Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Maintenance of External Tubes and Lines - Small Gas Turbine Engines

AWB 02-024 **Issue** : 1
Date : 15 August 2007

1. Applicability

All operators and maintainers of small gas turbine engines.

2. Purpose

This AWB highlights the importance of proper installation of engine tubing and provides general advice on their maintenance. In all cases, maintenance data provided by the engine or aircraft OEM supersedes any guidelines contained in this AWB.

The information and photographs contained in this AWB are courtesy of Rolls Royce, North America.

3. Background

There have been many aircraft accidents and incidents which are attributable to improper alignment, clamping, and torquing of engine tubing during installation. Instances of twisted lines, kinked lines and split flares have resulted from installation practices contrary to those specified in the OEM service documents. Compliance with the manual procedures is critical to the safety of flight.

In most cases, the failure of the tube assemblies can be traced to one or any combination of the following causes:

i) Bent tubes which induce misalignment at the flare and result in cracked flares or fretting of the tube at the end of the ferrule.

ii) Tube to fitting misalignment caused by poorly aligned fittings, which result in cracked flares or fretting of the tube at the end of the ferrule.

iii) Clamps of the improper size that cause fretting wear and failure at the clamp due to stress concentration at the wear step.

iv) Clamps with incorrect cushion material that causes corrosion and eventual stress corrosion failure of the tube.

v) Installation of chafe-wrapping to correct a loose clamp. This chafe-wrapping then causes corrosion and eventual stress corrosion failure of the tube.

vi) Incorrect clamp locations that do not properly dampen tube vibrations. The vibrations then lead to fatigue failure of the tube.

vii) Unauthorized clamping of other hardware to the engine tube assemblies, which induce vibratory stress that results in the tube failure.

viii) Failure to properly torque tube coupling nuts can cause leakage if under-torqued, which can result in fuel or oil leaks or engine power loss. Over-torqued B-nuts result in deformed and cracked flares.

Example 1

Following are the pictures (Figures 1-3) of some tube assemblies that were not properly installed (Rolls Royce 250- series engines).

Figure 1 - Tube Assembly - chafing marks and signs of corrosion

Figure 2 - Tube Assembly - chafing led to holing and fluid leakage

Figure 3 - Tube Assembly - Chafing

Example 2

P/N 23033896 tube assembly was removed from a Rolls Royce Model 250-C20R Series engine. Photographs were taken of the deformations in the tube assembly and are indicated in Figure 4. The following discrepancies were noted during the examination of the tube assembly:

A. The deformations were caused by attempting to use Model C2OR Series single engine designated clamping on a multi-engine configuration tube.

B. The previously mentioned clamp hid the large dent. Only removal of the tube assembly allowed discovery of the extent of damage to the tube.

Figure 4 - Tube Assembly, Rolls Royce P/N 23033896

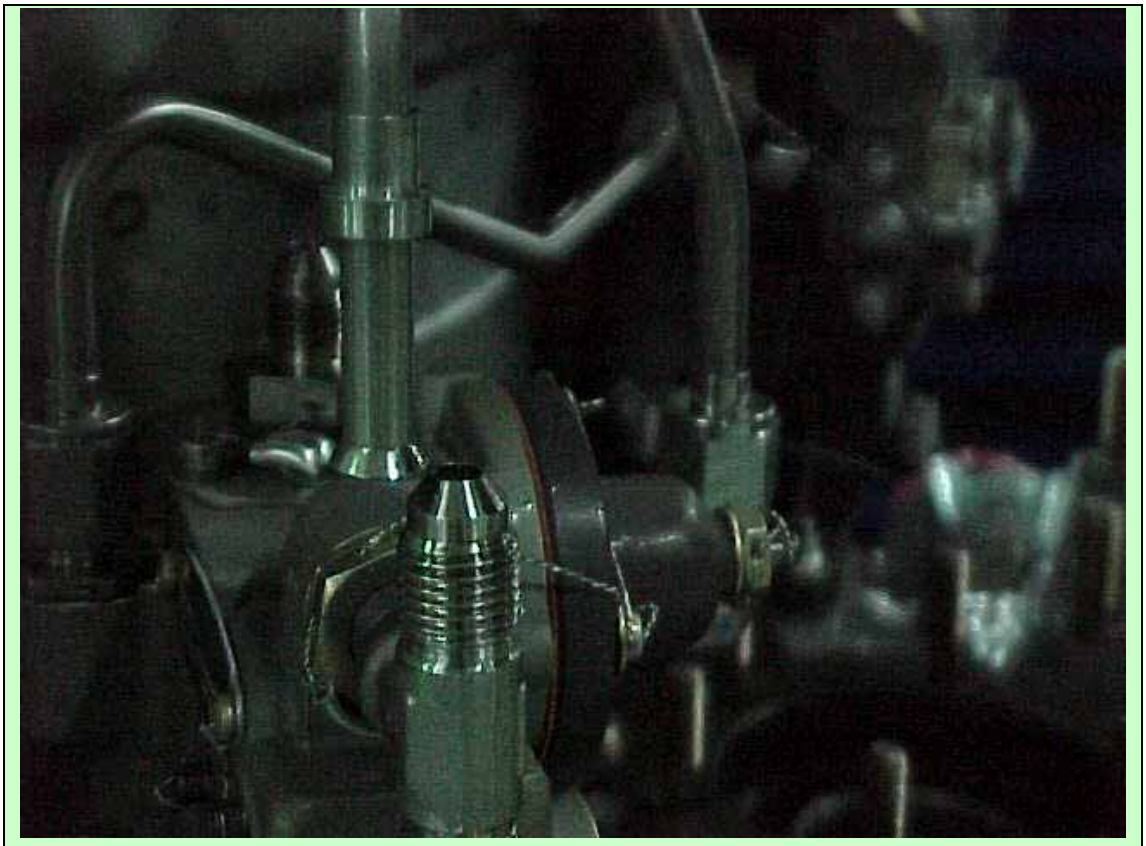

Figure 5 - Misaligned Tube

4. Recommendations

Following maintenance practices are recommended when handling any pneumatic control system, lubrication system, or fuel system tube assemblies on small gas turbine engines.

A. Use only approved tube assemblies with the correct part number.

B. Follow the appropriate engine / aircraft manual(s) for tube to fitting alignment procedures, correct torque values, and installation/ tightening recommendations.

C. Always use a torque reaction wrench when tightening tube assembly B-nuts.

D. Tube assemblies must fit and be aligned with the mating flare tube fittings to the degree that at both ends of the assembly, the flares shall be uniformly seated in a free state on the cones of the mating fittings. The fitting shall be without distortions or stretching of the tube assembly, and to the degree that the nuts can be fully engaged up to the final one-half turn with light finger pressure. (See Figures 5 and 6).

E. In the event that a tube does not align with the mating fittings, re-position the mating fittings to the degree that proper alignment may be achieved. Final tightening of these fitting lock nuts must be accomplished before the tube assembly is torqued.

F. The practice of tightening fitting lock nuts with tube assemblies installed can result in damage to the tube, with possible failure of the tube and engine. If proper alignment cannot be attained by re-positioning the mating flare tube fittings, bend the tube to provide alignment in the free state as specified. Accomplish all bending with the tube removed from the engine. Follow manufacturer's instructions at all times.

G. To prevent flattening of tube at the bend radius, extreme caution must be observed while bending previously formed tubes. Ensure that the tube is clamped in a fixture or device which will not scratch, indent, crimp or mark the surface of the tube during the bending operation. The flattened effect of the cross section of the tube, as a result of the reforming operation, must not exceed fifteen percent of the tube outer diameter (OD). Again, follow manufacturer's instructions at all times.

H. When proper free-state alignment is attained, complete the tubing installation by simultaneously securing the coupling nuts.

I. Old slippage marks (torque paint) must be completely removed and renewed each time the B-nut is retorqued. Consult applicable service documents for proper removal procedures and slippage mark remover solvent.

J. After properly torquing the B-nut, a slippage mark of a contrasting colour shall be applied by a continuous stripe approximately 0.0625 inch wide, minimum, that extends down the side of the B-nut and onto the fitting.

K. The B-nuts shall be inspected for indications of slippage at regular 100 hour maintenance intervals.

L. Clamp the tube assemblies as shown in / required by the appropriate service documents.

M. Do not install unapproved clamps, hardware, fittings, chafe-material, etc., on the engine tube assemblies. See Figure 7 for a correct cushion material example.

N. Visually inspect tube assemblies before each installation for the following items: cracked flares, nicks, dents, severe fretting in the area of clamps and end ferrules, corrosion, bent or malformed tubing, correct part number, and proper clamping. Failure to meet acceptable criteria is cause for rejection of the tube assembly.

O. Perform detailed visual inspection of the tube assemblies each time the tubes are removed in the completion of maintenance procedures. For example, if the fuel control unit is removed from the engine, all tube assemblies connected to the fuel control unit should be visually inspected.

P. Assure that the tube to fitting alignment is in accordance with the applicable service documents.

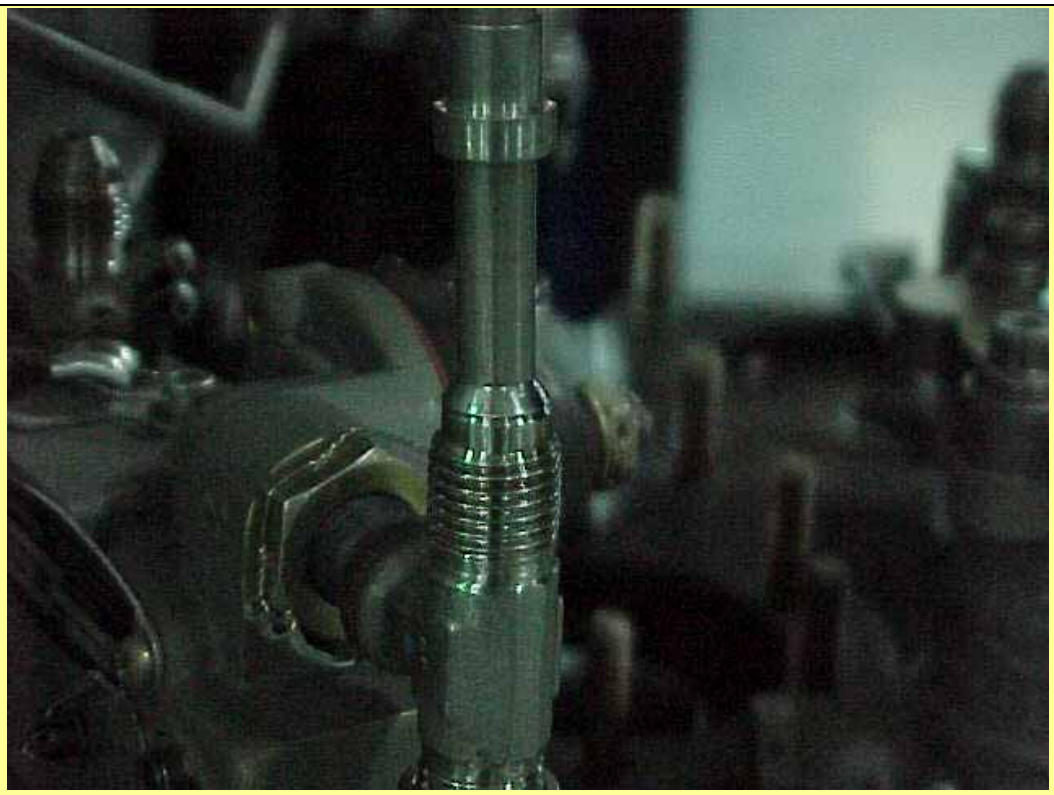

Figure 6 - Properly Aligned Tube

Figure 7 - Correct Cushion Material

5. Summary

Failure of a pneumatic, lubrication, or fuel system tube assembly can cause the engine to cease operation, resulting in an in-flight shutdown (IFSD) or a forced landing. Properly maintained engine tubing will greatly lessen the probability of an IFSD or a forced landing.

6. Enquiries

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

AirworthinessBulletin@casa.gov.au

Or in writing, to:

CASA Airworthiness Engineering Branch,

GPO Box 2005, Canberra, ACT, 2601