer's data, the manufacturer or a CASR 21M Delegate should be approached to provide assistance.

5. Reporting

All defects found concerning internal tubular corrosion and failures should be submitted via the CASA SDR system.

6. Enquiries

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

AirworthinessBulletin@casa.gov.au

or in writing, to:

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Standards Division
Civil Aviation Safety Authority
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