Boeing 747-236B, G-BDXJ, 18 June 1996

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Aircraft Type and Registration:	Boeing 747-236B, G-BDXJ
No & Type of Engines:	4 Rolls Royce RB211-524D4 turbofan engines
Year of Manufacture:	1980
Date & Time (UTC):	18 June 1996 at 2130 hrs
Location:	During climb, near London Heathrow
Type of Flight:	Public Transport
Persons on Board:	Crew - 18
	Passengers - 298
Injuries:	Crew - None
	Passengers - None
Nature of Damage:	Damage to left wing inboard upper trailing edge panel
Commander's Licence:	Not relevant
Commander's Age:	Not relevant
Commander's Flying Experience:	
	Last 90 days - Not relevant
	Last 28 days - Not relevant
Information Source:	AAIB Field Investigation

During the climb phase of a flight from London Heathrow to Delhi,a moderate airframe vibration became apparent on selecting Flap5° to Flap 1°, and continued during selection from Flap1° to zero. The vibration level reduced to 'slight' afterflaps up until passing FL 265 at Mach 0.83, when moderate airframevibration returned. The aircraft was levelled at FL 270 and thespeed reduced to 310 kt IAS, whereupon the vibration level againreduced. The decision was made to dump some 50 tonnes offuel and return to Heathrow. Vibration was again experiencedas the flaps were selected from 0° to 1°, and increasedon selecting 5°. However the vibration level decreased withfurther flap selection and decreasing speed. An uneventful landingwas made, and a subsequent inspection revealed that a sectionof the left wing trailing edge upper inboard panel was missing.

Examination of aircraft

The panel in question (often referred to as the 'flying panel')formed part of the fixed wing trailing edge above the inboardflap (see the attached diagram and photograph) and was constructedof glass fibre skins around a Nomex honeycomb core. During flapretraction, the panel is deflected upwards by the fore-flap loadingthe underside at the inboard end. The panel is supported by atorsion bar assembly which is rigged to give a downwards pre-loadwhen the flaps are retracted. This ensures a snug fit of thefore-flap against the panel, and thus provides an aerodynamicseal.

A large section of the inboard trailing edge of the panel, extendingapproximately 2m in span and 0.7m wide at the wing root end, hadbroken away. A large tear, and several minor tears, were apparenton the upper surface of the fore-flap. In addition, the detachingpanel fragments had caused minor scuffing on the mid and aft flaps,and on the paint on the aft fuselage. Beneath the panel, oneof the torsion bar support struts had failed in compressive overload.

Examination of the panel indicated that the damage had initiatedin the bond between the upper skin and the core, and was associatedwith previous repairs. A laboratory examination was conductedon parts of the panel containing the repairs, and it was foundthat a spanwise 'wrinkle' was present in the upper skin, and thatthis had occurred as a result of a partially filled region ofhoneycomb. Damage to the underside of the upper skin indicatedthat it had suffered fretting damage due to contact with the fore-flap. This in turn suggested that the panel failure had been progressive,as opposed to the missing portion having become detached instantaneously. Additional examination of the wrinkled area indicated that thefiller had not penetrated to the full depth of the honeycomb cells,and that it had broken up into blocks. It was apparent that afurther repair had been carried out, involving a honeycomb insert. However, no attempt had been made to join the inserted plug tothe surrounding core. All repairs had been carried out usingcold setting adhesives. There was no evidence of the failurehaving been caused by moisture ingress.

It was concluded that the failure probably occurred due to a localisedchange in stiffness in bending caused by the presence of fillerin the core. It is probable that pieces of the panel became detachedafter the aircraft took off, with additional damage occurringas the flaps were retracted. This would have brought the fore-flapinto contact with the broken trailing edge of the panel, crushingit in a chordwise direction, with consequent downwards deflection,thereby damaging the torsion bar assembly.

Panel history

The airline stated that sometime prior to September 1995 the panelhad been the subject of a repair in accordance with the BoeingStructural Repair Manual (SRM). The full details of the repairwere not available, but the SRM provides for a variety of repairmethods. On 2nd October 1995, a Design Deviation Authority (DDA)was raised to allow the aircraft to remain in service with a crackthat had appeared from the SRM repair. The DDA system is a CAAapproved procedure that allows the airline to design and implementrepair schemes that constitute minor deviations from the aircraftmanufacturer's processes or drawings, in this case the SRM. Theaction associated with this particular DDA was to mark the crackwith ink to allow subsequent checking for propagation, and totape the crack up to prevent moisture ingress. The DDA also calledfor re-inspection of the panel at each Ramp 2 check (every190 hours, or approximately 16 days), and repair of the crackat the next S2 check, which was due in December 1995.

In the event, an additional DDA was raised on 9 October 1995 torepair the delamination that had occurred around the originalrepair, and the cracking. This DDA called for a temporary, 'onthe wing' repair of the delaminated area, to be inspected at eachRamp 3 check (every 540 hours, or

approximately 45 days), withterminating action, in the form of Modification 57G012, to becarried out at the next Inter check, due in December 1996. Therepair that was done as a result of the later DDA was seen asterminating the requirement both for the repeat inspections, andthe repair called up in the earlier DDA. The airline stated thatat least two 540 hour inspections were performed on the panelbefore the incident occurred, with no defects being reported.

Modification 57G012 was the airline's designation for Boeing ServiceBulletin SB 747-57-2289, issued in July 1994. The text of theSB noted that there had been 93 cases of the subject panel breakingup and departing the aircraft. Two of these occurred to Boeing747 aircraft G-TKYO and G-BDXH, and were reported in AAIBBulletins 8/92 and 2/95 respectively. The modification introduceda redesigned and strengthened panel, which is being embodied acrossthe fleet on an attrition basis.

The scheduled inspections on these panels (both pre and post modification),consist of visual and 'tap' inspections for delamination and cracking,during every S2 check.

Safety action

As a result of this incident, a Special Check was raised by theoperator to inspect and repair, as required, all trailing edgeflying panels within one calendar month for all aircraft withSRM repairs, and at the earliest possible service interval forall other aircraft. In addition, it was decided to cease deviationsfrom the SRM using the DDA system, as far as this panel was concerned,and the SRM was amended to permit no cracks.

The airline considered that panel damage could also result frommaintenance personnel walking on the panels during inspectionand servicing. To reduce this problem, all panels are to be placarded"NO STEP", and Modification 57G012 was raised in issueto show the same placard. Additionally, it is intended to publicisethe problem of damaged panels in an issue of an in-house technicalnewsletter.