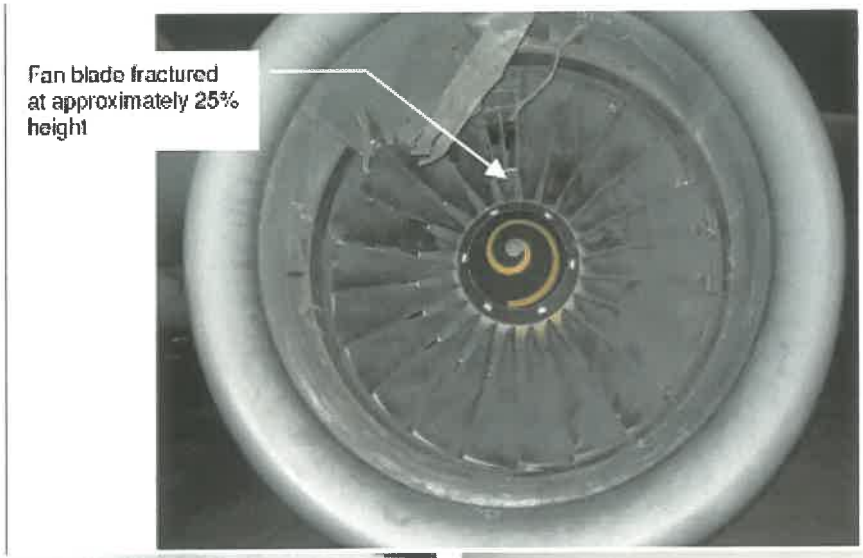
HQCAA/1901/308/SIB

سول ایوی ایشن اتھارٹی

PAKISTAN CIVIL AVIATION AUTHORITY
(SAFETY & INVESTIGATION BOARD)



SERIOUS INCIDENT TO M/S. AIR BLUE, A-320, REG. NO. AP-BGV ON 24 JULY 2006 AT ALLAMA IQBAL INTERNATIONAL AIRPORT, LAHORE

FINAL REPORT

SERIOUS INCIDENT TO M/S AIR BLUE ED-207, A-320, REG. # AP-BGV ON 24 JULY 2006 AT LAHORE

Authority: Director General Civil Aviation Authority Memorandum No.HQCAA/1901/308/SIB dated 18 August 2006. **(Appendix 'A').**

SYNOPSIS

"An Air Blue flight ED-207 on 24th July 2006 from Islamabad to Karachi experienced severe vibrations while climbing through 33000 feet FL to 36000 feet FL. The ECAM indicated engine damage, hence No. 1 engine was shut down and aircraft made a safe single engine landing at Lahore. On post flight inspection, one fan blade was found broken and all acoustic linings were found peeled off."

The damaged engine V2500 is manufactured by International Aero Engine Manufacturer (IAE), hence the investigation was conducted with the help of IAE. It was decided between CAA Pakistan and IAE that engine and broken parts will be preserved and despatched to Germany for detailed analysis. There were some delays while despatching the engine parts and documents to Germany by Air Blue. The engine was disassembled in Germany and China due to overhaul facilities. The final report from IAE was received in April 2007 which indicated presence of metallic parts in the engine not belonging to engine and aircraft. The final investigation report does not state that whether FOD had caused vibrations which resulted in fan blade failure or fan blade fatigue process was responsible for vibrations before failure. However the presence of foreign materials and metal deposits in the engine; extensive damage to the fan low pressure compressor and high pressure compressor implies that ingestion of foreign object in the engine at high rotation could have been a cause of vibrations. Additionally impact damage due to FOD could have contributed to final fracture of a fan blade which was already under fatigue with two origins as determined by

the fracture analysis. Analysis of maintenance documents also show periods of high level vibration during March & May 2006 and a period of extremely high level of vibrations in October – November 2005.

1. FACTUAL INFORMATION

1.1 **History of the Flight**: N/A

1.2 **Injuries to Persons**: Nil.

1.3 **Damage to Aircraft**: Nil

1.4 **Engine Damage**: Fan blade of No. 1 Engine broke away during flight and caused extensive damage to the intake duct, low and high pressure compressors.

1.5 **Flight Recorders**: **See figures 1 and 2** for aircraft parameters and LP vibrations for both engines after departure from Islamabad and

1.6 **Impact Information**:

1.7 **Fire**: No fire damage

2. TECHNICAL INVESTIGATION & ANALYSIS

2.1 **Interested Parties**

The sudden increase of vibrations leading to engine failure was a cause of concern for all the interested parties. The engine V2500 is manufactured by a consortium of four partners i.e. Rolls Royce UK, Pratt Witney, USA, JAEC, Japan and MTU Germany. The NTSB, USA was also interested party. IAE treated this event extremely serious with highest priority. The engine was moved to an approved overhaul facility in Germany, where it was disassembled and the fan assembly was handed over to Rolls Royce for analysis whereas the remaining engine was despatched to Zhu, China for detailed damage analysis and recovery. IAE was also provided with DFDR data and complete maintenance records for last three years with specific references to engine defects and vibration history. Based on the DFDR and engine damage analysis, the IAE issued a preliminary report from Germany after strip examination in September 2006 and final report from IAE Customer Service in April 2007.

The following technical analysis is based on information in the IAE reports, analysis of the maintenance documents and interviews of aircrew, ground crew and ATC personnel.

The air crew debrief and interview indicated that this particular engine S. No. V0320 has a history of vibrations for at least last one year.

2.2 History of Defect (Vibration)

In order to ascertain the history of vibration, the complete record of engine vibration since its induction in Air Blue was scrutinized **(See Appendix 'B' and 'C')**. It was revealed that the engine had a chronic vibration history and at times the vibrations were out of limit. An analysis of previous year's maintenance documents showed that there was a period of extremely high vibrations from 23 October 2005 to 30 November 2005. In this period at least 18 times the defect was observed **(Appendix 'D')**. The vibration level were between 4 .8 to 7.2 units. The rectification write up shows that for 17 times the rectification was focused on opening the engine cowlings and checking for loose stay rod or other items; but the defect could not be removed. On 30th November, the vibration transducers 4004-EV along with vibration harness was interchanged with number 2 position engine. As per the records produced by Air Blue, after this rectification there was no pilot report on No. 1 engine. This is not logical that by exchanging the vibration pick up system from on e engine to other, could solve the problem. The documentation of vibrations is under suspicion. There might be documentation malpractices that vibration defects on No. 2 Engine were not reported after exchanging the vibration pick up harness. The rectification work performed during this period indicated lack of professionalism on part of ground crew and Quality Control. There was no effort exerted to seek guidance from manufacturer, which could have helped to diagnose the root cause. However the vibrations were reported on NO 1 engine during subsequent operations but were within limits. Prior to the eventful flight there were phases of vibrations between March to May 2006. These were high level vibrations and were

addressed by Air Blue maintenance in accordance with Aircraft Maintenance Manual (AMM).

2.3 History of the Engine

The maintenance performed on this engine since last shop visit is attached as **Appendix 'E'**. The engine was sent to the shop on 16th August 2003 at TSN 22732 and CSN 9117. It was installed on aircraft Reg. No. 00.TCC on 28-08-2003 in MASCO.

It was inducted in Air Blue Fleet on 22-05-2005 at A/C TSN-26723 Flt and Aircraft CSN-12127 FC.

In its service at Air Blue, Checks A-1 to Check A-10 were carried out between August 2004 and July 2006. These A-checks did not reveal any abnormality in the engine Fan Blade or cowlings.

2.4 DFDR:

The DFDR data was sent to BAe France for converting into excel format. The data as required by IAE Tech Services, Germany was sent them on priority. The data indicates the time of event i.e. 09:26:50 GMT while the aircraft was passing FL 337 with an air speed of 252 Kts. N1 rotor speed of both engines was 92.5% at the time of event (See Fig. 1.) The DFDR parameters in Fig 2 showed that vibration level of Engine 1 increased above advisory threshold level of 5.0 ACU and oscillated between 4.5 and 5.4 ACU before the fan blade fractured.

2.5 Preliminary Report by IAE Technical Services.

2.5.1 The MTU – Hanover, Germany conducted initial strip examination on behalf of CAA Pakistan. The investigation revealed:

2.5.1.1 The engine was covered with polythene, but the polythene was found torn at different places exposing engine.

2.5.1.2 The initial examinations identified the following:

a. The acoustic lines were missing around the upper area of the casing extending from approximately 8 to 3 o'clock positions. The majority of the outer surface of the remaining panels was missing, exposing the honeycomb structure. A small amount of honeycomb remained at the 10 o'clock position. The surface of the casing from the 12 to 2 o'clock position was considered to be clean with little evidence of adhesive.

b. All the ice impact panels were missing from the casing, with the exception of a strip rear of the fan track approximately 80mm wide extending from the 2 to 8 o'clock positions.

c. Several brackets on the outside of the casing were broken.

d. The Oil filler cap was loose with no evidence of the sealing ring.

e. Aerofoil sections from the Booster were protruding from the Booster Bleed Valve annulus located immediately forward of the struts.

f. MCD of the front bearing compartment was not fitted.

g. Rotor 1.5 blades – tip curt on the leading edge tip. Apart from the tip curt the blades were relatively undamaged. Heavy rubbing was evident on the casing in line with stage 1.5 rotor paths. The severity of the rubbing resulted in the casing being worn trough in an area of the blade tract extending from 9 to 11 o'clock positions.

h. Stator 1.5 vanes – the majority of the vanes had failed at their outer location. All the vanes exhibited impact damaged and tearing to the trailing edges.

i. Rotor 2.0 blades – the trailing edges had impact and tearing damage on their trailing edges.

j. Stator 2.0 vanes – all of the vanes had failed at their inner location and the majority at their outer location resulting in the release of the aero foils.

k. Rotor 2.5 blades – impact damage along the entire length of both the leading and trailing edges.

l. Stator 2.5 – the leading edges of all the vanes exhibit impact damage. Several released vanes were bent across and trapped between the vanes.
The report is attached as **Appendix 'F'**.

2.6 **The engine after initial strip examination was disassembled at approved overhaul facility in China. The detailed examination revealed following**

2.6.1 All fan blades were damaged.

2.6.2 Fan Blade No. 21 had failed at approximately 25% height. This particular fan blade part number 6A7650 and serial number RGA10904 showed two fatigue origins. See **Figures 3 and 4** for Fan blade 21 Fracture and fatigue origins.

2.6.3 The trailing blade No 20 had an impact mark at the leading edge at about mid height. A piece approximately 150mm X 75mm was missing at the upper section of the trailing edge. The blade also had an impact mark and scratches at approximately 60% aerofoil height, which is consistent with the impact of the released blade on the trailing blade.

2.6.4 The impact damage, rule marker and fracture of bolts etc were evident throughout the Fan, Case, Low Pressure Compressor (LPC) and High Pressure Compressor (HPC), See Fig 5,6 and 7 for extent of damage, metal deposits on aerofoils, remains of FOD metal pieces in fan area at 6 ' O clock position and fractures of bolts at No 1 Bearing.

2.6.5 HPC 3-12 showed impact damages. However, there were no fractured blades and vanes at any stage. The rotor path lining and path rings from stages 3-12 were all subhead.

2.6.6 The diffuser case, inner and outer combustion chamber and the fuel nozzle displayed metal disposals. The foreign object which was ingested and got broken and crushed in the fan and L/H compressor area; left two pieces in the fan area as shown in **Figures 8, 9 and 10**. The figures show their relative size and material identification through electronic scanning.

3. FINDINGS

3.1 The engine documents show a high level of vibration period in October, November 2006; and non professional rectifications.

3.2 The vibration levels in July 2006 were within limits with sudden increase in a flight previous to eventful flight.

3.3 On 24 July, during the eventful flight, the engine damage was indicated on ECAM and engine was shutdown.

3.4 The blade was damaged initially by fatigue cracking on the concave panel. Two origins were found on the inner surface of the panel at 25% height in the front part of the cavity.

3.5 The crack had propagated from the first origin forwards to the leading edge and rearwards to the trailing edge prior to final release.

3.6 The second origin initiated due to load changes in the blade subsequent to the first origin.

3.7 Organic remains found in the fan case did not contain DNA.

3.8 The fatigue crack found was not initiated or caused by a bird strike.

3.9 The two metallic pieces of debris found in the fan case did not belong to the engine or aircraft and showed no signs of impact marks.

3.10 Due to missing parts of the fan blade, it can neither be proven nor disproven that impact damage caused the load change and/or accelerated the crack propagation.

3.11 The partially released fan blade (P/N: 6A7650, S/N: RGA10904) was contained, as required by certification regulations.

3.12 No fan blade debris exited forward through the nose cowl.

3.13 The nose cowl inner skin was damaged; the outer skin was not punctured.

3.14 The flight data did not show any anomalies with the engine performance other than a sudden increase of N1-vibration in flight prior to the event.

3.15 Other than an increase to the fan blade population that requires a reduced inspection interval and the introduction of a TAP-test in the trouble shooting procedure in case of high N1 vibration, no

changes to the existing fan blade service management are proposed as a result of this event.

3.16 Aircraft engine documentation is a weak area.

3.17 The Quality Control did not preserve evidence through photography.

3.18 The despatch of material and documentary evidence to IAE was delayed for months and months.

Finalization

Misc – FOD – Avoidable.

Cause of Occurrence

The blade during the eventful flight failed due to fatigue. The cause of fatigue origin can not be proven to be an FOD effect but presence of Foreign Objects in the engine, prolonged vibration defects and extensive damage to engine major assemblies during eventful flight substantiate that foreign object damage (FOD) ~~must~~ have had contributed to the occurrence.

4. RECOMMENDATIONS

4.1 Air Blue is to improve its Quality Control System and Safety Investigation through procedures to be included in SMS Manual in consultation with SIB (CAA).

4.2 Air Blue is to develop a more stringent procedure to avoid FOD through Maintenance Procedures Manuals in coordination with Directorate of Airworthiness (CAA).