Access door loss and fuselage damage, Boeing 777-236B, G-VIIA

Micro-summary: **The crew opted to divert back to base after an access door disengaged and damaged the airframe.**

Event Date: **2003-06-26 at 1000 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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Aircraft Type and Registration:	Boeing 777-236B, G-VIIA
No & Type of Engines:	2 GE90-85B turbofan engines
Year of Manufacture:	1997
Date & Time (UTC):	26 June 2003 at 1000 hrs
Location:	Near Reigate, Surrey
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 272
Injuries:	Crew - None Passengers - None
Nature of Damage:	Access door detached, cabin windows damaged, minor damage to fuselage and fin
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	14,750 hours (of which 2,350 were on type) Last 90 days - 190 hours Last 28 days - 36 hours
Information Source:	AAIB Field Investigation

Synopsis

A large access door, measuring 4 x 6 feet and weighing 70 lb, detached from the aircraft shortly after takeoff from Gatwick Airport, causing substantial damage to two cabin windows and minor damage to the fuselage and fin. Fragments of the door penetrated into the cabin and large parts of it landed close to persons on the ground. It was likely that only one of the thirteen door catches had been fastened and that the door had suffered overload failure due to aerodynamic forces as the aircraft accelerated, allowing it to open and detach. Multiple walk-round inspections of the aircraft by different personnel had failed to detect the open catches. The inadequate fastening had apparently occurred during a routine maintenance check due to a deviation from standard procedures; a practice that reportedly had been fostered by features of the maintenance system and may have been commonplace. It appeared likely that the human performance factors evident in this event could be affected beneficially by improvements in the operator's maintenance and inspection systems. One safety recommendation has been made.

History of the flight

The aircraft was scheduled to fly from London (Gatwick) to Antigua with a full passenger load. The commander was aware that the aircraft had just completed a period of maintenance when he carried out his external pre-flight check. At 0946 hrs, after a normal engine start, the aircraft was cleared to taxi for Runway 08R. The aircraft took off at 1000 hrs and was cleared by ATC for a 'Southampton Two Papa' (SAM2P) Standard Instrument Departure (SID), requiring it to fly straight ahead for 3.5 nm before turning left to intercept and follow the 263° radial from the Detling (DET) VOR beacon. During the SID the crew contacted London Control and were cleared progressively to 6,000 feet. Before reaching this altitude the aircraft was established on the required radial from Detling, in the clean configuration and at the speed control limit of 250 kt. ATC then cancelled the speed control, allowing the aircraft to accelerate to its optimum climb speed.

Whilst accelerating, in calm flight conditions, both flight crew members briefly felt a slight tremble through the airframe. The cabin attendants seated at Doors L3 and R3 (left and right cabin doors just behind the wing root trailing edges) felt a thump and heard a loud bang; other cabin attendants were aware of a dull thud. The cabin attendants at Doors L3 and L4 moved immediately to the area of Seats 26A to 29A (the left seats in the 1st and 4th rows behind Door L3) where they suspected that the bang had occurred on the side of the fuselage. One of them then informed the flight crew that something had struck the side of the fuselage, whilst the other informed the Cabin Services Director (CSD).

The commander engaged the autopilot and gave control to the first officer (FO), instructing him to maintain 6,000 feet and reduce speed to 250 kt, and summoned the CSD to the flight deck. The commander then went back into the cabin to assess the damage for himself. He saw that the outer pane of the window adjacent to Seat 29A had suffered substantial impact damage but that the inner pane remained intact. There was no obvious damage to other windows or to the fuselage itself. He considered it unwise to continue the flight to Antigua but there appeared to be no reason to land straight away. He reassured the passengers in the immediate area and returned to the flight deck.

The commander briefed the CSD on the nature of the problem, his intention to return to Gatwick and the expected time to landing. He then informed ATC of the situation and requested radar vectors to an area where they could dump fuel, down to the maximum landing weight, before returning to Gatwick. He also made a public address (PA) to reassure the passengers and inform them of his intentions. At the request of ATC the aircraft was climbed to FL 80 before fuel dumping commenced. At this altitude the cabin pressurisation system continued to operate normally.

As the fuel weight reduced the cabin crew perceived a gradually increasing hissing noise in the area of the damaged window and informed the flight crew of this change. A slight vibration through the

floor of the cabin was also reported in the area around Seat Rows 26 to 29. At the same time cabin attendants found that a lighting trim fitting had been dislodged from its housing and was lying on the floor near Seat 29A, together with small items of debris that they did not recognise. They also found a larger piece of debris, approximately 2 inches square and painted dark blue, which they passed to the flight deck. The commander considered that these changes could collectively indicate a deteriorating situation and therefore decided to cease dumping fuel and to return to Gatwick immediately for an overweight landing. He organised this with ATC and was given radar vectors for an ILS approach to Runway 08R. The aircraft completed a normal approach and landed at 1047 hrs, approximately 10 tonnes above the maximum normal landing weight.

Fire and rescue services

At 1040 hrs the airfield fire and rescue services (AFS) were notified that an aircraft would be landing overweight with suspected damage to its fuselage. Once the aircraft had landed safely and vacated the runway the Fire Chief, using an external jack point, contacted the flight crew on the interphone system. He informed the aircraft commander that the landing gear appeared normal following the overweight landing but that a panel was missing from the fuselage just behind the left wing root. The commander confirmed that all cockpit indications for the landing gear system were normal and decided to taxy to the allocated stand with the AFS in attendance and maintaining a listening watch on 121.6 MHz.

Flight Recorders

Satisfactory recordings were obtained from the Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR). However, power supplies to the CVR had not been isolated after the incident and the recording of the incident was overwritten. The FDR provided no information relevant to the incident.

Aircraft Description

General

The Boeing 777-200 is a twin-engined aircraft of conventional layout approved for ETOPS (Extended Twin-Engine Operations). Certificated maximum take-off weight is 590,000 lb (267,619 kg). G-VIIA was Aircraft Line No 41.

Air Driven Unit bay access door

Hydraulic power is generated in part by two Air Driven Units (ADUs) powered by engine bleed air. The units are installed in the aft end of the left wing-body fairing (Figure 1) and can be accessed via

a large rectangular door (No 197JL). This has a curved vertical profile to match the fairing and is 4.18 ft wide, 5.95 ft high (along the curve, Figure 3), generally 1.3 inch thick and weighs around 70 lb. It is constructed of laminated carbon-fibre skins bonded to a 'nomex' honeycomb core. The inner and outer skins are laminated directly to each other around the periphery of the door, providing a lip which fits into a recessed part of the doorframe. The door is attached to the fairing by 3 steel hinges on its top edge and is retained closed by 13 push-release catches (Part No (PN) HA260-3), numbered in this report as in Figure 3. The lower catches are accessible from the ground by a moderately tall person.

When unlatched, the door hangs partially open on its hinges. It can be propped open in either an 'Intermediate, No 1' or 'Fully Open, No 2' position by a stay fitted in one of two doorframe brackets. A red-painted placard on the lower part of the outside of the door warns 'CAUTION - DO NOT OPERATE FLAPS WITH DOOR IN THE INTERMEDIATE POSITION'.

Each catch consists of a mechanism attached to the inner face of the door lip by 4 bolts (Figure 4). Cut-outs in the door skin provide external access to each catch and clearance for it to open. When the catch is closed, a pivoting latch lever bears against a latch pad fixed to the doorframe and fitted with a wear plate. Door adjustment is achieved by fitting different thickness wear plates; those on G-VIIA were between 0.015-0.040 inch thick.

The latch lever is spring-loaded to open and is retained closed by contact with a trigger lever, which itself is spring-loaded to close against a stop on the catch frame. The latch lever/trigger lever contact point is positioned so as to over-centre the mechanism; ie an increased latch lever opening force provides an increased trigger lever closing force.

The catch is released by manually pushing the trigger lever inwards until it disengages from the latch lever, allowing the latch lever to rotate under spring loading and disengage from the pad (Figure 5). The latch lever rotates 90°, its inner end passing through the door cut-out and protruding 0.85 inch beyond the outer surface of the door. The protruding portion has a generally rectangular cross section of approximately 0.7 x 0.4 inch; on G-VIAA the exterior face (when closed) was painted the same dark blue as the door and the side and inner faces were generally unpainted silver-coloured aluminium. It was noted that the side faces of the latch levers on the replacement door were painted orange. The trigger lever returns to its flush position when released. The outer face of the trigger lever was generally painted dark blue; in G-VIIA's case this paint had disappeared from some of the catches, leaving the silver-coloured metal surface of the trigger levers visible (Figure 6).

Cabin windows

Each cabin window unit consists of two transparent acrylic panes fitted into an elastomeric edge seal (Figure 2). The seal bears against a fuselage sidewall flange formed around the window aperture and the unit is held in place by 10 small steel clips, each fixed by a single bolt, which bear against the inner pane. A third pane, fitted into the cabin trim panel, forms an inner protective cover. The outer pane has a bevel around its exterior edge and, with the cabin unpressurised, is recessed approximately 0.12 inch from the outer surface of the fuselage skin.

Aircraft examination

Examination of the aircraft revealed the absence of the ADU bay door and the presence of paint deposits, scraping and gouge markings on the side of the fuselage just below and aft of L3 Cabin Door. All three ADU door hinges were found fractured. The markings showed that the ADU bay door had rotated open on its hinges until its outer surface had struck the fuselage skin immediately above the door aperture. The hinges had over-travelled and failed in overload and the door had travelled upwards and rearwards with parts of its outer surface in firm contact with the fuselage. Six deep gouges in the fuselage skin, with progressively increasing spacing, were evident near the forward edge of the scrape markings. With the catches closed, the outer surface of the door is smooth and it appeared highly likely that the gouges corresponded to sequential contact by the protruding latch levers of the six catches on the door forward edge. The spacing suggested that the door had rotated as it had translated and accelerated upwards and rearwards relative to the aircraft.

The fuselage scrape marks passed over the lower aft corner of Door L3 and over the first two cabin windows aft of the door. A piece of blue-painted carbon-fibre laminate, approximately 2 x 2 inch in size, reportedly entered the cabin at the first window ('Window A', Figure 1), adjacent to Seat 26A. It was clearly part of the external skin of the ADU bay door, although its original location on the door could not be established. Inspection indicated that it had been forced in between the window unit seal and the window frame. Some of the retaining clips for Window A had been distorted or displaced and the retaining screws bent, allowing the window unit to displace inwards at its aft top corner. The sidewall trim panel adjacent to Seat 26A had been displaced slightly and a sidewall light cover in the area had detached.

A portion of carbon-fibre laminate approximately 3 x 6 inch in size was found at the fourth window ('Window B', Figure 1) embedded between the window unit seal and the aft upper corner of the fuselage window aperture. This piece, identified as the outer skin of the aft lower corner of the ADU bay door (Piece 6, Figure 3), protruded partially into the cabin at Seat Row 29. The outer pane of Window B exhibited heavy scrape marks terminating in an approximately 3.5 x 0.7 inch irregular penetration hole, with associated local fracturing of the pane. The damage profile and paint deposits

on the pane were consistent with impact by a latch lever protruding from one of the catches. Additional damage consisted of an approximately 6 inch long gouge in the composite skin forming the left side of the fin, about one third of the way up.

The ADU bay doorframe had not been damaged and all the latch pads were in place and undistorted. Most of the pad wear plates had been severely worn by frettage against the latch lever of the associated catch. Seven of the plates had been completely penetrated and the wear had continued into the respective pads, in one case reducing the pad thickness from 0.112 inch to 0.046 inch, but none of the pads had failed. Within the ADU bay a duct insulation blanket had been disrupted and severely damaged. With this exception, the components in the bay showed no signs of damage.

Debris lying in a wooded area near Reigate, discovered by a dog walker, was identified as part of the missing door. A search of the area located other parts and a large portion was found when a couple who had been out walking described having seen it fall nearby after their attention had been drawn by another substantial part of the door impacting the ground around 20 feet from them. Around 60% of the door was recovered (Figure 3), all from the ground beneath the flight path, apart from the small portions of door skin that remained with the aircraft. Much of the ground area was covered with dense, high undergrowth and in spite of a prolonged search the remainder was not located.

The recovered parts included 9 of the 13 catches. Five of these were found in the open state, with no apparent damage. The other four catches had been distorted. In the case of two of these (Catches 2 and 10) the damage was consistent with the effects of door fractures that passed through their location. Catch 10 also had marks suggesting that some damage had resulted from impact on the protruding latch lever. One (Catch 5) was located immediately adjacent to the door skin piece that had penetrated the cabin at Window B. The evidence suggested that the protruding latch lever of this catch had caused the hole in the window's outer pane and that the catch had been damaged in the process. The remaining distorted catch (Catch 6) had not been in a region of appreciable door damage; the evidence was consistent with it having been damaged by an inward overload applied to the closed latch lever.

Detailed examination of the catches revealed no plausible mechanism by which they either could only partially engage or could spontaneously release.

Maintenance background

At the time of the accident the operator was in the process of modifying its Boeing 777 maintenance programme to align it more closely with the aircraft manufacturer's programme. The realignment had occurred over a period of approximately a year, during which time the schedule of check items had varied. Some personnel interviewed during the investigation considered that the changes in the

schedule of check items over an extended period increased the likelihood of errors, although no evidence was found positively to show that this was the case. G-VIIA was the first of the fleet to become aligned with the new programme. The first maintenance operation in accordance with the new programme, a 'B+2A Check', had been carried out on G-VIIA in a hangar at Gatwick Airport between 22-25 June 2003. The accident flight was the first since completion of the check.

Detailed inquiries were made in an attempt to establish the sequence of possibly relevant events during the check. The personnel involved in the incident provided full assistance with the investigation and their approach suggested that it had been their intention to be conscientious.

Standard practice was for the maintenance check to be carried out in accordance with a 'Work Pack', where each item of scheduled work was specified on an individual 'Work Card'. Four boxes on each card required an identity stamp, respectively signifying authorisation, completion and clearance of the task and clearance of the Work Card. It was intended that the mechanic or engineer carrying out a task would stamp the completion box and a Licensed Aircraft Engineer (LAE) would then stamp the boxes certifying clearance of the work and the card.

To enable the progress of the check to be controlled, the cards were generally stored in a number of racks. The racks for the cards covering avionics and cabin tasks were located on the mezzanine floor of the maintenance docking stands and the racks for the cards covering the other items were on the hangar ground floor to one side of the aircraft. The cards were thus not in the immediate vicinity of individual work sites and task completion stamping therefore tended to occur in batches.

The Work Cards included a considerable number that specified the opening of individual access panels, to enable the required work to be done in accordance with other individual Work Cards. Further cards each specified the inspection of an opened bay after completion of the work, followed by closure and re-securing of the access panel. It was reported that some complication was typically introduced by the inclusion in the Work Pack of duplicated cards and of cards requiring the opening of a number of bays without any subsequent requirement to carry out work within them. Additionally, while the Work Cards requiring access panel opening or closing specified the panel identity number, they did not provide an illustration of the location of the panel on the aircraft. The location could be determined from access panel diagrams in the Aircraft Maintenance Manual (AMM) but this reportedly tended to be a lengthy process.

Discussion with a number of the maintenance personnel indicated that in practice some access panels would be re-secured after the work in the associated bay had been completed but the completion boxes in the relevant panel closure Work Cards would remain unstamped. In other cases, where a number of separate work items in the bay could possibly be required, the panel would remain open.

Thus the LAE supervising the check typically would be left towards the end of the check with a number of cards with unstamped panel closure boxes for panels that had already been closed.

As was usual, G-VIIA's check had been conducted by three shifts of workers over each 24 hour period; shift rotation patterns and absences meant that the personnel forming a particular shift could vary from day to day. Thus tracing an individual who had closed a panel but not stamped the associated card was difficult. In such a case the panel should be re-opened, the bay inspected and the panel re-closed, but some of the personnel reportedly felt that such a practice could invoke management criticism of unwarranted delay in the completion of the check. The available evidence indicated that it was thus apparently normal practice, when all the maintenance tasks had been completed, for the LAE to instruct all access panels remaining open to be closed and then to visually inspect the aircraft and, on this basis, stamp the remaining panel closure cards.

G-VIIA maintenance

The only routine maintenance requiring the opening of the ADU bay door was to allow for checking of ADU gearbox oil levels, specified at 6,000 hour intervals by the manufacturer's maintenance programme. Inquiries indicated that during the check G-VIIA's ADU door had been opened to the No 1 position for this purpose early on 22 June. It was reportedly seen to be closed before the trailing edge flaps were retracted on 25 June but it was not possible to establish how the closure had been carried out. The Work Card for ADU bay inspection and door closure had been cleared on the basis of 'the panel being seen to be secured'.

At completion of the work in the early hours of 25 June, G-VIIA had been towed to the apron outside the hangar where the responsible LAE and another engineer each conducted a walk-round inspection. It had then been towed to a stand near the cargo area (Stand 178), where it remained for approximately 24 hours. This stand, although in a somewhat remote area of the airport, was immediately adjacent to a continuously manned security checkpoint, from where it was clearly visible.

Early on 26 June a 3-man maintenance crew had replaced a passenger seat set in the rear cabin, using a high-loader vehicle at Door L3. This operation would have placed the vehicle and crew directly in front of the ADU bay door before the vehicle body was raised. After the seats had been fitted, G-VIIA had been towed to the departure stand. Crews towing the aircraft to and from Stand 178 were required to conduct a pre-tow walk-round check. At the departure stand an Engineering ETOPS Transit Check had been conducted, requiring an engineer to make a preliminary inspection, a detailed inspection and a final walk-round inspection. The captain had then conducted his pre-flight walk-round inspection, followed by a further walk-round check carried out by each of the two push-back crew members.

All of the walk-round checks were carried out in daylight and in fine weather. All were reportedly carried out in the same direction; ie moving rearwards down the right side of the aircraft and forward along the left side.

Previous events

Information on previous cases of problems with the ADU bay door catches was obtained from the aircraft manufacturer. Cases of catches being found open after flight were experienced during Boeing 777 type certification flight testing; these were attributed to catch deformation under in-service loads and an improved higher-strength catch (PN HA260-3) was introduced. G-VIIA was fitted with the improved catch. The manufacturer has received no reports of this type of catch opening in flight. Based on the manufacturer's test results, forcible door opening would be expected to cause substantial deformation of the catch mechanism.

Cases of excessive in-service wear of the catch pads on the ADU bay doorframe associated with the PN HA260-3 catches had been reported to the aircraft manufacturer. The latter had issued a Fleet Team Digest (777-FTD-53-02002) on 12 April 2002, requesting operators to inspect the pads at the earliest maintenance opportunity, to report back on cases of excessive wear and to replace worn components. A revision of the FTD issued on 11 July 2003 noted that a Service Bulletin on the matter would be issued and that this would also advise that a further improved design of catch (PN HA745-1) was available for aircraft fitted with a previous standard. This improvement was apparently aimed at reducing pad wear and improving adjustability.

One previous case of in-flight detachment of the ADU bay door, in 1998, had been reported but the cause was not established. Damage had reportedly been confined to loss or disruption of insulation blankets in the bay.

It appeared that G-VIIA's accident could have had similarities with three other known recent cases of uncompleted maintenance operations on other aircraft in the operator's fleet that had led to serious incidents. The incidents, which involved a Boeing 757 on 7 September 2003, a Boeing 757 on 19 November 2003 and a Boeing 777 on 10 June 2004, are under investigation by AAIB.

Discussion

Airframe damage

It was evident that G-VIIA's ADU bay door had opened violently as the aircraft was accelerating and climbing towards 6,000 feet amsl. Over-rotation of the door had caused its three hinges to fracture and the door to detach and fracture. Corners of the door skin had snagged on the edge of the window

frame at Windows A and B as the door slid up the side of the fuselage and been driven between the frame and the window unit. This had allowed small parts of the door skin to enter the cabin and caused minor displacement of the cabin trim.

The window unit displacement was unsurprising as the fastening arrangement did not appear to be particularly robust, consistent with the lack of a design requirement for the fasteners to normally withstand substantial inward forces. The usual forces on the window unit are predominately outward-acting cabin differential pressure loads reacted by the frame flange. At the time of the door detachment only a small differential pressure would have been present to assist in reacting the impacts. The slight recessing of the window unit in this condition, together with the effect of the outer pane bevel, may have assisted in the snagging of the door. At greater altitudes a higher differential pressure would be expected both to reduce these effects and to increase the resistance to both window seal and window unit displacement.

Door Detachment

The door detachment was consistent with the effect of normal aerodynamic forces acting on an inadequately restrained door, causing any catches that were fastened either to disengage because of door distortion or to fail under overload. The doorframe and the latch pads remained undistorted and the wear on many of the pads, while severe, would not have allowed the catches to disengage. It did not appear likely that a lack of engagement of a few catches would significantly compromise door retention. It was therefore evident that multiple catches had either failed, spontaneously come open or been left open.

The state of the four recovered catches that had been distorted could not be ascertained with certainty from examination but damage to the aircraft indicated that at least two of them (Catches 5 and 10) had been open. The damage to one of the others (Catch 6) was consistent with the effects of overload while the catch had been fastened. The remainder of the other five recovered catches were found undamaged but open. In addition, as the catches are flush with the door outer surface when closed, the deep regular gouge markings on the fuselage skin indicated that all six of the catches on the forward edge of the door were open. The evidence therefore indicated that 11 of the catches, and possibly all of them except No 6, had been open when the door detached. As examination of the catch mechanism identified no way in which it might spontaneously release, it appeared that 11 or 12 of the 13 catches had been open at the time G-VIIA had left the departure stand and that Catch No 6 had probably been fastened. This conclusion was supported by previous service history.

The last known occasion on which the ADU bay door had been opened was during the maintenance check preceding the flight and there appeared to be no plausible reason for the latches to have been disturbed during subsequent aircraft preparations. Most of the catches could not be reached from the

ground. The aircraft had been parked on a remote stand for a period after the check, but this was in an area of the airport intended to be highly secure and the aircraft had been in clear view of a nearby security post. The aircraft had subsequently been located on the departure stand at the airport terminal. It was therefore concluded that unauthorised interference with the catches after the check was improbable.

Post maintenance inspections

It would be expected that a door, inadequately secured at the end of a maintenance check, with apparently at least 11 of the catches open, should have been detected by the 11 subsequent walk-round inspections, conducted in good ambient conditions by 9 different individuals. However, a number of factors may have influenced this.

The square, perpendicular appearance of the released latch levers and their regular spacing might appear less abnormal than a more irregular, angulated mechanism. The trigger levers would have been in their normal closed position and the metallic finish of some of them might have made protruding latch levers somewhat less conspicuous. The orange paint found on the latch levers of some other ADU bay door catches did not appreciably add to their conspicuity and could be considered likely to have been of only marginal benefit.

Additionally, the routine nature of the inspection task and the knowledge, by each of the 'inspectors' that others had made, or would make, similar checks might subconsciously have led to a reduced level of attention. All of the aircraft walk-round inspections were apparently conducted in the same direction (clockwise as viewed from above). When approaching the rear of the left wing during the inspection it appeared possible that an 'inspector's' attention could transfer directly from the left horizontal stabiliser to the left wing, No 1 engine and left main gear consequently reducing the attention paid to the apparently less complex wing/body fairing region.

General

Satisfactory completion of the complex maintenance operations relied on the procedures being followed and the accident apparently resulted from an omission made when there had been a departure from procedures. The changes in the schedule of check items over an extended period, occasioned by the maintenance programme realignment, reportedly may have increased the likelihood of errors, but this could not be confirmed. However, the available evidence suggested that some features of the maintenance system could have made it difficult to both follow the procedures exactly and carry out the work expeditiously. These features, which included the duplication of scheduled tasks, the scheduling of unnecessary tasks, the separation of maintenance and panel

closure tasks and the lack of a ready means of identifying panels, had apparently reduced the likelihood of strict adherence to the procedures.

A considerable amount of research has been carried out in recent years into the human factors involved in maintenance errors. General conclusions have been that improvements to maintenance systems and to the corporate culture in which they operate can help to ensure that procedures are followed and thus the likelihood of human errors can be reduced. In many instances the possibility for errors to occur cannot be entirely eliminated and it must be incumbent on any system to detect errors and to limit their consequences. Whilst disciplinary action taken against individuals for non-conformances can have an isolated and sometimes short term effect it has been widely accepted that this is likely to be less effective in preventing recurrence than systematic improvements. Furthermore, in cases where disciplinary action is considered appropriate, conflict of interests can often result from the attribution of this responsibility to a department responsible for quality.

Conclusions

Although major airframe damage did not occur in this case, the loss of the door constituted not only a hazard to those on the ground but it also had the potential to hazard the aircraft.

While it appeared improbable that multiple open catches would not have been detected during the numerous inspections following the maintenance check, elimination of other possible scenarios indicated that this had in fact been the case. In the absence of other plausible explanations, it was concluded that the door had probably been temporarily closed and secured with Catch 6 during the maintenance check, possibly to allow operation of the trailing edge flaps, and that the remaining catches had subsequently remained unfastened. The excessive wear of a number of the doorframe pads, although not relevant to the detachment of the door, was indicative of an inappropriate level of maintenance in this area.

The available evidence suggested that the maintenance personnel involved in this event had intended to be conscientious. Standard procedures were in place aimed at ensuring the inspection of the ADU bay and the correct re-securing of the door before completion of the maintenance check, but the evidence suggested that the LAE supervising the check could experience difficulty in assiduously following these in practice. It appeared that this had led to a lack of proper bay inspection certification and to the door having been inadequately secured and that the omissions had been missed by the subsequent inspections.

The available evidence did not positively indicate the extent to which maintenance practices may generally have deviated from specified procedures. However, a number of areas where there appeared to be scope for improvement of the system were identified and it appeared likely that

addressing these may be more effective in preventing recurrence than attributing the failures solely to individual error. This conclusion was reinforced by the preliminary evidence that similar maintenance issues to those indicated above may have been involved in three other serious incidents to the operator's aircraft in a 10 month period.

Safety Recommendation

The company agree that it is prudent to continually review its management systems and practices to ensure the correct completion of maintenance operations. The following recommendation is therefore made to bring to the company's notice areas, within their maintenance operations, where focussed attention should be considered:

Safety Recommendation 2004-77

It is recommended that British Airways, when reviewing their maintenance inspection and management systems and practices should consider:

(a) reviewing work packs to ensure that no duplicate or unnecessary tasks are specified;

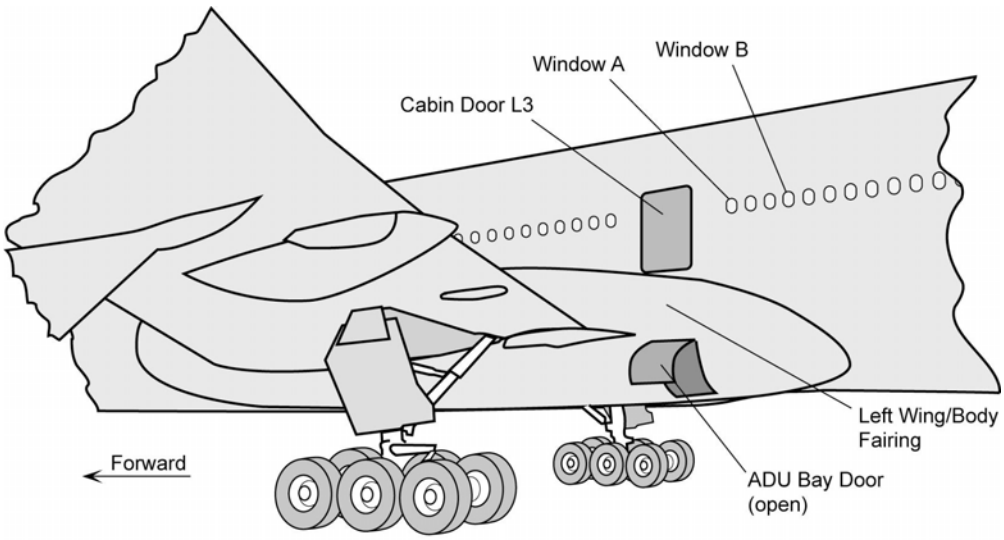
(b) combining access panel opening and re-securing actions during maintenance with the associated maintenance task on a single work card

(c) including on work cards illustrations indicating access panel locations;

(d) additional measures to ensure the re-securing of access panels after maintenance;

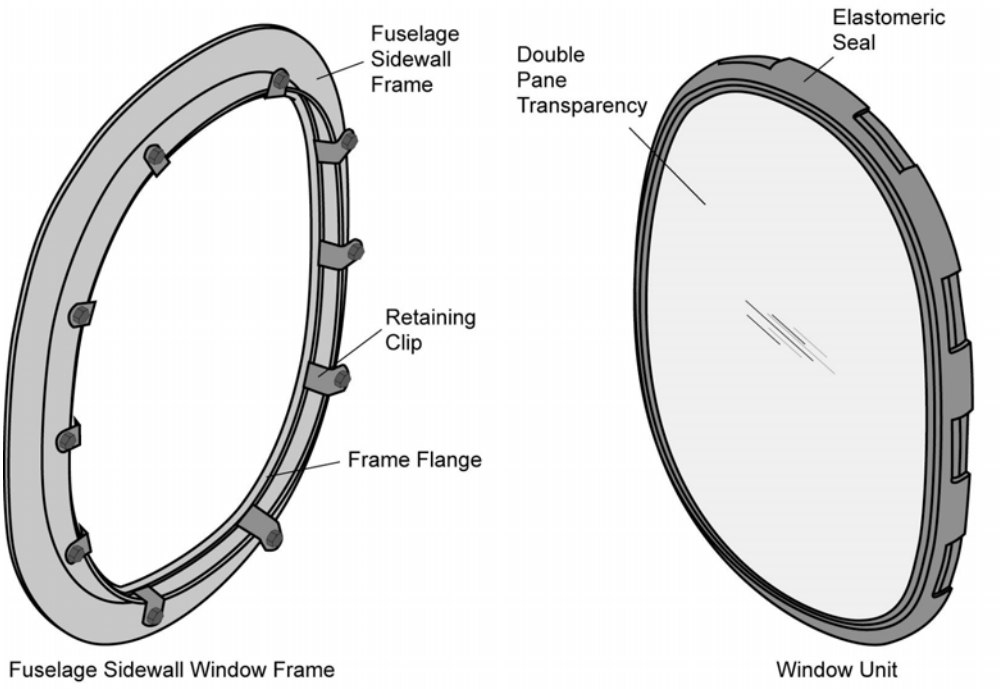
(e) measures aimed at ensuring that access panel latch pads wear is rectified before it becomes excessive and,

(f) examining the possible benefits of varying the walk-round direction for some of the multiple airframe inspections.



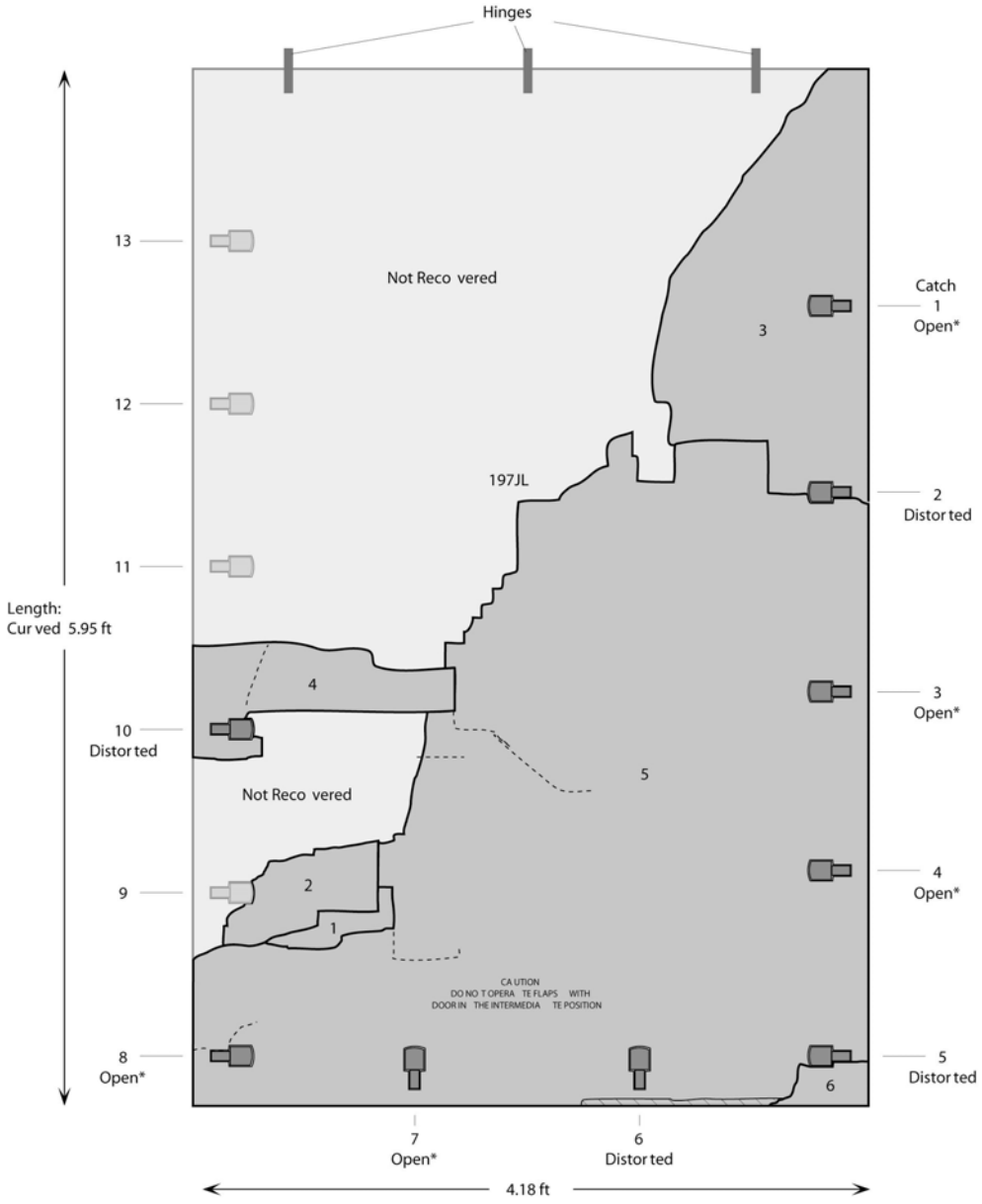
Air driven unit access door location

Figure 1



Cabin window unit

Figure 2

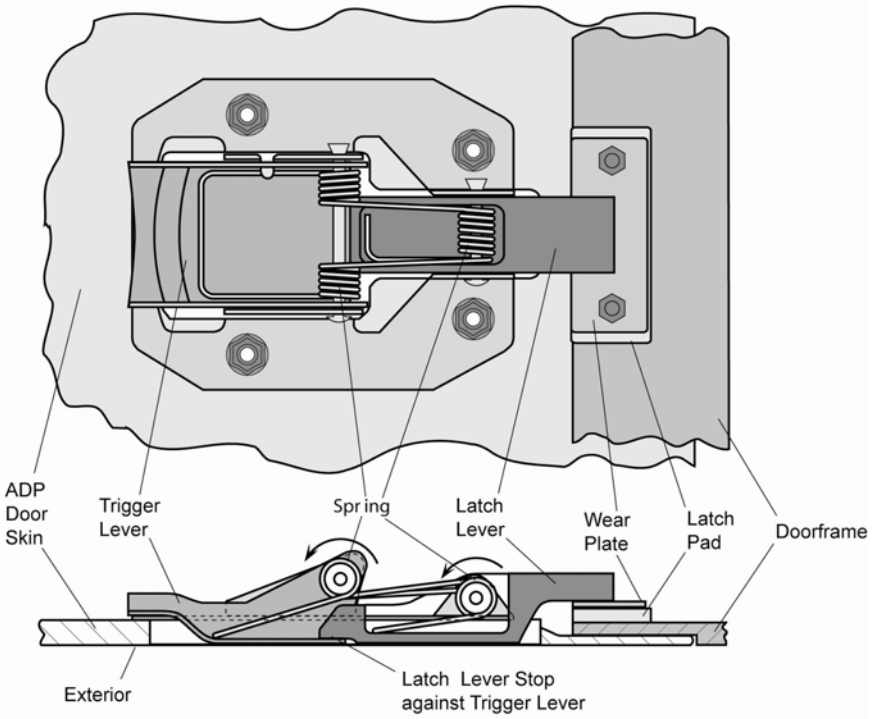


NOTE
1. Door drawn flattened.
2. All recovered items shown except for several small pieces whose location on the door could not be established
3. All recovered items found on ground beneath flight path, except as noted below.
4. Piece 6 found embedded between Seal and fuselage aperture for Window B
5. Piece 8 (approx 2x2 inch, not shown) entered cabin between Seal and fuselage aperture for Window A.

KEY
1. Recovered items in darker shading.
2. * Apparently undamaged.
2. Paint scraped off.
3. ------ Crack in outer skin.

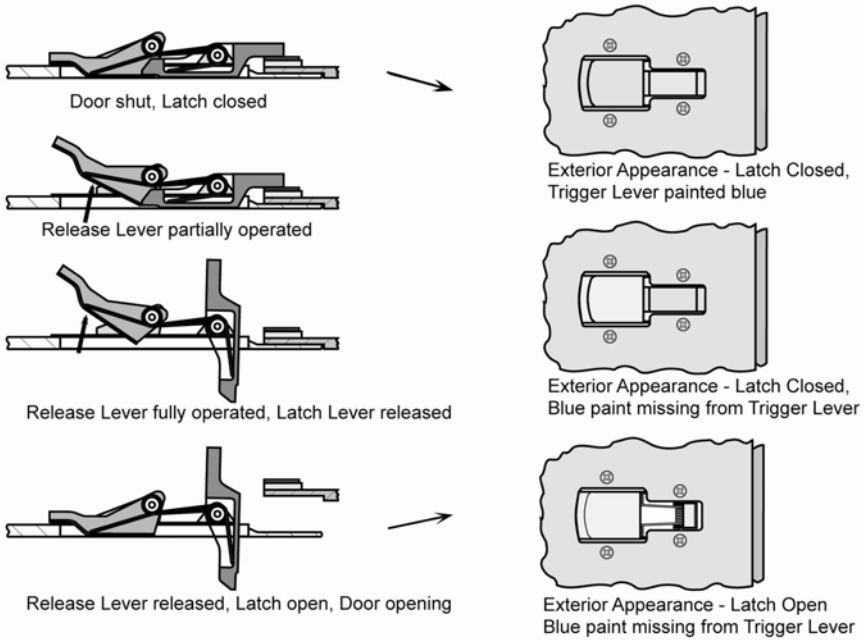
G-VIIA ADU acesss door schematic

Figure 3



ADU bay door latch

Figure 4



ADU bay door latch operation
(side view)

Figure 5

ADU bay door latch
(Plan view)

Figure 6