Boeing 747-238B, G-VJFK, 28 April 1996

AAIB Bulletin No: 9/96 Ref: EW/C96/4/10 Category: 1.1

Aircraft Type and Registration: Boeing 747-238B, G-VJFK

No & Type of Engines: 4 Pratt & Whitney JT9D-7J turbofan engines

Year of Manufacture: 1974

Date & Time (UTC): 28 April 1996 at 1326 hrs

Location: Near London Heathrow Airport

Type of Flight: Scheduled Public Transport

Persons on Board: Crew - 20 Passengers - 306

Injuries: Crew - Nil Passengers - Nil

Nature of Damage: Loss of right hand 'off-wing' escape slide, minor damage to inboard flap upper surface and aft fuselage

Commander's Licence: Air Transport Pilot's Licence

Commander's Age: Unknown

Commander's Flying Experience:

Last 90 days - 158 hours

Last 28 days - 78 hours

Information Source: AAIB Field Investigation

History of flight

The aircraft departed from Runway 27R at 1326 hrs for a flightto the USA, following a period of some 17 days of third partycontracted maintenance at London Heathrow airport. The take offproceeded normally but during the early stages of the climb oneof the cabin crew seated near door R4 heard an unusual 'whooshing'sound. She reported what she had heard to the senior cabin crewmember who in turn reported it to the commander. At about thesame time a security guard at an airport control post and a persondriving along the M25 saw an object fall from the aircraft. Bothwitnesses reported their observations and the driver stated thatthe object had fallen 'outside' the M25. These messages were forwardedto Heathrow ATC who in turn alerted the flight crew that a yellowcoloured object had fallen from the aircraft. A check of the flightdeck did not reveal any unusual warnings or anything amiss (thereare two warning lights on the flight engineer's panel to indicateoff-wing slide deployment and neither was illuminated). With noother indications of abnormality such as airframe vibration orunusual handling qualities, the commander chose to continue theflight and await a more accurate description of the object beforedeciding whether to proceed or divert. Meanwhile ATC had initiateda debris check of the runway which proved negative.

A lorry driver in the Blackthorne Road area of Poyle (about 1nm from the end of the runway) had also seen the object fall fromthe aircraft and he watched it descend; he described it as resemblinga large package and saw it fall into a tree, breaking two branches.He recovered the object onto his lorry and reported the eventby telephone to the Heathrow police at 1336 hrs. They relayedthe information to ATC that a lightweight object which appearedto be an aircraft's escape slide had fallen in the Poyle area.

The Heathrow police contacted their colleagues in the Thames Valleyforce to inform them that the object had probably landed withintheir operational area. Engineers from the operator, police officersand a member of the Heathrow Airfield Operations Safety Unit thendeparted to locate the object. Whilst they were en-route the commandercontacted both ATC and his company by radio to ask if the objecthad been identified. On hearing that it had not, he decided tocontinue the flight.

The object was located at 1450 hrs and positively identified at1530 hrs by the company engineers as the right hand side off-wingslide assembly. Positive identification reached the commanderby HF radio shortly afterwards. He discussed his options withthe company staff and they asked him to return to Heathrow tohave the aircraft repaired.

At 1610 hrs ATC were informed by the operator that the flighthad reached longitude 30° West and was returning to Heathrow.Shortly before 1830 hrs the cabin crew thought they heard another'whooshing' noise from the vicinity of door 4L. This too was reportedto the commander but again there were no warnings of slide deploymenton the flight deck. At this point the commander became concernedby the possibility that the left hand slide might deploy and becomeentangled in the empennage; consequently, he declared an emergencyand restricted the airspeed to 270 kt maximum. The aircraft hadbeen airborne for over five hours and there was no need to jettisonfuel.

Heathrow ATC brought the emergency services to a high state ofreadiness for the landing and vectored the aircraft for a straight-inILS approach to Runway 09L. The flight crew added 5 kt to $V_{REF}$and flew a normal approach without noticing any unusual vibrationsor handling characteristics. The landing at 1855 hrs was uneventfulexcept for a smoking brake unit noticed by the fire service. Aftertheir inspection, which revealed that the smoke was due to extraneousgrease on the brakes, the aircraft taxied to the stand where thepassengers and crew disembarked normally.

Technical examination

As the aircraft taxied to its stand, it was apparent that thedoor for the right-hand off-wing escape slide was open and theentire slide pack was missing (Figure 1).There was minor damage to the upper surface of the inboard sectionof trailing edge flap, attributable to the slide pack as it departedits housing, and minor damage to the aft fuselage. The area ofthe fuselage-wing fairing just aft of the slide housing carriedsoot marks, indicating that the pyrotechnic 'cool gas generator',which inflates the slide when activated for emergency egress,had fired and was operating as the slide pack departed from theaircraft.

Recent maintenance

The aircraft had just returned to service following third partycontracted maintenance at London Heathrow. This work had beenfor a scheduled '5C' check and, within the total work packagesupplied by the operator of G-VJFK, two work cards dealt withthe off-wing escape slide compartment. One card, part of the 5Ccheck, required a visual check of the condition and security ofthe system, an inspection check and lubrication of the cables.The other work card implemented Service Bulletin SB 747-25-2501,recurring every 730 days, which required detailed inspection ofthe firing cable to the cool gas generator on each side of theaeroplane.

The maintenance records show that the work was performed on 14April and the duplicate inspection had been performed on the ServiceBulletin portion of the task: no duplicate inspection was requiredfor the 5C task. A Ground Occurrence Report had been raised bythe Technician performing the work, concerned with fasteners missingfrom the left-hand firing cable and this report had been forwardedto the CAA as a Mandatory Occurrence Report.

Description of the Off-wing slide system

The off-wing escape slide is provided to allow rapid movementfrom the overwing door ('Door 3') to the ground in emergency conditions.The slide is operated from the overwing door and includes a 'systemintegrator' mechanism (Figure 2) becauseof the requirement to inhibit the slide operation for maintenance,or when the slide is operated from outside the aircraft. Thissystem integrator is located just forward of the slide compartment(Figure 1) and has a small access door. After maintenance or inspection,the latching operation on the main door is performed by movingthe latch lever on the system integrator and the final operationis closure of this small access door.

In operation of the slide, a mechanical signal through the systemintegrator unlatches a series of four door latches ('Hartwell'type) along the upper edge of the slide compartment door: thedoor is hinged along its lower edge. These latches operate fromlatch sliders attached by coupling shafts to the system integratorand the latch mechanism is connected to two pyrotechnic deploymentthrusters. Operation of these thrusters rotates the compartmentdoor and slide pack outboard, actuating the inflation mechanismfor the slide. The inflation may be by stored gas bottle or coolgas generator (as in G VJFK) and the gas flow induces ambientair to inflate the slide through two injector pumps.

On the Flight Engineer's instrument panel there is one illuminatedcaption for each of the off-wing slide compartment doors ("L*and* R WING ESCAPE DR"). When properly rigged, this captionis lit by a microswitch detecting incomplete latching of the appropriatedoor. The caption circuit has the usual "Press-to-test"function of the caption bulbs but no means of testing the microswitch.There is also a physical 'Positive latching indicator', an indicatorpin, normally painted red, mounted just forward of the aft doorlatch (Figure 1): this is designedto provide an external verification of the latching mechanism.

The operating instructions for the system integrator are displayedon a decal on the inside of the access door (Figure 2). Thisdecal includes six checks after latching and prior to closingthe access door, with a baulk on the access door providing thefinal check.

In some 747-100/-200 fleets the off-wing slide system was removedwhen the overwing door (Door 3) was deleted. In some of theseaircraft the overwing door was later reinstated but this has generallybeen with the provision of 747-400 doors, where the off-wing slideis incorporated into the door itself. For maintenance organisationsaccustomed to servicing aircraft with 747-400 standard doors,as in this case, the off-wing slide system would only be seenduring third party maintenance work.

Further technical examination

Examination showed that the right-hand cool gas generator hadfired and the left-hand generator had not. Neither of the thrusterson the right-hand side had fired, indicating that the openingof the door had not been initiated by mechanical signal throughthe system integrator.

Further detailed examination of the latching mechanism on theright-hand side showed that, although slightly worn, the bayonetswhich mated with the door latches were in good mechanical condition,as were the latches themselves. The latch sliders were found,however, in an intermediate position, neither fully latched shutnor fully open, but around the middle of the range between thesepositions: the effect was that the latch jaws would allow thebayonets to enter and allow the door to remain, apparently locked,in the vertical position but would not retain them against outboardpressure. Operation of the latching mechanism showed that, followingthe maintenance instruction and using a 1/4" drive wrenchon the latch lever, a false but distinct detent was reached afterapproximately 90° of latch lever rotation and that this appearedto be the end of the mechanism's travel. It took a deliberatefurther action to overcome this false detent and reach the fullylatched position. It was also noted that, with the door unlatched,the positive latching indicator pin could be pushed flat withthe fuselage and would remain in this position. At some time theoriginal red paint had been oversprayed with white paint and thered had not been renewed.

The cause of the 'false detent' was investigated. It was foundthat the indicator pin mechanism was stiff due to the indicatorpin's spring being improperly located.

The investigation of the failure of the "R WING ESCAPE DR"caption to illuminate after the departure of the off-wing slideshowed the microswitch, mounted on the latching mechanism, tobe out of adjustment and giving no indication as to the positioneither of the latching system or of the door. The microswitchon the left-hand side also proved to be out of adjustment. TheInspection/Check instructions in the Maintenance Manual and onthe inside of the access door are very similar and call for acheck that the caption on the Flight Engineer's panel is extinguishedafter latching: there is no equivalent procedure in this sequencefor checking that the caption is illuminated with the door unlatched.It is likely, therefore, that the microswitches had

been out ofadjustment for some time representing an unexpected dormant failurewithin the warning system.

Human factors

The maintenance technician who performed the work was well-regardedby his employer and considered conscientious, a view reinforcedby his having raised the MOR on the left-hand slide system. Thetechnician confirmed that he had performed the work with "hard"(*ie* paper) copies of the Service Bulletin and MaintenanceManual pages and that, after the system appeared to latch "witha positive clunk" (actually the false detent) the six checksdetailed on the access door appeared to be satisfied, includingthe check that the indicator pin was flush.

Analysis of the six checks (Figure 2) showedthat one does not alter with latch position and another represents,as noted previously, a dormant failure of the system for illuminatinga warning caption at the Flight Engineer's panel. With the remainingfour checks, including the indicator pin, the design of the systemintegrator made it very difficult to detect a 'nearly latched'condition, as found in this mishap. Finally, with the mechanismin the 'nearly latched' position, the physical baulk on the accessdoor did not interfere with the latching mechanism and thus allowedclosure of the door.

Previous occurrences

A number of previous instances of in-flight losses of off-wingslides have been reported and further instances of the compartmentdoor being found unlatched after flight. The airframe manufacturerreports some 30 in-flight losses in the previous 20 years, generallyfollowing maintenance, and further reports the causes as improperclosing or latching, incorrect indications of latching and improperrigging.

Following the incident, the operating airline, the maintenanceorganisation and AAIB have discussed with the aircraft manufacturerthe unexpected dormant failure within the warning system. Themanufacturer has undertaken to correct this. AAIB have recommendedthat the FAA and CAA should monitor progress and ensure that theresulting changes are fully promulgated.