FINAL REPORT

AAIU Synoptic Report No: 2006-006
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In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Accidents, on 5 June 2004 appointed Mr. John Hughes as the Investigator-in-Charge to carry out a Field Investigation into this occurrence and prepare a Synoptic Report.

Aircraft Type and Registration:	Airbus A330-301, EI-JFK
No. and Type of Engines:	2 x GE CF6-8OE1A2
Aircraft Serial Number:	086
Year of Manufacture:	1994
Date and Time (UTC):	4 June 2004 @ 10.07 hrs
Location:	On take off from RWY 28, Dublin Airport
Type of Flight:	Scheduled Public Transport
Persons on Board:	Crew - 12 Passengers - 303
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	No damage to aircraft
Commander's Licence:	ATPL
Commander's Details:	Male, aged 44 years
Commander's Flying Experience:	15,000 hours of which 110 were on type
Information Source:	Operator informed AAIU

SYNOPSIS

The flight crew of EI-JFK declared an emergency at 10.09 hrs after they received a fire alarm indicating a fire in No. 2 engine. The aircraft had just taken off from Runway (RWY) 28 en route to New York. The Airport Fire Service (AFS) deployed all their first line vehicles at strategic points adjacent to RWY 28. The aircraft landed safely on RWY 28 at 10.25 hrs. and there were no reported injuries. Following inspection by the Airport Fire Officer, the aircraft was towed to Stand 36 where the passengers disembarked normally. Engineers inspected the aircraft and confirmed that they located a pneumatic duct leak in No. 2 engine. The electrical harness also sustained overheat damage.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was on a take-off roll at 10.07 hrs. when, on aircraft rotation, No.2 engine EGT (Exhaust Gas Temperature) over limit switch was triggered along with a pilot advisory EN62 Nacelle Temperature indication. Take-off was completed as per operational requirements.

At 10.08 hrs, the EN62 FIRE warning was triggered, the crew made a PAN call to ATC and shut down No.2 engine. The Captain activated the onboard fire suppressant system prior to landing with one engine inoperative. He requested the emergency services to standby as a precaution. An automatic dual autopilot autoland was conducted. The aircraft touched down smoothly on RWY 28 at 10.25 hrs, vacating on to taxiway E7. Following inspection by the Airport Fire Officer the aircraft was towed to Stand 36 where the passengers disembarked.

1.2 Initial Findings

Engineers inspected the engine and confirmed they located a pneumatic duct leak. A full post event inspection revealed that a V-band clamp at the 14th Stage Manifold lower engine port had detached, allowing hot air (greater than 600ºC) to bleed into the engine core compartment. There was a circumferential split along one of the V-band clamp segments. Localised heat distress was noted over an area of 12 square inches particularly to the electrical harness outer jackets. It was also noted that there was misalignment of the manifold at one of its ports. The tolerance take up (TTU) adjustment sleeves had separated and its inner duct suffered distortion (see **Appendix A**).
Three V-band couplings attach the manifold to the engine ports. The coupling at the lower port had failed. A portion of this coupling was recovered and sent to the manifold manufacturer. The remainder of the coupling was discovered during the subsequent engine shop visit.

1.3 Engine History

The engine had been removed from another aircraft of the fleet on 31 March 2004. A "Top Case" inspection was then performed prior to the installation in EI-JFK. It could not be confirmed if the manifold or its lower coupling had been removed during this inspection.

However, it was confirmed that the TTU and the adjacent No.2 High Pressure Bleed Valve (HPBV) had both been removed. The later was replaced on the 17 May 2004 and again on the 20 May 2004.

1.4 Laboratory Analysis

It was confirmed that the coupling was manufactured from A286 alloy. Scanning electron microscopic (SEM) examination revealed that the coupling failed due to fatigue fracture morphology. It was determined that no corrosion or embrittlement mechanism was involved in the coupling failure.

It was concluded that "the coupling was subjected to prolonged cyclic tension loading, which initiated and propagated the fracture to the point of coupling failure".

1.5 Manifold Examination

The manifold was returned to the manufacturer for examination. It was placed in the production tooling for a conformity check. The following observations were made:

- Upper tube flange out by 17/32 inches.
- Lower tube flange out by ⅝ inches.
- PRSOV (Pressure Relief Valve) tube out by 7/32 inches.

1.6 TTU Examination

The TTU provides an adjustable duct interface between the High Pressure Bleed Valve (HPBV) and the intersect duct. In the event of over-extension three tabs would normaly contact the flange at the base of the adjustment threads, preventing further extension of the TTU.
During examination the following was noted:

- Broken TTU adjustment sleeve lockwire.
- Disengagement of the adjustment sleeves.
- Distortion of the inner duct confirmed.
- Over-extension stops deformed and worn by 50% of new stop dimension.
- Witness marks on TTU adjustment sleeves resulting from contact with over extension stops.
- Flange sealing surfaces damaged
- Races worn beyond limits

Sections of the Manufacturer's report are reproduced below and their pictures appear in **Appendix A**.

2. ANALYSIS

The Manufacturers report included the following:

The lockwire securing the TTU adjustment sleeves in the adjusted position failed, allowing in-service rotation of the adjustment rings. The adjustment rings rotated in a direction that extended the TTU to the point of maximum extension. The over-extension tab deformation and wear identified during the examination of the TTU, permitted continued rotation of the adjustments sleeves beyond the mechanical stops. The TTU adjustment sleeves continued to extend to the point of thread disengagement.

The disengaged TTU adjustment sleeves permitted unrestrained extension of the inner duct. Additionally, the disengagement of the adjustment sleeves compromised the HPV/intersect duct support structure that is normally provided by the TTU. The inner duct distortion identified during inspection of the TTU, was the result of duct deflection around the inner duct bellows.

The tension loading introduced into the 14th stage manifold lower coupling installation by the unrestrained TTU inner duct, exacerbated by a HPV cyclic loading component due to the loss of TTU support, initiated a fatigue fracture in the coupling. Fracture propagation continued to the point of coupling failure.

The 14th stage manifold-to-port mismatch observed on the engine, and the deviation to the alignment features when installed in the tool, was attributed to manifold distortion resulting from pressure application with the manifold unrestrained at the port.

The Manufacturer agrees with the Operator's assessment that the thread disengagement of the adjustment sleeves occurred prior to the coupling event.

On the 10th February 2005 the Manufacturer issued an All Operator Letter (AOL-CF6-80E-NAC-012) advising operators of a requirement to inspect the lockwire installation on the TTU duct. This document also referenced this event as background information.

A Service Bulletin (CF6-80E1-NAC-71-039) was also issued which, besides directing attention to the TTU wirelocking and duct length adjustment, also provides recommended maintenance procedures and adjustment checks to the engine bleed system hardware installation.

In view of the above action the Investigation does not intend to make any Safety Recommendations.

3. CONCLUSIONS

(a) Findings

1. The lockwire securing the TTU adjustment sleeves in the adjusted position failed, allowing in-service rotation of the adjustment rings. The TTU then extended beyond its point of designed maximum extention. The inner duct then became unsupported.

2 Tension loading in the 14th Stage Manifold due to the unsupported duct initiated a fatigue fracture in the coupling, which then failed.

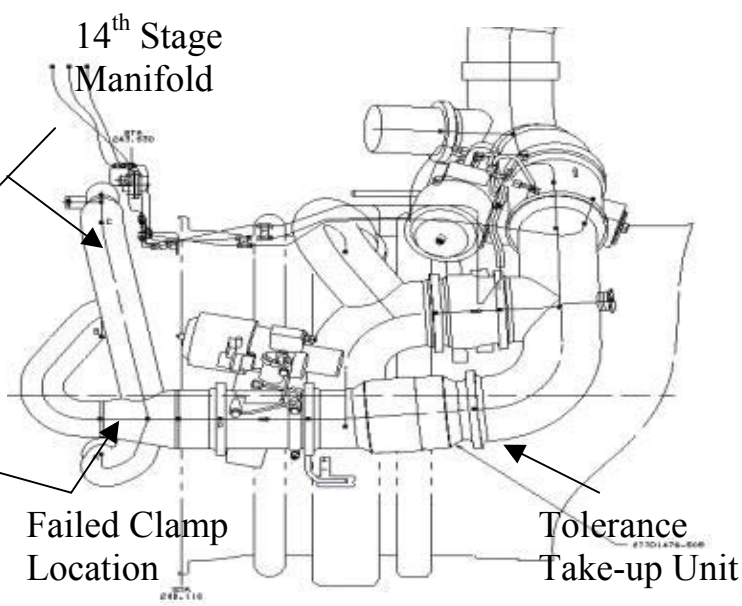
(b) Cause

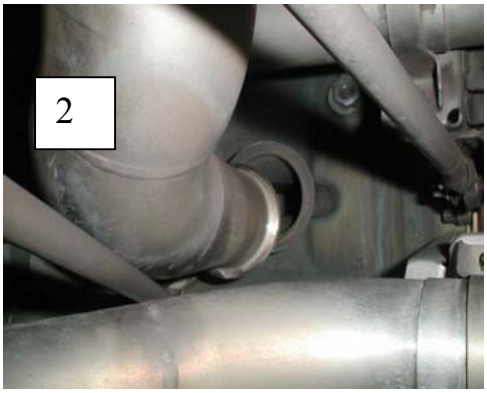
1. The cause of the coupling failure was due to in service wear in the TTU components and the subsequent failure of the TTU wire locking.

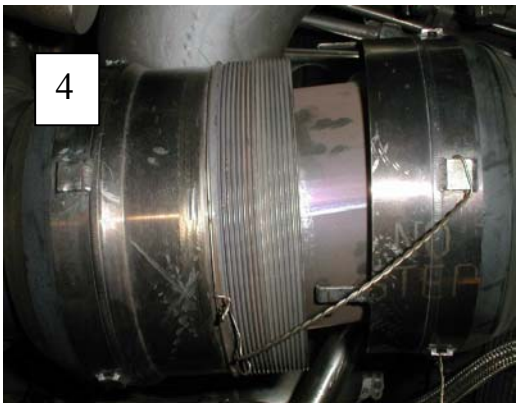
4. SAFETY RECOMMENDATIONS

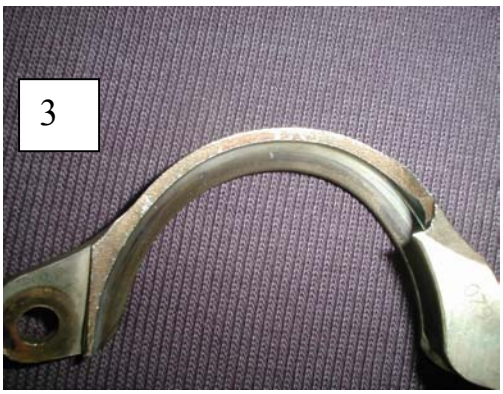
This Report does not sustain any Safety Recommendations.

APPENDIX A









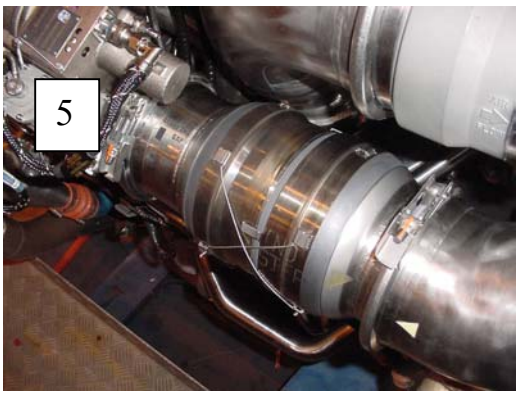


Photo 1: The 14th Stage Manifold on a tool rig
Photo 2:The failed manifold coupling position
Photo 3: The fractured clamp

Photo 4: The detached TTU of EI-JFK
Photo 5: A serviceable TTU