S2/2001 - Airbus A300B4-605R, G-MONS

AAIB Bulletin No: S2/2001 Ref: EW/C2001/5/5 Category: 1.1

Aircraft Type and Registration:	Airbus A300B4-605R, G-MONS
No & Type of Engines:	2 CF6-80C2A5 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	18 May 2001 at 1120 hrs
Location:	In cruise, near Casablanca
Type of Flight:	Public Transport
Persons on Board:	Crew - TBA - Passengers - TBA
Injuries:	Nil
Nature of Damage:	Uncontained failure of No. 2 engine Low Pressure Turbine, minor impact damage to wing skin panels and inboard aileron
Commander's Licence:	Airline Transport Pilot's Licence
Information Source:	AAIB field investigation

History of the flight

The aircraft was on a scheduled passenger flight from London (Gatwick) Airport to Banjul in the Gambia. In stabilised cruise conditions at FL290, abeam Casablanca, there was a sudden onset of very noticeable vibration accompanied by some thrust loss from the No. 2 engine. This was confirmed by the No. 2 engine N_2 vibration indication rising rapidly to 5.8 units. Manual throttle was selected and maximum continuous thrust was applied on the No. 1 engine and the No. 2 engine throttle was retarded to idle. The N_2 vibration decreased to just below 5.0 units then increased to 5.6 units before settling. A 'PAN' call was made and a precautionary diversion to Faro was initiated. The No. 2 engine throttle was kept at idle and the engine parameters were carefully monitored but these remained normal, with the exception of the N_2 vibration. An uneventful overweight landing was completed at Faro with the fire service in attendance. The aircraft was taxied off the runway and the No. 2 engine shut down. The fire service confirmed that there was no sign of fire or obvious damage, however it was subsequently noticed that the No. 2 engine cowl was holed.

Engine information

The No. 2 engine was a CF6-80C2A5 turbofan, serial number 695-323. At the time of the incident it had completed a total of 7,778 hours and 2,513 cycles since previous overhaul in December 1998. It had completed 237 cycles since the previous boroscope inspection of the High Pressure Turbine (HPT).

A review of the aircraft Technical Log reports did not identify any significant related defects on the No. 2 engine, nor were there any recent reports of bird or foreign object ingestion. Flight Data

Recorder and engine trend monitoring data did not show any adverse trends prior to the engine failure.

Damage assessment

(Note: For simplicity all circumferential locations on the engine are referred to as positions on the clock, as viewed from the aft of the engine looking forward).

From photographs of the damage and from inspection of the aircraft and the No. 2 engine at the operator's maintenance base, a large hole could be seen in the left hand core cowl at the 10 o'clock position measuring approximately 12" circumferentially. A smaller, circular 3" diameter hole could be seen in the right hand core cowl at the 2 o'clock position, in the same axial plane as the hole in the left cowl. Debris from the engine had struck the lower surface of the starboard wing causing minor penetrations of the wing skin and inboard aileron but no damage was sustained by any of the aircraft systems.

A continuous 0.5" wide circumferential opening was visible in the Low Pressure Turbine (LPT) case over a 330° arc from the 5 o'clock to 3 o'clock positions, in the plane of the LPT Stage 5 rotor. The edges of the opening were heavily blued and scored from rubbing. All of the Stage 5 rotor blades were attached but were missing their tip shrouds. Several of the blades were bent backwards opposite to the direction of rotation. One blade tip shroud was found lodged in the opening in the LPT case. A large quantity of Stage 5 blade and tip shroud fragments were recovered from within the engine cowls. The LPT case was also punctured at the 12 o'clock and 1 o'clock positions in the plane of the LPT Stage 1 rotor and at the 4 o'clock position in the plane of the Stage 4 rotor, but the debris had been contained within the LPT case and engine cowls.

Preliminary investigation findings

The engine was dispatched to the operator's engine overhaul facility at Prestwick in Scotland for strip examination under AAIB supervision.

Significant issues relating to the LPT uncontainment were identified. These will be addressed in detail in the final report.

The origin of the engine failure was established to be separation of an HPT Stage 2 rotor blade, which had broken off just above the blade platform. The fracture had propagated from the edge of a 0.25" deep notch, which had been worn in the blade leading edge. Similar notches were found on all of the Stage 2 blades. Several HPT Stage 2 nozzle segments around the 12 o'clock position were found to have large cracks in the aerofoil to outer platform fillet. The cracking had weakened the cantilevered nozzle segments and allowed them to deform rearwards under aerodynamic loading and contact the leading edges of the Stage 2 blades.

Discussions with the engine manufacturer revealed that this was a known failure mode and that there had been several similar failures prior to this event. The engine manufacturer issued Service Bulletin CF6-80C2 S/B 72-0952 in December 1998, which called for a special boroscope inspection of the part number 9373M80G29/G30 HPT Stage 2 nozzles to check for nozzle cracking and distress. The inspection for the pre-part number 9373M80G29/G30 HPT Stage 2 nozzles was added to the fourth Revision of the Service Bulletin, issued 30 June 2000. The operator had not carried out this inspection of the Stage 2 nozzles and was not required to, as the Service Bulletin was not of mandatory status. It is believed that the cracked Stage 2 nozzles would have been identified and that corrective action could have been taken in time to prevent the engine failure had the nozzle inspections been accomplished.

Safety Recommendation

On the basis of the preliminary investigation findings and the previous history of similar failures, the following Safety Recommendation is made with the intention of preventing further uncontained CF6-80C2 engine failures due to HPT Stage 2 nozzle cracking:-

Safety Recommendation 2001-60

The FAA and the CAA should expeditiously issue a mandatory instruction requiring operators to perform boroscope inspections of the CF6-80C2 HPT Stage 2 nozzles to check for nozzle cracking and distress in accordance with GE Service Bulletin CF6-80C2 72-0952.