Australian Government
Australian Transport Safety Bureau

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Uncontained engine failure and air turn-back Near San Francisco Airport, USA 30 August 2010

Abstract

On 30 August 2010 at approximately 2330 Pacific Daylight Time, a Boeing 747-438 aircraft, registered VH-OJP, departed San Francisco International Airport on a scheduled passenger service to Sydney, Australia. As the aircraft passed through 25,000 ft, the aircraft's number-4 engine sustained an internal mechanical failure, resulting in the energetic release of debris and puncturing of the engine casing and nacelle. The engine was shut down and the flight crew returned the aircraft to San Francisco, where it landed without further incident.

The investigation is continuing.

FACTUAL INFORMATION

The information contained in this preliminary report is derived from the initial investigation of the occurrence. Readers are cautioned that there is the possibility that new evidence may become available that alters the circumstances as depicted in the report.

History of the flight

On 30 August 2010 at approximately 2330 PDT[1], a Boeing Company 747-438 aircraft, registered VH-OJP, with 213 passengers and 18 crew on board, departed San Francisco International Airport for a scheduled passenger service to Sydney, Australia.

Around 15 minutes into the flight, as the aircraft climbed through 25,000 ft, severe vibrations were felt through the airframe, and sparks and flames were reported emanating from the number-4 engine exhaust. Significant airframe vibrations continued for the remainder of the flight.

Cockpit indications received by the crew were consistent with severe damage to the number-4 engine; however, there were no indications of an engine fire. The flight crew completed the appropriate non-normal checklist[2], and after the engine was shut down, elected to return to San Francisco, which was the nearest available airport.

The aircraft entered a holding pattern at 20,000 ft where fuel was jettisoned to bring the aircraft under maximum landing weight. A PAN[3] radio call was made by the flight crew on completion of the fuel jettison, and clearance obtained to return to San Francisco, where emergency services were requested to be on standby.

The aircraft landed without incident on runway 28R at approximately 0050 and held on a taxiway while the engine was inspected by emergency services. The aircraft subsequently proceeded to the gate for passenger disembarkation. At this

1 The 24-hour clock is used in this report to describe the local time of day, Pacific Daylight Time (PDT), as particular events occurred. PDT was Coordinated Universal Time (UTC) –7 hours.

2 The operator's Flight Crew Operations Manual contained a series of checklists for dealing with 'non-normal' conditions – that is, conditions outside normal operating parameters – such as an engine failure.

3 Radio code indicating uncertainty or alert, but not yet at the level of MAYDAY.

time the flight crew were informed that 'holes' were present in the number-4 engine nacelle.

There were no reported physical injuries to passengers or crew.

Commencement of the investigation

Upon receiving notification of the occurrence, two Australian Transport Safety Bureau (ATSB) investigators travelled to San Francisco to commence an investigation into the event. As the engine failure occurred over international waters, responsibility for the investigation fell to the State of (aircraft) Registry under the provisions of Annex 13 to the Convention on International Civil Aviation (ICAO Annex 13). Once on-site, investigators conducted a preliminary examination of the engine and aircraft, in conjunction with representatives from the aircraft operator and engine manufacturer.

Aircraft information

The Boeing 747 aircraft, serial number 25545, was manufactured in 1992 and first registered in Australia at that time.

Aircraft propulsion was generated by four Rolls-Royce RB211-524-G2-T-19/15, high bypass, three-shaft, turbofan engines. The number-4 engine, serial number 13247, was last overhauled in May 2009 and had accumulated approximately 5,000 hours and 500 cycles since that time.

Damage to the aircraft

The number-4 engine had ruptured through the left and right sides of the turbine case and fairings, resulting in a large perforation in the right side of the engine nacelle (Figures 1 and 2) and several smaller punctures through the left side (Figure 3).

Figure 1: Right side of the number-4 engine

Debris ejected through the hole in the right side of the engine had impacted the underside of the wing, producing superficial nicks and scratches to the wing skin. There was a puncture through the composite, leading-edge, variable-camber flaps and the associated torque tube was slightly bent.

There was no airframe damage inboard of the number-4 engine.

Figure 2: Perforation in the engine nacelle, right side

Figure 3: Punctures in nacelle, left side

Engine disassembly

After removal from the aircraft, the engine was shipped to an engine overhaul facility in Hong Kong for systematic disassembly and inspection. ATSB investigators and representatives from the engine manufacturer, aircraft operator and airframe manufacturer oversaw the examination.

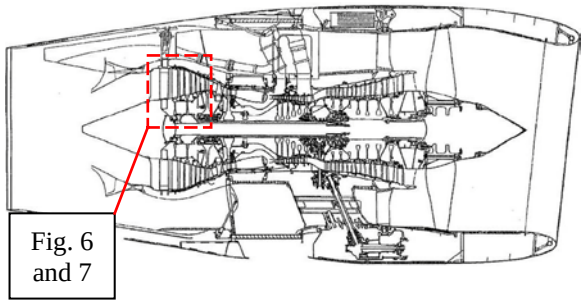
Figure 4 shows the general layout of the RB211-524 engine and Figure 5 presents the subject engine with the fairings removed. During the early stages of the examination, it was evident that the internal turbo-machinery had been significantly disrupted, with extensive damage sustained by the intermediate pressure (IP) and low pressure (LP) turbine rotors (Figure 6 and 7).

Key observations included:

- All of the turbine blades had separated from the IP turbine disk.
- Blades from the three LP turbine stages were either fractured through the airfoil section or separated from the disk.
- The LP stage 1 nozzle guide vanes were destroyed. The remaining LP nozzle stages were substantially damaged.
- The LP turbine bearing and adjacent phonic wheel and speed probes were destroyed.
- The IP shaft was severed towards the aft end.

A number of engine components were retained for further testing and analysis by specialists from the engine manufacturer. That examination will be overseen by representative/s from the UK Air Accident Investigation Branch (AAIB), acting as Accredited Representatives to the investigation (State of Manufacture – Engines).

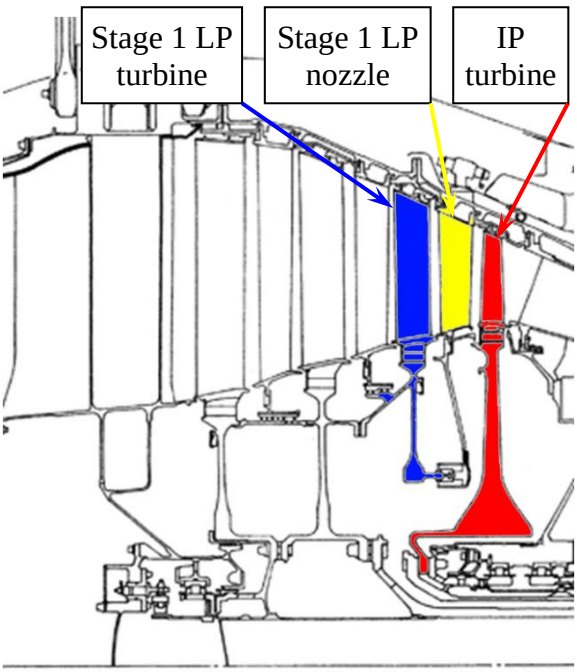
Figure 4: RB211-524 engine



Courtesy: Rolls-Royce

Figure 5: Engine serial number: 13247

Figure 6: RB211-524 turbine section



Courtesy: Rolls-Royce

Recorded information

The aircraft's Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR) and a download of the Quick Access Recorder (QAR) were sent to the ATSB's recorder facility in Canberra for analysis.

FURTHER INVESTIGATION

The investigation is continuing and will include:

- further examination and testing of engine components with a view to identifying the factors that contributed to the engine failure
- examination of the provisions for the containment of debris during engine mechanical failures in the HP/IP turbine area
- review and analysis of the recorded flight data
- review of the engine maintenance records
- review of safety within the aircraft cabin during and after the engine failure

Figure 7: IP and stage 1 LP turbine disks