No: 10/92 **Ref: EW/A92/6/1** **Category: 4**

Aircraft Type and Registration:	Boeing 747-283B, G-VOYG
No & Type of Engines:	4 Pratt and Whitney JT9D-7A turbofan engines
Year of Manufacture:	1971
Date & Time (UTC):	13 June 1992 at 0001 hrs
Location:	Newark Airport, New Jersey, USA
Type of Flight:	Public Transport (Scheduled passenger)
Persons on Board:	Crew - 21 Passengers -245
Injuries:	Crew - None Passengers -None
Nature of Damage:	Damage to leading edge of inboard left wing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	10,100 hours (of which 5,000 were on type)
Information Source:	AAIB Field Investigation

The aircraft took off from runway 22R at Newark Airport, at a weight of 300,000 kg, using full power (1.44 engine pressure ratio (EPR)), with the commander handling the controls. During the take-off roll, he had noticed that the No 2 engine had lagged in accelerating past 1.29 EPR and that the No 3 engine showed an exhaust gas temperature warning light, but small throttle adjustments rectified these problems and the aircraft climbed away normally. As the aircraft accelerated through the flaps retraction schedule, a green light remained illuminated, indicating that the No 4 left leading-edge flap was still extended. The commander therefore limited the indicated airspeed to 250 kt in order to maintain it below the associated flap extended speed limitation of 275 kt.

As the aircraft climbed through 3000 feet, the flight engineer called "Problem-wing overheat light, low duct pressure on the left hand side". As this was a training flight for a new first officer, the commander remained at the controls, allowing the first officer to work through the appropriate emergency checklist drill, with the flight engineer.

As required by the drill, the left side air ducting was isolated by closing the Pylon, Wing Isolation and Pack (*ie* air conditioning) valves and a period of five minutes was allowed for the duct to cool. During this period, and while climbing through 10,000 feet, the No 4 leading-edge flap was successfully retracted using the alternate electrical retraction system. At the end of the five minute period, the overheat light remained on and therefore the checklist drill was continued with the No 1 engine

throttled back for five minutes. However, the light remained on and so the No 1 engine power was restored, and the No 2 engine throttled back. After another five minutes cooling period (*ie* fifteen minutes total) and just as the No 2 engine power was being restored, the wing overheat light extinguished. With the entire left side pneumatic system isolated and since the aircraft handled normally, the commander decided to continue the flight to Gatwick where a landing with 30° flap was accomplished without further event.

Subsequent examination of the aircraft revealed that the bleed air duct in the left wing, between the No 2 pylon and the fuselage, had failed circumferentially at a weld adjacent to a coupling, in the vicinity of the pylon. Extensive damage had occurred to the leading-edge honeycomb structure on the underside of the wing, and one panel on the upper leading-edge was distorted. The leading-edge structural members were also distorted, but there was no leading-edge flap damage, nor was there any apparent mechanical interference with the flap which might have prevented retraction. The pressure relief panel, which is located at the inboard leading-edge position, had not released (see photographs). The aircraft manufacturer has since advised that this panel is designed to release in the event of a relatively slow leak. Sudden failure of the duct can release volumes of bleed air sufficient to damage the structure before the relief panel can operate. Examination showed that the panel had been assembled using Thiokol, or similar sealant, instead of the specified RTV154 sealant. However the aircraft manufacturer advised that this factor had probably not contributed to the damage in this instance.

Metallurgical examination of the duct fracture surfaces showed that it had failed due to cracking from multiple origins on the duct inner surface, adjacent to the weld. Hydride formations were present and the metallurgical report concluded that the failure was similar to that described in Boeing Service Bulletin 747-36A2074, issued on 11 February 1988, and Revision 5 of 27 June 1991. This states "At duct operating temperatures of 300 to 350 degrees Fahrenheit, hydrogen in the titanium duct material tends to migrate towards areas of high stress, and then during cooling, hydrides form. These hydrides have an embrittling effect on the duct material and may contribute to crack initiation.....Studies indicate that stress relieving the ducts eliminates the residual stress and local stress concentrations which stops the migration of hydrogen to the circumferential welds." The Service Bulletin calls for dye penetrant inspections, pressure testing and stress relieving of the ducts. The requirements of the Service Bulletin had been made mandatory by FAA Airworthiness Directives 88-17-07 (superseded) and 91-06-08.

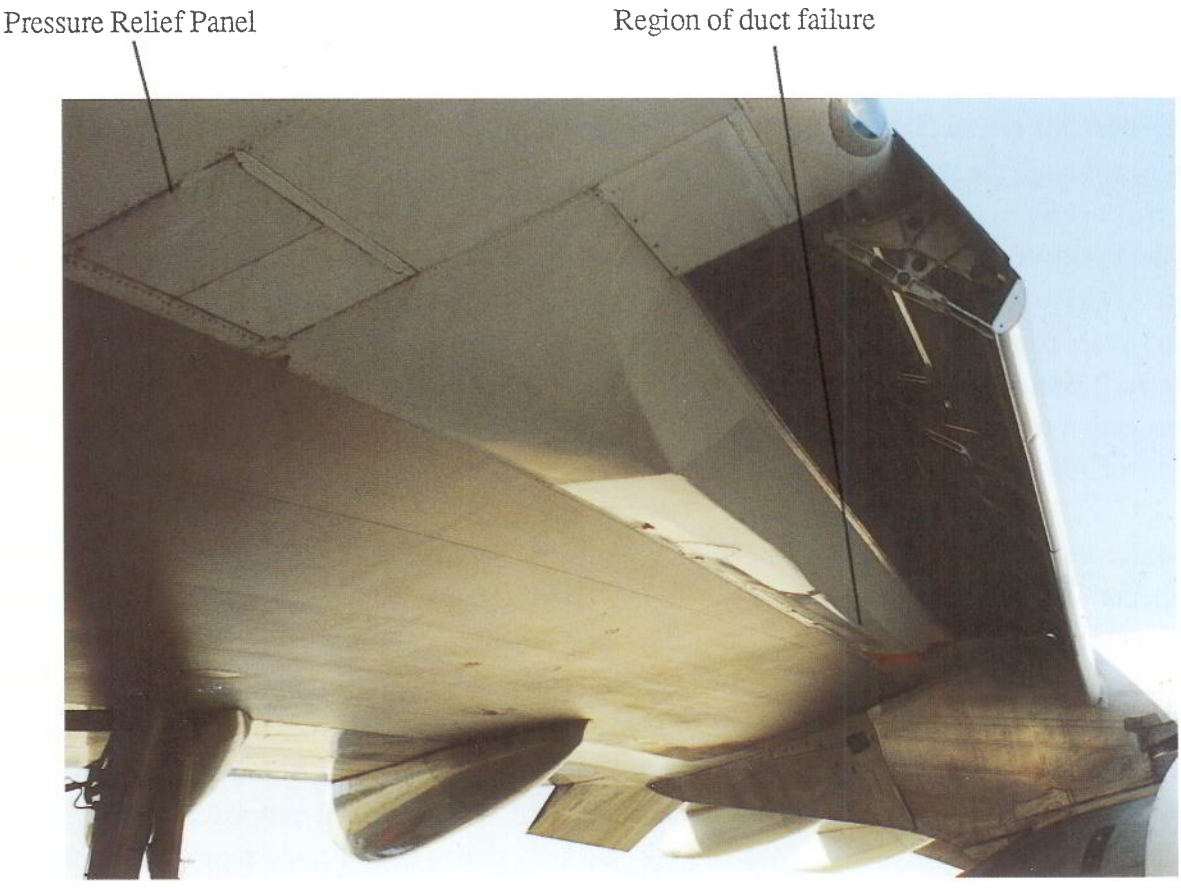
At the time of the duct failure, the aircraft had accumulated 14,698 airframe cycles. When the Service Bulletin was first issued in 1988 it set a threshold for inspections at 7,000 cycles, or 3,000 cycles from the issue date, whichever was the later. At that time this aircraft had accumulated 11,825 cycles, so that no action was required until 14,825 cycles. The Service Bulletin was re-issued five times, during which the compliance times were extended. AD 88-17-07, which was issued on 5 September 1988, required compliance within 3,000 cycles which for this aircraft (which had accumulated 12,247 cycles at that date) required compliance by 15,247 cycles. AD 91-06-08, which was issued on the 15 April 1991, reduced the period to 1,850 cycles from that date. For this aircraft, which had then accumulated

13,957 cycles, this meant that compliance was then not required until 15,807 cycles had been attained. Therefore, although the period was reduced, the number of cycles allowed before compliance for this aircraft had been progressively extended by the requirements current at each stage. However, the failure had occurred within the allowed period of both the original Service Bulletin at Revision 0 and the latest AD 91-06-08. With a utilisation rate on this aircraft of about 650 cycles per annum, a period of about 5 years could have elapsed before compliance would have been required with the initial issue of the Service Bulletin. A check of the U.K. Boeing 747 fleet status showed that compliance with the initial inspection requirements of the AD and/or termination of the AD would be achieved fleet-wide by the middle of 1993.

The operator had acquired the aircraft in 1990 with documentation which appeared to show that the requirements of the AD had been implemented in 1988. However a comprehensive check of the aircraft's records showed that this was not the case and the document in question, a computer-generated status report, held no legal significance and actually referred to control of the documentation and audit requirements. Notwithstanding this, it was entitled "AIRCRAFT STATUS REPORT" and showed the aircraft life under a column headed "JOB LAST DONE". The company which had previously operated the aircraft and which had supplied the document proposes to clarify such computer reports by the addition of a 'header note', since it advises that because reprogramming of the system software would be involved it is not practicable to revise the title, or content, of the document format.

As a result of this investigation, the following Safety Recommendation is made:

92-80: The FAA should consider reducing the compliance timescale requirements of Boeing 747 bleed air duct inspection AD 91-06-08, particularly on those aircraft which have low utilisation and/or high life cycles, in order to prevent further duct failures and associated secondary damage.



VIEW ON INBOARD LEADING EDGE SHOWING COLLAPSE OF COMPOSITE PANEL AFT OF KRUGER FLAP

VIEW OF CIRCUMFERENTIAL FAILURE OF BLEED AIR DUCT AT WELD