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## Airframe vibration during climb, Boeing 747-367, AP-BFY

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**Micro-summary:** This Boeing 747-367 experienced airframe vibration during climb.

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**Event Date:** 2000-09-05 at 0420 UTC

**Investigative Body:** Aircraft Accident Investigation Board (AAIB), United Kingdom

**Investigative Body's Web Site:** <http://www.aaib.dft.gov/uk/>

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# Boeing 747-367, AP-BFY

<b>AAIB Bulletin No:</b>	<b>11/2000</b>	<b>Ref:</b>	<b>EW/C2000/9/1</b>	<b>Category:</b>	<b>1.1</b>
<b>Aircraft Type and Registration:</b>	Boeing 747-367, AP-BFY				
<b>No &amp; Type of Engines:</b>	4 Rolls Royce RB211-524C2 turbofan engines				
<b>Year of Manufacture:</b>	1987				
<b>Date &amp; Time (UTC):</b>	5 September 2000 at 0420 hrs approximately				
<b>Location:</b>	Over the Arabian Sea				
<b>Type of Flight:</b>	Public Transport (Passenger)				
<b>Persons on Board:</b>	Crew - 18 - Passengers - 446				
<b>Injuries:</b>	Crew - None - Passengers - None				
<b>Nature of Damage:</b>	No 3 engine bypass duct scraped, inboard (high speed) aileron dented, inboard and outboard flaps (RH) holed and dented, outboard aft flap drive rod bent, movable flap track fairing ("canoe fairing") broken, cam track dislodged				
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence				
<b>Commander's Age:</b>	53 years				
<b>Commander's Flying Experience:</b>	16,500 hours				
<b>Information Source:</b>	AAIB Field Investigation				

The aircraft was operating a scheduled passenger from Karachi to Manchester. The Technical Log showed that the aircraft was serviceable for the flight, and that a number of minor defects had been rectified between flights, including replacement of the No 2 igniter plug on the No 3 engine. The Flight Engineer completed the pre-flight walkaround check and noticed nothing untoward.

The departure from Karachi was uneventful, but passing about 20,000 feet in the climb the crew suddenly became aware of a medium frequency airframe vibration. All cockpit indications were normal and the crew therefore began a troubleshooting process to identify the vibration source. Before the process could be completed the vibration disappeared and did not recur for the rest of the flight. On arrival at Manchester all systems operated normally and the aircraft landed and taxied to its parking stand.

On inspection, it could be seen that there was impact damage on the outboard ends of the right inboard flaps, the adjacent high speed aileron and inboard ends of the outboard flaps. The top inboard edge of the movable flap track fairing ("canoe fairing") was also broken and, inside that fairing, a link attaching the mid to foreflap cam track to the main carriage had been broken. The

cam track had moved out of alignment with the roller on the sequence carriage and the inboard drive rod for the aft flap had also been bent by impact. In No 3 engine (immediately ahead of the airframe damage described above) there were scrape marks and indentations on the internal surfaces of the by-pass duct, particularly on the left side, and the two combustion section side fairings on the engine core were missing. Neither the passengers nor the cabin crew reported noticing any damage during flight, and the missing panels have not been found.

### **Flight recorders**

The DFDR and Quick Access Recorder (QAR) both retained an identical record of the incident flight in terms of the parameters monitored and their sampling rates. The 30-minute CVR had recorded over the time of the event but retained the recording of the approach and landing at Manchester.

Amongst the parameters recorded were N1, N2, EPR, Fuel Flow and Turbine Gas Temperature for each engine and aircraft body accelerations in all three axes. In the absence of anomalies in any of the data recorded between FL180 and FL220 it was not possible to determine the exact time that the event occurred. However, it was possible to corroborate crew evidence that, during troubleshooting, air conditioning pack and autopilot settings were altered as the aircraft continued to climb through FL240.

During the subsequent approach and landing, no anomaly was observed in the recorded flap parameters and no crew conversation pertinent to the event was recorded on the CVR.

### **Engineering**

The combustion section fairings cover the combustion section of the engine core and, together with the other duct fairings, provide a smooth profile in the duct and some acoustic absorption. The fairing covering the combustion area is made up of three sections. The top section, still in place in the No 3 engine of AP-BFY, covers from approximately the 11 o'clock to the 1 o'clock positions (looking forward). The right section covers 1 o'clock to 7 o'clock and the left, smaller section, the remainder. The two side sections are each retained at their top edges by three hooks which engage pins in the top section. They are held closed together by two latches in their bottom edges.

As the fairings were not found on the departure airport it would appear that their detachment probably did coincide with the period of vibration experienced by the crew at about 20,000 feet in the climb. Track data from the FDR showed that this happened over the Arabian Sea. Also, because the fairings (Part Nos LK70363 and LK70365) were not recovered it cannot be determined whether the latches were secure or whether there was a mechanical failure in either fairing or in the attachment hooks and latches. The six pins on the retained upper fairing were intact. On the left side a projecting lug, adjacent to the front pin, was bent backwards and there was some adjacent distortion of the fairing. This is considered to be secondary damage incurred during the separation of the lower fairings and probably indicates that the front left hook was the last to disengage.

The No 2 igniter plug, which was changed on the No 3 engine before the flight, is positioned under the right combustion section fairing. Access to the No 2 igniter can be obtained by unlatching the fairings, unhooking the right fairing and removing it, which requires the removal of another fairing further aft, or moving it forward in the bypass duct. The right fairing weighs 24 lb (10.9 kg).

The fitting instructions for the fairings in the aircraft Maintenance Manual contain a warning about the possibility of all the hooks not being engaged; a hook butting against a pin or riding over it without engaging it. A visual inspection is specified to check for a step or a gap at the top edge of the two side fairings. The instructions also specify a check on the closing load for each latch.

Furthermore a "CAUTION" message is given as follows:-

WHERE ANY ONE OF THE COMBUSTION SIDE FAIRINGS HAVE (sic) BEEN DISTURBED, NOT NECESSARILY REMOVED, IT IS ESSENTIAL THAT ALL COMBUSTION FAIRINGS ON BOTH SIDES OF CORE ENGINE ARE CHECKED FOR CORRECT ENGAGEMENT AS DETAILED IN ABOVE. INCORRECT ENGAGEMENT OF SIDE FAIRING HOOKS MAY RESULT IN THE FAIRINGS BECOMING DETACHED.

In 1977 Rolls-Royce issued a Service Bulletin (RB 211-72-4647) which stated that detachment of the fairings had occurred in service and this was attributed to incorrect fitting. The bulletin introduced modified front hooks to the left and right fairings, which gave increased engagement, and a projecting lug alongside the front pins on the top fairing. The subject fairings were to the modified standard. The bulletin contains the statement, "It was also demonstrated that mal-assembly cannot now take place and that once assembled the fairings are physically prevented from becoming unhooked."

The UK CAA occurrence database contains three previous cases of combustion section fairings detaching, each attributed to incorrect fitting. One occurrence, in 1977, stated that Rolls-Royce Service Bulletin 72-4647 was, "... subsequently issued to overcome this design defect, whereby the cowl can be fitted and latched with the 3 top attach hooks not engaged". At least one of the other two occurrences (reported in AAIB Bulletin 8/97) had modified fairings and also a requirement in the operator's maintenance manual for duplicate inspection.

Rolls-Royce has reported to the AAIB that the company's incident database contains 20 similar occurrences up to May 1999 and the company knew of one further occurrence later in 1999. Of these, at least five (involving RB211-524G & H engines) and probably more, would have had the modified hook fittings to SB-72-4647. In one of these cases it was reported that a duplicate inspection was required by the operator's maintenance manual but had not been carried out. Rolls-Royce has reported that the company will review 60 occurrences of duct fairings being lost where the identity of the fairings was not specified in the database. Co-incident with the issuing of the AAIB recommendation below the company undertook to investigate the incident rate of these occurrences and to review the mechanical design and the fitting instructions of the combustion section fairings.

In view of the number of occurrences of combustion section fairing detachment that are known to have occurred since the introduction of Service Bulletin RB211-72-4647 and the significance of the damage that can be inflicted on the aircraft the following recommendation was made:-

### **Recommendation No 2000-48**

That the Civil Aviation Authority and Rolls-Royce Limited review the history of occurrences of the loss of combustion section fairings from RB211 engines and re-assess the effectiveness of the current (post SB RB211-72-4647) design in preventing mal-assembly, with a view to design and/or procedural changes to minimise the chances of future mal-assembly .

