Aviation Safety Investigation Report 199501217

Boeing Co
B747

21 April 1995

Readers are advised that the Australian Transport Safety Bureau investigates for the sole purpose of enhancing transport safety. Consequently, Bureau reports are confined to matters of safety significance and may be misleading if used for any other purposes.

Investigations commenced on or before 30 June 2003, including the publication of reports as a result of those investigations, are authorised by the Executive Director of the Bureau in accordance with Part 2A of the Air Navigation Act 1920.

Investigations commenced after 1 July 2003, including the publication of reports as a result of those investigations, are authorised by the Executive Director of the Bureau in accordance with the Transport Safety Investigation Act 2003 (TSI Act). Reports released under the TSI Act are not admissible as evidence in any civil or criminal proceedings.

NOTE: All air safety occurrences reported to the ATSB are categorised and recorded. For a detailed explanation on Category definitions please refer to the ATSB website at www.atsb.gov.au.

Aviation Safety Investigation Report

199501217

Occurrence Number: 199501217 **Occurrence Type:** Accident
Location: 15km SE Sydney, Aerodrome
State: NSW **Inv Category:** 3
Date: Friday 21 April 1995
Time: 1605 hours **Time Zone** EST
Highest Injury Level: None

Aircraft Manufacturer: Boeing Co
Aircraft Model: 747-200
Aircraft Registration: N942PR **Serial Number:** 21833
Type of Operation: Air Transport High Capacity International Passenger Scheduled
Damage to Aircraft: Substantial
Departure Point: Sydney NSW
Departure Time:
Destination: Manila Philippines

Crew Details:

Role	Class of Licence	Hours on Type	Hours Total
Pilot-In-Command		3950.0	14500

Approved for Release: Friday, August 23, 1996

FACTUAL INFORMATION

Sequence of Events

During a scheduled transit stop, the number 1 engine required three engine starts for the rectification of a minor oil leak and troubleshooting of other defects before the aircraft was subsequently released for service. Soon after departure, whilst climbing through 8,500 ft at 263 kts, the pilot in command noticed that the number 1 engine start valve OPEN light was illuminated and he requested the engine shutdown checklist. Almost immediately, whilst disconnecting the auto-throttle, there was a bang, a slight yaw to the left and vibration for a very brief duration. During the engine shutdown sequence, the engine fire detection light on the centre panel illuminated momentarily. After securing the engine, 30 tonnes of fuel was jettisoned before the aircraft returned to Sydney for an uneventful landing.

Damage to the Aircraft

Inspection on the ground revealed that only the top sections of the fan cowls, containing the hinge fittings, remained on the number 1 engine. The forward section of the pylon, and the wing leading edge outboard of the pylon, were holed and dented. The paint on the starter case was blistered and there were detached turbine blades in the starter exit screen.

Additional Information

After repairs to the aircraft were completed, a fuel leak was detected from a loose connection at the highest point in the engine environmental drain system. During engine run testing, the leak only became apparent after the third engine shutdown, and resulted in the leaked fuel pooling on top of the engine gearbox, immediately above the starter.

ANALYSIS

Examination of the fan cowl latches revealed they had all failed in tension overload. This, together with the nature of the deformations found on the recovered cowl sections, indicated that an explosion had occurred within the cowled area in the vicinity of the starter. The explosion was of sufficient magnitude to deform and weaken the integrity of the cowling in the area of the starter pressure relief panel and to deflect it into the airflow. The high speed airflow then tore the cowls from the engine. Damage to the pylon and wing leading edge resulted from collision with the separated cowl sections in the airflow.

It is considered likely that fuel had leaked from the environmental drain system as a result of the four engine shutdowns during the transit stopover prior to the flight. Fuel pooled on the gearbox above the starter and evaporated as the unvented undercowl temperature rose during the climb. When the start valve opened, the starter oversped and disintegrated, liberating hot debris in the immediate vicinity which ignited the explosive fuel/air mixture. The force of the explosion deformed the cowl to such an extent that the airstream tore the cowlings apart.

Investigation of the start valve and its associated wiring and control circuitry failed to determine a reason for the uncommanded opening. The aircraft maintenance records revealed a history of starter problems and failures involving uncommanded start valve openings in flight on both number 1 and 2 engines.

There is other documented evidence to show that uncommanded opening of the start valve in flight is not an uncommon event.

SIGNIFICANT FACTORS

The following significant factors were identified as contributing to the accident.

1. A fuel leak occurred from a loose connection in the environmental drain system of the number 1 engine which pooled in the area above the starter.

2. The fuel evaporated to form an explosive mixture in a contained, unvented area within the fan cowls during flight.

3. The engine start valve opened, uncommanded, in flight.

4. The starter oversped and disintegrated, having no engine load to contain its speed.

5. The hot liberated debris from the starter ignited the explosive fuel-air mixture.

6. The subsequent explosive force deformed the cowlings into the high speed airstream, resulting in overload failure of the cowl latches and loss of the cowl panels.

SAFETY ACTION

As a result of the investigation the Bureau made Interim Recommendation 960026 to the Civil Aviation Safety Authority:

The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority bring this occurrence to the attention of the Federal Aviation Administration and the equipment manufacturers. In the light of the history of this problem, these organisations should consider further research into the possible causes of uncommanded start valve openings in flight.

Similarly, the development of an appropriate engineering modification to the relevant start valve should be considered. This would ensure that if a start valve opened in flight, and a starter overspeed occurred, the potential for an ignition source is minimised.

The Civil Aviation Safety Authority responded on 17 July 1996 as follows:

'I refer to Interim Recommendation IR960026 regarding the incident involving US registered Boeing 747 200, N942PR on 21 April 1995 which recommended that CASA notify both the Federal Aviation Administration and Boeing Aircraft Company of the incident.

I have attached copies of the Authority's correspondence with the FAA and Boeing for your information. In each case a copy of the Interim Recommendation was attached to the facsimile.

The Authority will keep you informed of any relevant responses from either the FAA or Boeing.'