Boeing 747-246B, TF-ATB

AAIB Bulletin No: 5/2002	**Ref: EW/ C2000/6**	**Category: 1.1**
INCIDENT		
Aircraft Type and Registration:	Boeing 747-246B, TF-ATB	
No & Type of Engines:	4 Pratt & Witney JT9D turbofan engines	
Year of Manufacture:	1971	
Date & Time (UTC):	12 June 2000 at 1200 hrs	
Location:	Between Luxembourg Airport and Manston Airport	
Type of Flight:	Positioning	
Persons on Board:	Crew - 3	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Port fairing-mounted escape slide door damaged, slide torn from its mounting and lost, inflation gas feed pipe fractured at bifurcation	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	N/A	
Commander's Flying Experience:	N/A	
Information Source:	AAIB Field Investigation	

History of flight

The crew collected the aircraft at Luxembourg Airport after the completion of a scheduled maintenance check. There were no unserviceabilities detailed in the Technical Log and the external inspection and pre-start checks were normal. Prior to start, the flight engineer closed the aircraft doors and armed door L1. No abnormalities were noted from before start-up until after the initial climb. Then, as the aircraft was climbing through approximately 1,500 feet amsl, the flight engineer saw the 'L WING ESCAPE DOOR' light illuminate on his panel. The crew experienced no handling problems and checked that the pressurisation was normal. The Quick Reference Handbook (QRH) stated that in the event of a 'L WING ESCAPE DOOR' light illuminating, the crew should *'Proceed normally'*. Additionally, a note was included to advise the crew that *'Affected Door 3 Off-wing slide May Not Deploy'*.

In accordance with the QRH, the crew continued with their flight to Manston Airport. Throughout the flight, with the cruise portion at Flight Level 270, the 'L WING ESCAPE DOOR' light remained illuminated. A normal landing was made at Manston Airport and the commander taxied to his allocated parking area. The crew were informed that the left over-wing escape slide was missing by the receiving ground personnel. The slide was subsequently seen floating on the sea but it had sunk before it could be recovered.

Description of the Door 3 Escape Slide system (Figure 1) ***(jpg 304kb)***

The passenger cabin over-wing (No.3) main doors, on both sides of the aircraft, each had a two piece off-wing escape slide system. The first part, housed in a pack at the base of the door interior trim, was designed to deploy aft, alongside the fuselage as far as the flaps. The second part, located in the wing-to-fuselage fairing, over the forward edge of the flaps, also deployed aft. During an emergency evacuation these two slides, in tandem, would provide passengers with a means of descent to ground level from the over-wing doors (3L and 3R). In this incident, only that part of the system affecting the fairing-mounted portion of the slide was involved.

Fairing-mounted Escape Slide

The fairing-mounted escape slide was attached to the inside of the slide compartment door. Slide inflation was designed to be initiated when the slide compartment door opened and caused an independent linkage, operated by movement of the door, to fire a cool gas generator. The gas from this was used to drive two injector pumps which were capable of inflating the slide fully in about ten seconds.

Opening of the slide compartment door was controlled by the integrator which was situated in a separate compartment just forward of the slide. Forward movement of the rear piston of the integrator unlatched the slide compartment door and fired the door deployment thrusters, which ensured that it opened vigorously. The integrator also served as a safety dead stop for the slide compartment door mechanism to ensure that the compartment door latches remained fully closed in flight. The integrator compartment door had an interlock system which prevented it from being closed if the integrator was not in the fully latched position, but left the system free to operate once the door had been closed.

The integrator was operated via a teleflex type cable from a bellcrank in the main landing gear well. The initial movement, when this bellcrank was operated, caused withdrawal of the spring loaded integrator latch pin by a slack motion mechanism on the integrator forward piston. With continued rotation of the bellcrank, the integrator forward piston then drew the integrator rear piston which, in turn, pulled four slide compartment door latch sliders forward to unlatch it. The latch sliders, which closed the latch jaws and then pulled the door fully shut, had a neutral dwell area at each end of their stroke. As a result, the mechanism had to be drawn forward appreciably from its fully closed position before the latch mechanism began to release. Once into the releasing sector of latch travel, however, any outward forces on the door would assist in driving the latch mechanism towards the open position. A microswitch, located near the rearmost of the four door latches, operated the 'WING ESCAPE DOOR' indications on the flight engineer's panel in the cockpit.

The No.3 door slide system was designed to be deployed either manually or automatically. In either mode, deployment of the fairing-mounted portion of the slide was effected by operating the bellcrank in the main landing gear well. In automatic mode, this was operated by the fairing door unlatching thruster, which fired when the No.3 main door was opened and the main door

emergency power mechanism clutch had been activated. In manual mode, it was operated by pulling the manual inflation handle located, with the ditching deactivation handle, in a covered panel in the passenger cabin sidewall lining, just forward of the No.3 main door. The manual inflation handle was rendered inoperable, unless the main door was open, by a lockout pin released by a lever and cable system from the door aperture.

Previous Maintenance

The maintenance which had just been completed on the aircraft had been an A4 check; scheduled at a maximum interval of 1,300 flight hours. Included in this check was a test of the door warning system on all the main cabin doors but there had been no requirement either to open the fairing-mounted escape slide compartments or to test the indications from the escape slide panel mechanisms. Since there had been no disturbance of the escape slide compartment doors, there was no requirement to check the condition of the integrators.

Amongst the tasks performed in addition to those specified in the A4 check schedule was an AD (98-26-13), which required an inspection of the main door stop support fittings. In order to inspect those on the forward edges of the No.3 door apertures, it had been necessary to remove the cabin sidewall lining panels, located just forward of these doors. These panels were situated directly aft of the enclosure containing the fairing-mounted escape slide manual controls (the manual deployment and ditching deactivation handles) and the procedure for removing the lining panels forward of the doors requires that the cables to these handles be disconnected.

The work cards for this inspection task indicated that the forward panels had been removed, but no specific mention was made of the disconnection or reconnection of the escape slide manual controls. Enquiries of those persons who had performed the maintenance indicated that no problems or discrepancies had been noted whilst working in that area.

AAIB Examination of the Aircraft

On examining the aircraft, the fairing-mounted slide door, aft of main door 3L, was open. The slide had torn off its mountings, as it departed from the aircraft, and its inflation feed pipe from the cool gas generator had fractured at the bifurcation which directed the gas to the two injector pumps.

The integrator *(jpg 45kb)* mechanism was found fully unlatched. Its two piston components were well forward of the latched position and the four slide compartment door latches had been fully released. Neither door deployment thruster had been fired but the cool gas generator had discharged.

There was no evidence of either automatic or manual activation of the slide system. The fairing door unlatching thruster had not been fired, and the manual inflation handle appeared fully stowed with the lockout pin engaged. However, it was observed that when the door had been opened, the lockout pin had not been released due to the stiffness of the lever and cable mechanism from the door aperture. It could be seen that the operating cable from the manual inflation handle to the bellcrank, inside the sidewall lining, was slack.

Examination of the bellcrank *(jpg 63kb)* in the left landing gear well revealed that that the clevis pin of the fairing door unlatching thruster was at about the mid position of the bellcrank slack motion slot. This was consistent with the bellcrank having rotated forwards through about half its

range of movement. Undisturbed grease was present in the full length of the slack motion slot of the manual slide inflation mechanism.

Further investigation

As found, the integrator was heavily covered with grease which had become quite waxy. This grease obscured the area of the integrator body where the black lines to mark the fully latched position of the forward piston should have been. Before cleaning it, an attempt was made to reset the mechanism to the latched condition. It was found that, although the reset mechanism drove the integrator rear piston and the compartment door latches into the fully closed position, the spring loaded integrator latch pin would not draw the forward piston back and allow the interlock mechanism to achieve a safe condition. In the position at which the integrator mechanism came to rest, it was possible to push the door latch mechanism open with relative ease. If, however, the forward piston of the integrator was pushed back to its correct latched position, the latch pin moved to the correct position and acted as a dead stop to the slide compartment door latch mechanism.

Following this test, the integrator was cleaned with solvent whilst installed in the aircraft. After cleaning, the integrator was seen to be in very good condition and, when the resetting test was repeated, it reset correctly and the door latching mechanism became positively locked. Cleaning also revealed that the black lines which should have been present on the integrator body and forward piston, to indicate the fully latched position of the piston, were no longer present.

The setting of the door latch unsafe microswitch on the rearmost latch of the slide compartment door was established. This showed that the movement required to activate the microswitch, which operated the door warning on the flight engineers panel in the cockpit, was considerably less than that of the latch sliders before the unlatching process began.

Following these tests, the integrator was removed from the aircraft to allow measurements to be made to show the extent to which the piston could be positioned 'unsafely' without detection.

Measurements on the integrator showed that the forward piston could be drawn forward 0.115 inch before the slack motion was consumed and it started to draw the latch mechanism. (This was the position which the reset procedure achieved before the grease was cleaned off). When it had reached this position, it was possible to force the aft piston forwards through the positive latch, although the forward piston needed to be drawn a further 0.040 inches before the positive latch was at the top of its disengaging ramp. Thus, with the forward piston drawn forwards to the point where it was about to draw the rear piston with it, the sprung positive latch plunger was already sufficiently close to the top of the slope of its disengaging ramp to have disabled the integrator mechanism dead stop.

Probable Cause of Compartment Door Unlatching

The tests and measurements performed on the system for activating the fairing-mounted slide showed that the rigging, adjustment and state of wear of the system and its components were satisfactory. The only feature observed with the potential to jeopardise correct operation of the system was the presence of the stiff, waxy grease on the integrator which appeared to be capable of preventing the intended operation of its spring loaded latch.

That the system had remained latched until the aircraft had undergone its most recent maintenance inferred, strongly, that the integrator latch had been engaged and had prevented migration of the

slide compartment door latch mechanism. However, the fact that the mechanism had displayed indications of migrating to an unsafe condition shortly after the first take-off after that maintenance, together with the appearance of the 'L WING ESCAPE DOOR' indication, suggests that a critical change took place during the maintenance work. Although nothing had been done which involved work on the system directly, the subsidiary work required to gain access for the inspection of the door stop supports involved some disturbance of the manual inflation system for the fairing-mounted slide.

The resetting tests performed on the integrator system, before cleaning off the grease, suggested that, in the condition that it was in before this incident, the spring loaded integrator latch pin was not capable of drawing the forward piston back so that the pin could act as a dead stop to the slide compartment door latch mechanism.

The absence of the 'WING ESCAPE DOOR' indications on the flight engineer's panel before take-off and during the early part of the climb indicated that the slide compartment door mechanism had not moved significantly towards the open position by that time. The measurements and tests performed during the investigation showed that the forward piston of the integrator could be drawn forwards by 0.115 inch without moving the slide compartment door latch mechanism but, if placed at that position, could allow the door latches to migrate to open and the spring force on the integrator latch appeared to be insufficient to force it to reset correctly.

The possibility exists that during the work to remove the cabin sidewall lining panels, just forward of the No.3 main door, an inadvertent movement of the manual release cable could have occurred. There would have been little resistance to movement in the tensile direction until the integrator forward piston had taken up all the slack movement, which would have left it in the 'unsafe' condition described in the previous paragraph.

Since, following the maintenance work performed, no check of the fairing-mounted slide system was required, and consequently no check of the integrator position made, its condition before take-off was uncertain.

Previous occurrences

There have been no fewer than 30 instances of in-flight loss of the off-wing slide which are believed to have occurred on Boeing 747 aircraft over a period of 20 years, generally following maintenance. These have been attributed mainly to improper closing or latching of the slide compartment, incorrect indications and improper rigging.

Observations

The large number of previous incidents relating to latching of the slide compartment suggest a sensitivity of the system to ensuring the correct operation of the integrator latch pin. Although, in this instance the maintenance work did not require the slide compartment door to be disturbed, the latching mechanism for this door was somehow disturbed. Therefore, it would be prudent that after any maintenance check related to the overwing doors, a check on the integrator condition should be carried out.

The design of the integrator makes it difficult to detect a 'nearly latched' position, particularly when it is as heavily covered in grease as this one was. The grease present on the integrator would have

concealed the black mark indicators, had they still been there. The stiff and waxy condition of the grease appeared to have inhibited the intended free operation of the mechanism.