Aviation Safety Investigation Report 199401543

Airbus A300-B4-203

13 June 1994

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Aviation Safety Investigation Report

199401543

Occurrence Number:	199401543	**Occurrence Type:**	Incident
Location:	Sydney		
State:	NSW	**Inv Category:**	3
Date:	Monday 13 June 1994		
Time:	0737 hours	**Time Zone**	EST
Highest Injury Level:	None		

Aircraft Manufacturer:	Airbus		
Aircraft Model:	A300-B4-203		
Aircraft Registration:	VH-TAC	**Serial Number:**	157
Type of Operation:	Air Transport Passenger Domestic High Capacity International		
Damage to Aircraft:	Minor		
Departure Point:	Sydney NSW		
Departure Time:	0737 EST		
Destination:	Brisbane QLD		

Approved for Release: Friday, August 9, 1996

FACTUAL INFORMATION

1.1 The incident

The Airbus A300-B4 aircraft departed Sydney on a scheduled service to Brisbane. At about 700 ft after takeoff the left engine fire warning activated. The crew carried out the appropriate procedures and shut down the left engine. With the engine shut down the fire warning indications ceased, therefore the fire bottle was not discharged. The aircraft was vectored for a priority landing back onto the departure runway and, after ground inspections confirmed the absence of fire, the aircraft was taxied to the terminal for a normal disembarkation.

Inspection of the engine disclosed a rupture of the 14th stage lower bleed air duct. Secondary thermal damage had occurred to the reverser cowl and minor mechanical damage was evident to the reverser mechanism.

1.2. Duct cracking

The engine manufacturer, General Electric (GE), advised that cracking can occur in the lower bleed air duct due to differences in thermal gradients. This occurs because the duct is made from a nickel alloy Inconel 625 and the support link assemblies are made of 321 stainless steel. Thermal stresses occur when the bleed air valve is closed resulting in the lower duct being cooler than the engine case. Installation stresses can also result in cracking.

1.3. Duct examination

The duct is a 90 mm pipe spanning approximately one-third of the circumference of the engine core. Three mounting lugs are welded to the outside surface of the pipe. The duct had ruptured around the toe of the weld at the lap joint of an end lug. Cracking was also present along the toe weld of the other end lug.

The fracture surfaces were subjected to both low power and scanning electron beam microscopy which revealed that the failure was typical of that due to fatigue. The fatigue had multiple initiations along both the outside and inside surfaces of the duct; however, the majority of the fracture had propagated from the outside surface. The fatigue fracture consisted of very fine evenly spaced fatigue striations typical of a constant amplitude load from the stresses associated with thermal cycles.

The fatigue extended around the end of the weld lap joint and approximately 30 mm each side of the lap joint before rapid tearing commenced. The fatigue fracture was stained indicating that hot air had been escaping for some time.

1.4 Propagation rate

The fatigue striation spacing was measured on a small area of fatigue fracture at various distances across the duct section from an origin on the outside surface to the boundary line between two areas of fatigue. From these measurements it was estimated that approximately 2,000 fatigue striations were present on this small area of fatigue fracture. Assuming that a thermal cycle is equivalent to an engine cycle, it would appear that this small area of fatigue had been propagating for 2,000 engine cycles. However, the entire fatigue fracture consisted of many fatigue cracks initiating at different stages during the life of the duct. This indicates that the fatigue cracking had been propagating for in excess of 2,000 engine cycles.

1.5 Recent inspections

The last maintenance inspection was during a Check "A" inspection carried out at 199 hours and 180 cycles prior to failure of the duct. The last shop visit was 922 hours and 816 cycles prior to failure. The fatigue cracks were present, but not detected, when these inspections were carried out.

1.6 Operator's inspection requirements

The operator's inspection requirement was detailed on Task Card AB3-723300-0801-TN-L and R. This task card is called up at each Check "A" inspection which at the time of the incident was on a rotating 320/480 hour schedule. The task was originally created on 29 October 1987. The task card in use during the last inspection of the duct was issued with an amendment dated 6 September 1990 which required:

"Visual inspection of high pressure compressor emphasising.....14th stage bleed air manifold for cracks".

This visual inspection was carried out at the last inspection but failed to detect the cracking.

1.7 Manufacturer's requirement

GE issued Service Bulletin CF6-50-75-064 (SB 064) on 3 August 1990 to institute a recurring inspection aimed at detecting cracks in the 14th stage bleed air ducts.

On Page 4 of SB 064, at item 2.B was a requirement that a Spot Fluorescent Penetrant Inspection (SFPI) technique be used to detect cracks, with a requirement that the SFPI be carried out every 500 flight hours or 150 engine cycles whichever occurs last.

The operator's maintenance system is detailed in the Maintenance Instruction Manual (MIM). This manual sets out the procedures to be used to ensure compliance with the statutory requirements pertaining to engineering and maintenance activities.

Revisions to the MIM are accomplished by entering the necessary details onto a Manual Revision Authority form. The form is then processed in accordance with flow charts contained in the MIM. Some procedures are also contained within instructions raised within specific sections.

The preparation of the Manual Revision Authority form, the routeing through actioning sections, and the subsequent approval and incorporation of an amendment is accomplished by individuals actioning computer based commands.

1.8 Operator's action

The operator received information, known generically as service literature, regarding introduction of the SFPI technique from both GE and Airbus Industrie (AI), the aircraft manufacturer.

Within the operator's maintenance organisation there are two sections which are required to process changes to maintenance requirements for engines. These are the Power Plant Engineering (PPE) section and the Maintenance Development (MD) section. There were at least four occasions when either or both sections assessed or reviewed the requirements of the SB.

These were:

(a) at initial issue of SB 064,

(b) on receipt of GE Commercial Engine Service Memorandum 76 (CESM 76)

(c) on receipt of an amendment to Airbus Industrie Maintenance Planning Document (MPD) dated October 1991.

(d) on receipt of an MPD amendment dated October 1992

1.9 Initial assessment of SB 064

GE issued SB 064 on 30 August 1990. Contrary to MIM requirements there were no entries made into the computer system that would have allowed the investigation to accurately track the initial routeing of SB 064.

The SB should have been received by PPE and passed to MD for assessment. The PPE engineer involved was no longer employed by the operator at the time of this investigation and was unable to be interviewed regarding his memory of his handling of the SB.

Available records do show that on 28 August 1990 an engineer in MD raised a Manual Revision Authority, numbered AB3100190, requesting the following change to the Maintenance Instruction Manual (MIM):

"Revise tasks AB3-723300-0801-TN-L & R to add visual inspections of the 8th and 14th stage bleed air manifolds". (BASI note - the terms manifold and duct are interchangeable).

The Purpose/Justification part of the Authority stated:

"New General Electric requirement as per SB 75-064".

This request for an MIM change was presented to, and authorised by, the Engineering Manager who did not identify that the assessing engineer in MD had made an incorrect assessment of the inspection process called up in the SB. As a result of the Engineering Manager's authorisation, the task card was amended on 6 September 1990.

MD also raised a Engineering Instruction (EI) numbered EI AB3-075-0102R00. The purpose of the EI is to notify other action sections of any change that may require their attention. This EI was not actioned because the assessing engineer, having raised the Manual Revision Authority, annotated on the EI that the SB was actioned by stating that the EI was "Terminated.... Covered By Maintenance A Checks". There was no evidence of any communication taking place between PPE and MD prior to the decision to terminate the EI. However, anecdotal evidence suggests that there was often verbal communication between the sections regarding the processing of service literature.

The MIM did not require that a comparison between the SB inspection requirements and those contained in the Maintenance Check A be been carried out prior to terminating the EI.

The MIM requires that PPE issue an Action Advice to notify MD that the intent of the SB is to be included in the applicable aircraft checks. An Action Advice covering the initial assessment of SB 064 could not be located.

1.10 General Electric Service Memorandum

On 10 September 1990 GE issued Revision 6 to Commercial Engine Service Memorandum (CESM) No. 76 which contained a consolidated listing of all scheduled inspection and servicing intervals for engines. This was received by PPE on 18 October 1990. PPE raised Action Advice number 9043002 on 1 November 1990 to notify MD of receipt of the CESM. MD assessed and cleared this Action Advice stating it was "Covered by AB3 MPD Revision".

While the statement is correct in that the task cards had been revised, the incorrect assessment and subsequent incorrect procedure were not identified by the person in MD responsible for carrying out the assessment of CESM No. 76.

1.11 AI MPD amendment dated October 1991

Airbus Industrie first introduced the requirement to comply with GE SB 064 via an amendment to the MPD issued in October 1991. The revised MPD was received by MD and assessed. The assessing/action engineer, while noting that GE SB 064 had been incorporated into the MIM via the task cards, did not identify that the original assessment had resulted in an incorrect procedure being called up.

1.12 AI MPD amendment dated October 1992

AI introduced a revision to the inspection intervals for GE SB 064 via a revision to the MPD issued on 30 October 1992. Again, the MD assessing/action engineer while amending the inspection period did not identify that an incorrect procedure had been called up.

1.13 Operator's review

When the MIM listing of an incorrect maintenance procedure became apparent the operator immediately established a review of the MIM amendment system. That review examined the procedures in use and checked that all mandatory inspections were correctly specified in the MIM.

The review found that:

(a) action Advice procedures were not being used consistently across all engineering groups;

(b) applicable service literature requirements had not been inserted into the system of maintenance;

(c) there was possible reliance on verbal communication in the service literature decision process;

(d) there was limited review of the service literature assessment by supervisors;

(e) there was a lack of discipline in checking that action data includes all necessary requirements;

(f) there was a breakdown of communication between and within PPE and MD sections;

(g) the review of the acquitted Action Advices appeared to be on an ad hoc basis; and

(h) there was no documented receipt, assessment and maintenance system revision procedure for introducing MPD amendments;

The review recommended that:

(a) members of engineering groups receive training in service literature handling.

(b) in regard to Action Advices:

(1) Ensure that the addressing reflects the current organisational structure.

(2) Ensure actions required to be taken by the addressee are detailed.

(3) Any response must be in a form that provides an audit trail.

(c) The decision process must not use verbal communication that may by-pass the computer based recording procedure.

(d) A system of cross checking be introduced to ensure that service literature has been correctly interpreted and subsequent action is accurately presented.

(e) A formal procedure should be introduced to control receipt, assessment and revision certification for MPD amendments.

(f) Introduce a stand alone listing of outstanding maintenance related Action Advices.

(g) Carry out a follow-up audit to establish that the recommendations are effective.

2. ANALYSIS

The system employed to receive, assess and incorporate service literature that requires an amendment to the MIM was basically sound. However, the system relied on each person correctly accomplishing a task, but did not specifically require the approving authority to check that the assessment was correct.

The operator's review of handling of service literature found areas of non-conformance other than those which led to the development of the incident.

3. CONCLUSIONS

3.1 Findings.

3.1.1 The manufacturer's requirement for an SFPI inspection of the duct was not included in the operator's maintenance system.

3.1.2 Personnel who were required to action the documentation received from manufacturers did not follow established procedures.

3.1.3 There were inadequate safeguards in the system of maintenance to detect that established procedures had not been followed.

3.2 Significant factors.

3.2.1 Visual inspections of the high pressure duct did not disclose any evidence of cracking.

3.2.2 An SFPI inspection was not carried out because it was not called up on the relevant check sheet.

3.2.3 The check sheet had not been amended to include an SFPI inspection because of errors in transcribing the manufacturers requirement.

3.2.4 The errors in transcribing were not detected.

3.2.5 The high pressure duct cracked and ejected hot air into the cowl area which activated the fire warning system.

4. SAFETY ACTION

4.1 The operator has instituted revised procedures that require the approving authority to check that the assessment details are correct.

4.2 The operator carried out a total review of the MPD to ensure that mandatory requirements were correctly assessed and that amendments to the MIM were correct.

4.3 The operator introduced a formal certification system that assures an audit trail of all service literature actions.

4.3 After the amendments to the system had been implemented the operator carried out an audit to ensure that the revised procedures were effective and were being complied with. This audit identified the need for a formal procedure covering the handling of Action Advices. This procedure is to be prepared and introduced on a priority basis.