

Airbus A320-231, G-VCED

AAIB Bulletin No: 7/2000 **Ref:** EW/C2000/1/2 **Category:** 1.1

Aircraft Type and Registration: Airbus A320-231, G-VCED

No & Type of Engines: 2 International Aero Engine V2500-A1 turbofan engines

Year of Manufacture: 1991

Date & Time (UTC): 20 January 2000 at 0655 hrs

Location: London Gatwick Airport

Type of Flight: Public Transport (Passenger)

Persons on Board: Crew - 6 - Passengers - 146

Injuries: Crew - None - Passengers - None

Nature of Damage: Engine cowling and pylon severely damaged, localised damage to powerplant, wing, slats, flaps, fuselage and fin

Commander's Licence: Airline Transport Pilot's Licence

Commander's Age: 47 years

Commander's Flying Experience: 8,950 hours (of which 2,135 were on type)

Last 90 days - 134 hours

Last 28 days - 64 hours

Information Source: AAIB Field Investigation

Summary

As the aircraft rotated for take off, both fan cowl doors detached from the No 1 Powerplant and struck the aircraft. The doors were destroyed and localised damage resulted to the No 1 Powerplant and its pylon, the left wing, the left flaps and slats, the fuselage and the fin. The evidence indicated that the doors had probably remained unlatched, after having been closed following maintenance prior to the accident flight and had been torn off their pylon attachment hinges by aerodynamic forces as the aircraft rotated. There are no conspicuous cues to indicate an unlatched condition when the doors are closed and no flight deck indication. Three walk-round inspections had been conducted after the doors had been closed.

Fan cowl doors had previously detached from A320, A319 or A321 aircraft, which have similar door arrangements, on at least 7 previous occasions since 1992, apparently due to failure to re-

engage the latches after re-closure of the doors. The Powerplant manufacturer's recommendations for a procedure aimed at ensuring door latching and modifications to increase the conspicuity of unfastened latches were considered unlikely to significantly reduce the probability of recurrence. A recently issued modification, intended to hold the doors slightly open when unlatched, could possibly provide significant improvement but had been categorised as an operator's option. No remedial measures have been mandated by the airworthiness authorities and none had been incorporated on G-VCED. Six safety recommendations are made.

1 History of the flight

The aircraft arrived at Gatwick Airport the evening before the accident. It parked on Stand 13, at 1825 hrs, and remained there until pushback commenced at 0637 hrs the following morning.

During the night, a routine Weekly Check was carried out on the aircraft by a Licensed Aircraft Engineer (LAE); this required the fan cowl doors on both powerplants to be opened. After completion of the Check, a Pre-Departure Inspection was carried out by a mechanic; this included an external walk-round inspection.

The wings and tailplane of the aircraft were de-iced at 0503 hrs. The crew arrived at the aircraft about an hour later and the commander carried out a walk-round inspection. He used a torch for the inspection and did not observe anything unusual. The aircraft was also being refuelled at this time from a fuel truck located by the right wing. Local time of sunrise was 0753 hrs. The headset man of the pushback crew also carried out an external walk-round inspection, as required by his company's procedures, before commencing the pushback. Areas of particular concern for such inspections are wheels and chocks, doors and panels secured, aircraft damage, leaks and ground area free from debris. Nothing unusual was observed and the aircraft was pushed back and engines started.

After taxiing to holding point Alpha 3 for Runway 26L, the crew commenced a Flap 1, reduced power take off and rotated at a speed of 158 kt. The first officer was the pilot handling and he engaged the autopilot at about 500 feet agl. All indications to the flight crew were normal during the take off and the first sign of any problem occurred at 1,500 feet agl, when a caution appeared on the flight deck indicating a possible problem with the left forward overwing emergency exit.

During the take off, several passengers seated close to the leading edge of the left wing saw a panel fly off the aircraft and heard a bang. They used their call bells to draw the attention of the cabin crew to the fact that a section of the engine cowling was missing. At the rear of the cabin both cabin crew members heard a banging noise at rotation, apparently coming from underneath the aircraft. When released from their seating positions, one of these two went forward to pass the information to the senior cabin crew member.

The senior cabin crew member went into the flight deck and advised the commander that a passenger had seen a panel come off the aircraft. The commander then asked the first officer to go back and check what could be seen. The wing inspection lamp was switched on and the first officer was able to see that a significant portion of the cowling on the left engine was missing. He returned to the flight deck and a few minutes later the commander went back to inspect the damage. By now the crew had levelled the aircraft at FL 90 and entered a holding pattern close to the south coast, thus giving themselves time to consider the problem.

The commander radioed back to Gatwick to ask whether any debris from the aircraft had been found. After a period of a few minutes he was given the information that debris had been found and

that it appeared to be parts from an engine cowling. The aircraft was at this time 4,000 kg above its maximum normal landing weight and the commander considered that the best course of action was to remain in the hold for an hour to burn fuel and thus reduce the weight. It was initially his intention to return to Gatwick but, during the time in the hold several other options, including diversions to other airports, were considered. The crew used the time in the holding pattern to check that there were no handling difficulties with the aircraft or degradation of any systems. At 0809 hrs, low visibility procedures came into force at Gatwick due to a reducing Runway Visual Range (RVR). The commander decided to divert the flight to London Stansted Airport. The aircraft landed at Stansted at 0836 hrs without further incident.

2 Runway operations

There were five aircraft movements on the runway before the presence of debris was suspected; two of these aircraft sustained minor damage. One further aircraft received information from ATC, when below 1,000 feet on final approach, that there could be 'an engine panel' on the runway. The commander elected to continue and land. The runway was closed at 0706 hrs for inspection and a large number of pieces of engine cowling were found on and around the runway. The runway was re-opened at 0730 hrs.

3 Component description

The fan cowling of each engine includes two semi-circular fan cowl doors, fitted between the engine intake cowl and an aft fixed cowl (Figure 1). Each door is approximately 4.7 feet wide and 10 feet high, measured circumferentially (1.4 x 3.1 metres). They are of bonded sandwich construction, with carbon fibre composite skins and an aluminium honeycomb core. The left door weighs 93 lb (42 kg) and the right door 103 lb (47 kg). The doors are mounted on four hinges attached to the forward part of the engine pylon. They can be propped open by two stays carried on the interior of each door. The doors are secured closed by four latches attached to the lower edge of the right door, each of which contains a hook that engages in an adjustable eyebolt fitted in the lower edge of the left door (Figure 2). The hook is operated by an overcentre linkage in the latch, driven by a pivoted stainless steel handle, which is locked with a spring-loaded catch. Maintenance Manual procedures (Section 71-13-00-501) require eyebolt adjustment to produce a latch handle closure load of 45 to 55 lbf (20-24 daN).

Each latch assembly is mounted on a pivot pin attached to the right door. When engaged, the latch assembly fits flush with the outside of the doors. When not engaged, rotation of the latch assembly is limited by an anti-swivel plate, also carried on the pivot pin and itself able to rotate approximately 20°.

The doors have approximately 27 inch (69 cm) ground separation and it is usual to lie on the ground beneath them to operate the latches. Hinging the doors open to position the stays and lowering them closed after disconnecting the stays has to be done while standing. After opening the latches and disengaging the hooks from the eyebolts, the normal practice is to re-close the latches to prevent the hooks from protruding and misaligning with the eyebolts when the door is subsequently closed. This re-closure is not specified in the Aircraft Maintenance Manual Section dealing with fan cowl door operation (Section 71-13-00-201), but the accompanying illustration shows the latch disengaged and closed. Securing the doors closed is done by lowering them both with the latches closed and then opening each latch in turn, manually engaging its hook with the respective eyebolt and closing the latch handle until the catch engages. No flight deck indication system to warn of unlatched fan cowl doors is provided.

The fan cowl doors, including the latch arrangements, are the same for all the types of V2500 powered Airbus aircraft (A319, A320, A321, A330) and generally similar for the CFM56 powered versions of these types.

4 Aircraft background

Maintenance records showed that the aircraft was constructed in 1991 and at the time of the accident had accumulated 30,888 flying hours/10,253 flight cycles since new. The required maintenance certificates were valid at the time of the accident. The right-hand fan cowl door of the No 1 Powerplant had been replaced on 6 November 1999; the adjustment of the latch eyebolts had been checked at this time.

5 Maintenance

G-VCED's operator contracted the line maintenance of its aircraft at Gatwick to a third party maintenance company and one of their LAEs conducted the Weekly Check during the night prior to the accident. He performed the Check on Stand 13 between approximately 2000 to 2300 hrs, working alone, which was not highly unusual. The night was fine but cold; the stand was lit from overhead by lamp standards. The work included powerplant checks, which required the fan cowl doors of both engines to be opened.

The LAE encountered no abnormal difficulties during the Check and was not working to a tight schedule. He reported that there were no unusual distractions, apart from a visit from a construction worker from the adjacent stand, who wished to view the aircraft and conversed with the LAE for a period. The LAE subsequently reported that he believed that this had occurred after he had fastened the No 1 Engine fan cowl doors, but could not be sure exactly at what point in his activities it had taken place. He believed that he had latched the doors, remembering lying beneath the engine for this purpose, but could not positively recall doing so.

The LAE co-operated fully with the investigation and gave the impression of being well motivated and professional, with a commitment to quality. He had been employed by the company and its predecessors for approximately 23 years and had been approved for A320 line maintenance since 17 June 1997. His duty was organised in a swing-shift pattern consisting of working for two 12 hourdays followed by two 12 hour nights followed by four days off. When he conducted the Check he was working the second night shift of the pattern. He had not slept well during the previous day but was not aware of anything unusual in his approach to his work on the night of the Check. It was noted that, a sharp reduction in the maintenance company's business at Gatwick had required it to give notice, during the LAE's shift the previous night, that somewhat over 50% of its staff there would be declared redundant approximately two weeks later. At the time of the accident, volunteers had been invited to put themselves forward for 'voluntary redundancy' and the staff members were unaware of which of them would be moving on. The LAE, in company with many of his colleagues, had found the situation quite disturbing, but did not believe that this had affected his approach to his work.

The LAE was unaware of the maintainer's Quality Advisory Notice (QAN) or associated Technical Instruction (TI) (see below) which called attention to cases of fan cowl door detachment and required the doors to be latched any time that they were closed. In accordance with the maintenance company's systems, the QAN would have been displayed on notice boards in the hangar and the line office at Gatwick. However, a system whereby new or amended TIs were circulated to Line Engineers and signed by them individually had been discontinued approximately 2 years

previously, when the Base Engineer post had been abolished and the functions had been split between the Base Manager and the Shift Supervisors. The TI would have been brought to the LAE's attention during continuation training that was provided at 2 yearly intervals, but both the QAN and TI had been issued after his last training session. The maintainer took action shortly after the accident, aimed at improving the dissemination of technical data.

6 Component examination

Examination of the aircraft showed that most of both fan cowl doors from No 1 Powerplant had torn off near the hinges. Most parts of the doors were recovered from an area of Gatwick's RW 26L and its margins, approximately 1200 to 1900 metres from the start of the runway. A 9 x 38 inch (22 x 97 cm) piece of the left door external skin from the hinge area, weighing 1.8 lb (0.82 kg), was handed in from a country estate 6 nm west of Gatwick.

An access panel from the left door was returned from Dubai, United Arab Emirates, after having apparently been thrown up into the right main landing gear bay of an Airbus A330-200, that had run over the debris while landing on Runway 26L 4 minutes after G-VCED had taken off. The aluminium alloy panel measured 9 x 11 inch (22 x 28 cm) with its hinge and weighed 1.5 lb (0.7 kg). Two special inspections of the A330 were made during its stay at Gatwick, because of the possibility of debris damage, in addition to standard post-flight and pre-flight inspections. The evidence indicated that the panel, possibly together with other door debris, had been thrown into the gear bay where it was not apparent and had subsequently dislodged and interfered with operation of the landing gear. The debris at some stage had caused damage to components associated with the A330's right main landing gear and to a right flap that had rendered the aircraft unserviceable in Dubai.

All eight hinges for G-VCED's fan cowl doors remained intact and attached to the pylon. Damage and distortion to the hinges and considerable deformation of the forward part of the pylon, indicated that both doors had imposed appreciable aerodynamic loads on the hinges, causing them to overtravel before the doors broke away. All the latches and eyebolts were recovered intact and attached to parts of the doors. The eyebolts remained undamaged; all four were positioned towards the mid-point of their adjustment range. The latches had suffered moderate impact damage but remained functional with no signs of pre-accident failure. Nos 1 and 3 latches were found fastened and Nos 2 and 4 unfastened (numbered from the front). The exterior of the stainless steel operating handle and lock catch of all the latches had been coated with the same dark blue paint as the doors, with approximately 50% of the surfaces remaining covered. The evidence indicated that the latches had been oversprayed when the doors had been painted and that some of the paint had subsequently flaked off.

Virtually all of G-VCED's fan cowl doors were recovered. All of the left door and the upper part of the right door had suffered a severe degree of break-up. Markings on the aircraft indicated that the left door had travelled inboard and forcibly struck the left inboard (No 1) leading edge slat. Parts of the door had then passed over the left wing and impacted the left side of the fuselage and the fin. The right door travelled outboard, struck the left No 2 leading edge slat and passed under the wing, striking a flap track fairing and the left outboard flap. Aircraft damage consisted of:

- Lagging on No 1 Powerplant hydraulic pressure pipe cut.
- Left wing, No 1 and No 2 leading edge slats and No 1 Engine pylon locally dented and scraped.

- No 1 Engine pylon forward end severely distorted, necessitating a pylon change.
- Forward part of inboard track fairing of left outboard flap broken off.
- Left outboard flap leading edge holed.
- Fuselage left side, including forward overwing emergency exit, gouged and scraped.
- Left wing/fuselage upper fairing sliced, evacuation light detached and hanging on power lead.
- Fin leading edge scraped and a small hole in each side of the fin.

Examination of the undamaged fan cowl doors on the No 2 Powerplant showed that, when the doors are lowered, they close fully under gravity and align flush with the intake cowl and the aft fixed cowl without being latched, giving the appearance of being fully closed.

For both the No 1 and No 2 Powerplant doors, the latch assemblies were found to pivot freely, within the scope of the anti-swivel plate, when not engaged with the eyebolts and in this condition tended to hang down somewhat below the door profile under the influence of gravity. It was also found that in all cases the anti-swivel plate tended to bind on the pivot pin mounting and consequently to not rotate freely, and that the moment applied by the latch weight was insufficient to rotate the plate. The angle at which the closed but disengaged latches hung relative to the horizontal bottom profile of the doors therefore varied according to the position of the anti-swivel plate, between approximately 10 to 30°(Figure 2).

With the No 2 Powerplant doors unlatched and the latches closed and hanging at any angle in the 10 to 30° range, the latches were found to be hidden by the curvature of the cowl from a normal standing eye height until the observer was a considerable distance from the powerplant. From greater distances or lower eye heights the latches were generally quite inconspicuous in normal hangar lighting, particularly at the lower hanging angle, except when observed from close range. Close inspection required kneeling or lying down. These latches were unpainted and the external surfaces of the handle and catch therefore had a silvery appearance and would probably be somewhat more conspicuous than the No 1 Powerplant door latches. Overall, no cues were readily available to conspicuously indicate that the doors were unlatched.

7 Fan cowl door history

Information from the aircraft manufacturer on similar previous cases was requested on a number of occasions but was not received. Available information indicated that there had been at least 7 previous cases of fan cowl door loss from A319, A320 or A321 aircraft that had been attributed to inadvertent failure to latch the doors. These had occurred over the period 1992 to 1999, chiefly involving V2500 powered aircraft. It also appeared that there had been a number of other cases of fan cowl door losses from other Airbus types. No cases were reported of hinge or door primary failure, or of fastened latches having coming open.

The aircraft manufacturer, the V2500 powerplant manufacturer and the cowl manufacturer had provided information on the problem to operators. The V2500 powerplant manufacturer had provided information to operators in newsletters and at Operators' conferences, and had issued a

number of relevant Service Bulletins (SB). G-VCED's maintainer had issued instructions to their staff. The relevant aspects of the more recent measures are summarised as follows:

1. Powerplant Manufacture's All Operator Wire (AOW) 1047, issued 26 March 1999:

Provided information that 5 cases of fan cowl door loss on take-off from V2500 powerplants had occurred, on the first flight after maintenance, and summarised the appreciable damage in one case. Operators were strongly recommended that 'airline work practices should instruct latches to be made every time a fan cowl door is closed, regardless of whether the doors are to be opened again during that maintenance check.'

2. Maintainer's Quality Advisory Notice 99/021, issued 20 April 1999, superseded by Technical Instruction 312/71/117, issued 7 May 1999.

Summarised the information and recommendation from the above AOW and required: 'FAN COWL DOORS ARE TO BE EITHER OPEN OR CLOSED AND LATCHED.'

3. Powerplant Manufacture's SB V2500-NAC-71-0235, issued 13 May 1999:

Modification to apply a decal or stencil to each fan cowl door 'MAKE SURE THE FAN COWL DOORS ARE FULLY LATCHED WHEN CLOSED.'

4. Powerplant Manufacture's SB V2500-NAC-71-0227, issued 19 May 1999:

Modification to paint the fan cowl door latches with red/orange fluorescent paint.

5. Powerplant Manufacture's SB V2500-NAC-71-0256, issued 23 June 1999:

Modification of the fan cowl door latches by the addition of latch weights and changes to the anti-swivel plate to make the latches hang down when not engaged.

6. Powerplant Manufacturer's SB V2500-NAC-71-0259, issued 10 December 1999:

Modification to install a Hold-Open device to the fan cowl door guide mechanism with the aim of providing an obvious gap between the doors and the intake cowl after the doors have been lowered from the open position. The device consisted of a spring-loaded plunger that would block full closure of the doors until manually pushed clear. The SB was in response to an operator request for enhanced visibility of unlatched doors. The SB listed the cost as US\$3,911 and the labour requirement as 0.75 man-hours per powerplant.

7. Maintainer's Quality Advisory Notice 00/007, issued 21 January 2000, and Alert Technical Instruction 312/71/117, issued 21-1-00, after G-VCED's accident:

Specified a duplicate inspection of fan cowl door latching after any action that required the doors to be opened.

8. Aircraft Manufacturer's Operator Information Telex (OIT) AI/SE 999.0025/00/SB, dated 4 February 2000, after G-VCED's accident:

Indicated that Standard Operating Procedures in the Flight Crew Operating Manual (Chapter 3.03.05) would be changed to require a flight crew member to visually inspect the fan cowl doors prior to each flight to ensure that they are closed and latched.

The four SBs provided the background information that 'Several instances have been reported of Fan Cowl Doors not being fully latched prior to flight. This may result in actual Door loss in flight. There have been several reports from Operators of actual Fan Cowl Door loss due to doors not being fully latched.'

Compliance with the first three SBs was recommended as Category 4, 'Accomplish at the first visit of the Nacelle or Nacelle Component to a maintenance base capable of compliance with the Accomplishment Instructions regardless of the planned maintenance action for the Nacelle or Nacelle Component.' The measures aimed at increasing latch visibility (Items 4 & 5) have now been incorporated on production doors. The aircraft manufacturer reported that no cases of fan cowl door loss from aircraft with these SBs implemented had been reported.

For the last SB, the Hold-Open device, compliance was recommended as Category 8, 'Accomplish based upon experience with the prior configuration.' The powerplant manufacturer considered this categorisation to be necessitated by concern that incorporation of the modification on some aircraft and not others, could cause problems, in that an incorrect assumption that the device was fitted to a particular aircraft could lead to misinterpreting fully closed doors as signifying that they were latched.

Few details were available on the consequences of the door loss in the above previous cases. The AOW reported in one case that the engine had no longer responded to throttle movement, remaining at take-off power, and had been shutdown; some damage had occurred to the powerplant wiring harnesses and ducting; the pylon, leading edge slats and wing had been heavily damaged. In another case there had been considerable powerplant damage, including puncturing of the oil tank. Airworthiness authorities had not required any of the above measures to be implemented.

Shortly after G-VCED's accident, a similar accident occurred to an A300-200 aircraft at Vancouver International Airport in Canada, on 17 March 2000. The No 1 Powerplant outboard cowl door detached close to the point of take-off rotation and contacted the wing, fuselage and horizontal stabiliser. The inboard door remained jammed in place. The flight followed maintenance that had required the fan cowl doors to be opened. No flight deck indication of the detachment or damage was given and the aircraft was climbed to above 20,000 feet altitude before passenger and cabin crew reports prompted the flight crew to abort the flight.

8 Discussion

8.1 Door failure

Examination of G-VCED showed that the fan cowl door hinges had not failed and the evidence suggested that a lack of restraint to the lower end of the doors had allowed aerodynamic loads, at around the point of take-off rotation, to forcibly hinge the doors open. The hinges had then over-travelled, causing pylon damage, and most of both doors had torn away and struck various parts of the aircraft.

Correct latch engagement tensions, as indicated by handle operating loads, were impossible to confirm after the accident but had been checked less than 2 months previously; no extreme adjustment of the eyebolts was evident after the accident. Although Nos 2 and 4 latches were found open, both showed signs of having forcibly struck the aircraft and/or the runway and it appeared likely that the associated inertial forces could have caused them to open. There were no signs of latch or eyebolt failure and examination did not suggest any plausible mechanisms by which correctly engaged latches could either, disengage from the eyebolts while remaining closed, or open of their own accord, or by which latches could be mis-engaged. No previous reports of such events, or of fastened doors having failed, were found.

It was therefore concluded to be highly probable that the doors had inadvertently not been latched following the pre-flight maintenance. It would be quite understandable that such an omission could result, should any distraction intervene between the closing and latching operations. Given the lack of conspicuous cues to the doors being closed but unlatched, it was also readily apparent that the condition would not necessarily be detected during the remainder of the maintenance check or the subsequent three independent walk-round inspections, particularly at night, with lighting from overhead. The previous 7 cases in a 9 year period reinforced these conclusions. In G-VCED's case,

the dark blue paint on the latch handles was likely to have diminished their conspicuity somewhat, although it was judged that this would have made only a marginal difference.

8.2 Maintenance

The Quality Advisory Notice and Technical Instruction that the maintainer had issued in 1999, in response to information on the previous cases circulated by the powerplant manufacturer, may have assisted in preventing the accident, but the Engineer conducting the Check had not been aware of these. A system that should have positively ensured that the instructions were brought to his attention had been discontinued some time previously, when the maintainer's operations had been re-organised.

8.3 Door modifications and procedures

The aircraft modification issued by the powerplant manufacturer to apply instructions to the fan cowl doors to, 'ensure they were latched when closed' was considered unlikely to be highly effective. The measures that aimed at increasing the conspicuity of unfastened latches by painting them fluorescent red/orange or modifying them to hang down further may have been of some benefit, but were judged unlikely to significantly reduce the probability of recurrence. The aircraft manufacturer disagreed with this, noting that no cases of fan cowl door loss from aircraft with these modifications implemented had occurred, but this was not considered of great significance as the associated SBs had only been issued in mid-1999 and the service experience with the modifications was very limited.

It did appear that the modification to prevent the doors from initially closing fully when lowered could provide a powerful cue to an unlatched condition and would reduce the likelihood of recurrence of this accident. The device would not prevent the doors from being fully lowered, after moving the door blocker aside, and still left unlatched. However, this would seem to be considerably less likely, as the removal of the blocker would necessitate lying beneath the doors and would, therefore, tend to be an intrinsic part of the latching operation. It is considered that a detailed assessment would be necessary to determine whether the modification would be sufficiently effective. It was categorised as a customer option. Misunderstanding of the status of the doors that could result from incorporation of the modification on some aircraft and not others, could be prevented by requiring the modification for all relevant aircraft. Two major operators are understood to be incorporating the modification on their fleets.

While the aircraft damage in this case did not suggest an immediately obvious catastrophic hazard to the aircraft from this failure, the possibility cannot be dismissed. An example was provided by an accident to a different aircraft type, where numerous cases of cabin door detachment in flight occurred without the potential hazard being sufficiently recognised for effective action to be taken. This only resulted after the final case, where a fatal loss of control and in-flight break-up resulted when a detached door initially lodged on the tailplane and grossly disturbed its airflow (HS748 G-ASPL at Nailstone, UK, on 26 June 1981, AAIB Report 5/83). In addition, some of the other cases of fan cowl door loss apparently concerned A319, A321 and A330 aircraft and available information indicated that the fan cowl doors and their latching arrangements for these types were the same as for the A320. It is therefore recommended that the DGAC mandate aircraft modification aimed at appreciably reducing the likelihood of A320 fan cowl doors inadvertently remaining unlatched after maintenance. It is considered that, while measures to exhort maintenance personnel to ensure the doors are latched and to improve the conspicuity of unfastened latches may

assist, they are unlikely to be fully effective and modification aimed at providing obvious indication of unlatched doors is required (Recommendation No 2000-26).

Interim safeguards during the appreciable time that would likely be taken to implement the above measures could be provided by a procedure, requiring the unlatching and latching of fan cowl doors to be recorded and confirmed by duplicate inspection. Some comments on the investigation findings have claimed that this is impractical and unnecessary. However, such a practice is endorsed by the powerplant manufacturer, and was introduced both by G-VCED's maintainer immediately after the accident, and by the operator of the A330 that lost a fan cowl door at Vancouver (Paragraph 7). It is therefore also recommended that, until measures to satisfy the intent of Recommendation No 2000-26 are incorporated, the DGAC and Airbus Industrie recommend A319, A320, A321 and/or A330 aircraft maintenance organisations to record the unlatching and latching of fan cowl doors and to specify a duplicate inspection to confirm latching (Recommendation No 2000-27).

From the information available it was unclear whether similar problems could occur with other aircraft types. It is therefore recommended that the CAA, FAA and DGAC consider whether similar measures to Recommendations Nos 2000-26 and 2000-27 are necessary for other aircraft types (Recommendation No 2000-28).

8.4 Flight deck indication

G-VCED's commander commented that if he had received any indication of a lost engine cowl earlier he would not have changed the configuration of the aircraft before making a fuller assessment. This would have reduced the potential for causing further damage, in particular to flaps and slats. The lack of a flight deck system to warn of unlatched fan cowl doors did not appear reasonable, given that such systems were provided for many other access panels on this aircraft type and others in its class. These other panels were commonly much smaller and lighter than the fan cowl doors and likely to pose an appreciably lower hazard should they remain unfastened. It is therefore recommended that the DGAC and Airbus Industrie consider the incorporation of a system to provide flight deck warning of unlatched fan cowl doors on the A319, A320, A321 and A330 aircraft types (Recommendation No 2000-29). It is also recommended that the JAA and the FAA consider a requirement for future aircraft certification for a system to provide flight deck warning of all unlatched access panels or doors that could hazard the aircraft if left unfastened (Recommendation No 2000-30).

8.3 Previous cases

It appeared that the appreciable number of previous cases should have been sufficient to have prompted the introduction of effective measures to prevent recurrence, prior to G-VCED's accident and the subsequent A330 accident in Canada. The powerplant manufacturer had developed a number of measures, but those that had been categorised as recommended were considered unlikely to be sufficiently effective. The measure likely to be most effective, the installation of a Hold-Open device (SB 0259), was categorised as a customer option. Some information on the background that could justify incorporating the SB was presented to operators, but only in brief summary form. It would appear that the detailed information on fleet-wide experience available to the aircraft and/or powerplant manufacturer would place them in a considerably better position to judge, in conjunction with the airworthiness authorities, the necessity for a modification relevant to airworthiness and to advise operators accordingly. It is therefore recommended that Airbus Industrie assess the adequacy of their process for determining the possible adverse flight safety

implications of reported incidents and accidents to their aircraft and for advising operators of effective measures to prevent recurrence (Recommendation No 2000-31).

9 Safety recommendations

Recommendation No 2000-26

It is recommended that the DGAC mandate aircraft modification aimed at appreciably reducing the likelihood of A320 fan cowl doors inadvertently remaining unlatched after maintenance. It is considered that, while measures to exhort maintenance personnel to ensure the doors are latched and to improve the conspicuity of unfastened latches may assist, they are unlikely to be fully effective and modification aimed at providing obvious indication of unlatched doors is required.

Recommendation No 2000-27

It is recommended that, until measures to satisfy the intent of Recommendation No 2000-26 are incorporated, the DGAC and Airbus Industrie recommend A319, A320, A321 and/or A330 aircraft maintenance organisations to record the unlatching and latching of fan cowl doors and to specify a duplicate inspection to confirm latching.

Recommendation No 2000-28

It is recommended that the CAA, FAA and DGAC consider whether similar measures to Recommendations Nos 2000-26 and 2000-27 are necessary for other aircraft types.

Recommendation No 2000-29

It is recommended that the DGAC and Airbus Industrie consider the incorporation of a system to provide flight deck warning of unlatched fan cowl doors on the A319, A320, A321 and A330 aircraft types.

Recommendation No 2000-30

It is recommended that the JAA and the FAA consider a requirement for future aircraft certification for a system to provide flight deck warning of all unlatched access panels or doors that could hazard the aircraft if left unfastened.

Recommendation No 2000-31

It is recommended that Airbus Industrie assess the adequacy of their process for determining the possible adverse flight safety implications of reported incidents and accidents to their aircraft and for advising operators of effective measures to prevent recurrence.