SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A330-243, G-OMYT
No & Type of Engines:	2 Rolls-Royce Trent 772B-60 turbofan engines
Year of Manufacture:	1999 (Serial no: 301)
Date & Time (UTC):	24 June 2013 at 1110 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - 328
Injuries:	Crew - None Passengers - None
Nature of Damage:	Contained release of HP turbine blade in right engine, with resultant damage to IP and LP turbines
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	16,600 hours (of which 7,400 were on type) Last 90 days - 154 hours Last 28 days - 73 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

At approximately 105 kt on a takeoff roll on Runway 23R at Manchester, the right engine failed, emitting a flash and smoke from the exhaust. The crew quickly established that there was a loss of power and aborted the takeoff, brought the aircraft to an emergency stop on the runway and taxied clear using the unaffected left engine. Inspection of the right engine revealed there had been a failure of a single HP turbine blade which had detached, resulting in a high power engine surge and further secondary damage to the IP and LP turbines and nozzles. The blade failure was caused by high cycle fatigue (HCF) crack propagation with crack initiation resulting from 'Type 2 Sulphidation' corrosion[1].

Footnote

[1] Type 2 Sulphidation – A high-temperature corrosion mechanism that can take place in gas turbine engines when components, in the temperature range 550 – 700°C, come into contact with sulphur or compounds containing sulphur. The source of the sulphur may be from fuel or from airborne contaminants. The compounds containing sulphur react with the component parent material, exposing the component's protective oxide layer to decay and exposing the metallic surface to attack. This can generate stress raising features that give rise to crack initiation or generate corrosion cracks, which may then propagate in fatigue.

History of the flight

The aircraft was scheduled to fly from Manchester to Punta Cana with 328 passengers and 11 crew. The co-pilot was in control and was cleared for takeoff on Runway 23R. After a normal acceleration up to approximately 105 kt the aircraft, suddenly and without warning, yawed to the right. The aircraft captain called "Stop", took control and carried out a successful abort and emergency stop on the runway. Initially it was unclear what had taken place but an ECAM warning confirmed that a right engine failure had occurred. The emergency services were quickly in attendance and confirmed that the aircraft was safe to taxi but remained with the aircraft as a precaution.

By chance the event was observed and videoed by members of the public from a viewing area outside the airport. The videos show G-OMYT during its takeoff run and capture the right engine failure as a flash of flame and large cloud of smoke from the exhaust. This was accompanied by a bang, followed by significant shuddering of the engine pylon and nacelle.

Engine

This Airbus A330 is fitted with two Rolls Royce Trent 772B-60 triple-spool high-bypass turbofan engines. The three spools consist of low-pressure (LP), intermediate-pressure (IP) and high-pressure (HP) compressor and turbine assemblies, producing 72,000 lb of thrust. The right engine fitted to G-OMYT had completed 5,200 cycles since its last overhaul.

Engineering investigation

The engine was removed from the aircraft and it was noted that the IP and LP spools were seized. A borescope examination found that one of the HP turbine blades had detached just above its root fixing. Metallic debris collected from the runway immediately after the incident appeared to be turbine blade aerofoil section but was misshapen, with no discernible fracture faces. The engine was moved to an overhaul facility of the manufacturer for a full disassembly and it was confirmed that a single HP turbine blade had fractured just above its root. There was damage to the IP and HP nozzles and turbines and significant amounts of debris had collected in the lower parts of the gas paths to the exhaust. In addition there was minor damage, tip bending and material loss, to the final stage of the HP compressor, with evidence of rubbing and material loss on the abradable lining. The engine structure, casings and ancillary components were intact. The fuel spray nozzles were undamaged, in a condition commensurate with the life of this engine, and tested satisfactorily.

The damage to the HP compressor can be attributed to the engine surge and HP system imbalance following the HP turbine blade loss. The damage to the IP and LP turbines and nozzles was as a result of metallic debris from the detached blade as it was carried downstream in the gas path. This in turn caused additional release of material from components as they were rotating amongst debris caught in the gas paths. The seizure of the IP and LP spools was caused by debris becoming trapped between the turbine rotors and casings as the engine ran down. The condition of the casings and the nature of the internal secondary damage show that the turbine failure was properly contained in this incident.

Laboratory analysis of the fractured blade root found multiple crack initiation locations caused by Type 2 Sulphidation corrosion. This led to high-cycle fatigue (HCF) propagation, weakening of the blade and subsequent material rupture in tensile overload. In addition, unidentified deposits were present on the surfaces of the blade remains which are the subject of ongoing analysis by the manufacturer.

BULLETIN ADDENDUM

Aircraft Type and Registration:	Airbus A330-243, G-OMYT
Date & Time (UTC):	24 June 2013 at 1110 hrs
Location:	Manchester Airport
Information Source:	Engine manufacturer's forensic report

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The failure of the HP turbine blade in this incident was caused by high cycle fatigue propagation due to surface damage as a result of Type 2 Sulphidation corrosion. During examination of the remains of the blade, to determine the cause of its failure, unidentified deposits were found on its surfaces. There was concern that these deposits may have been volcanic in origin, in particular from the 2010 eruption of Eyjafjallajökull in Iceland, so additional forensic analysis was carried out. That work was completed in August 2014 and did not identify compounds typically associated with volcanic activity. However, although an encounter with volcanic gaseous sulphur cannot be discounted it is concluded that the deposits probably are an accumulation of atmospheric dirt and pollutants.