Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A00O0199

FAN COWL SEPARATION

SKYSERVICE AIRLINES INCORPORATED

AIRBUS A320-232 C-GTDC

TORONTO/LESTER B. PEARSON INTERNATIONAL AIRPORT

13 SEPTEMBER 2000

Canada

Aviation Investigation Report

Fan Cowl Separation

Skyservice Airlines Incorporated
Airbus A320-232 C-GTDC
Toronto/Lester B. Pearson International Airport
13 September 2000

Report Number A00O0199

Summary

Skyservice Airlines flight SSV960, an Airbus A320 aircraft, serial number 496, was departing from runway 23 at Toronto/Lester B. Pearson International Airport, on a domestic charter flight to Edmonton, Alberta. At 1613 eastern daylight time, the take-off run was started and considered normal until the aircraft rotated. At this point, there was a loud bang and simultaneous shudder of the aircraft. The master caution chimed; however, no electronic centralized aircraft monitoring messages were displayed. At 1500 feet above ground level, the electronic centralized aircraft monitoring began to display numerous faults related to the left engine (International Aero Engine V2500). The flight crew declared an emergency and made an immediate return to Toronto for an overweight landing on the runway from which they had just departed. During the landing roll, the captain navigated the aircraft around several pieces of debris on the runway, which were later identified as the fan cowlings of the left engine. After an inspection by emergency response services crew, the aircraft returned to the gate where the passengers deplaned normally. No one was injured.

Ce rapport est également disponible en français.

Other Factual Information

History of the Flight

On the evening of 12 September 2000, Skyservice maintenance crew 3 arrived at the Skyservice maintenance facility, located approximately 10 minutes' travel time off the airport property, for the night shift, 1900 to 0700 eastern daylight time.[1] The crew consisted of an acting crew chief (CC1),[2] three aircraft maintenance engineers (AME1, AME2, AME3), and a contract aircraft maintenance engineer. All held valid qualifications.

The work package for the night was given to the crew by the maintenance and operations control (MOC) coordinator. The package included the arrival and turnaround of a Skyservice A330 aircraft, and some minor inspection and parts replacement work on the A320, C-GTDC. The work on C-GTDC included the changing of the right-hand nose wheel assembly, the replacement of a loaner automatic direction finder (ADF) antenna on the top of the aircraft, and the replacement of an oil-scavenge line on the left engine.

C-GTDC was parked at Pearson Airport's central de-ice facility (CDF) and was not scheduled to fly until the following day at 1600. Due to limited space at the airport, it is common for air carriers to use this area for parking and general servicing of aircraft, when it is not in use for de-icing operations.

Crew 3 arrived at the CDF and opened the fan cowlings of the left engine to assess the work involved in changing the oil-scavenge line. Realizing the complexity of the job, and to avoid the risk of contaminating the CDF ramp with oil, CC1 contacted MOC and requested the aircraft be moved into the Skyservice fixed-base operator (FBO) hangar. MOC informed CC1 there was no hangar space available; however, they could move the aircraft to the ramp area in front of the FBO hangar. Before towing the aircraft, the right-hand nose wheel assembly was replaced, and the fan cowlings were closed.

AME1 started the oil-scavenge line change at the FBO ramp, while the rest of the crew completed the turn around of the A330. At 2400 some additional tooling and supplies were required from the maintenance facilities. Because the facilities are approximately 10 minutes' travel time from the airport property, the crew decided to break for lunch. After lunch, crew 3 returned to the FBO ramp where CC1, AME1 and AME2 continued the oil-scavenge line replacement, which was completed at 0430. To ensure the task was complete, AME1 inspected the area around the oil-scavenge line and noticed that several clamps were missing.

The maintenance vehicle, which carries a limited supply of commonly used items, was checked for parts, and none were found. This problem was discussed with MOC, and a decision was made to raise a separate work card and let the day shift complete the clamping. From 0500 to 0530 the left engine was ground run with the fan cowlings open, to check for

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[1] All times are eastern daylight time (Coordinated Universal Time minus four hours) unless otherwise noted.

[2] See Glossary at Appendix D for all abbreviations and acronyms.

leaks, after which it was serviced with oil. An oil rag was then placed under the drain mast to catch any residual oil drips. AME1 and AME2 began to close and secure the fan cowlings, but were told by CC1 to leave the latches unsecured. Since the end of the shift was approaching, crew 3 cleaned the area and returned to the maintenance facilities.

At 0600 the MOC coordinator shift change took place. The night-shift MOC coordinator verbally briefed the day-shift MOC coordinator and pointed out the entries in the MOC handover book. The operator provides a "handover" book, which is to be filled out during the shift. The handover book details the work accomplished and any outstanding work yet to be accomplished; this is to facilitate the continuity of maintenance between shifts. A verbal handover between crew, while not required by policy, helps to clarify any outstanding work and is the preferred method used by the changing crew. The entries showed the oil-scavenge line was replaced, the ground run and leak check were completed, and the aircraft was ready to go.

At the maintenance facilities, CC1 signed the work card and journey log book for the oil-scavenge line replacement as complete. However, a new work card was not raised for the missing clamps, and the required entries in the maintenance handover book were not done. Simultaneously, a verbal handover was conducted by AME1 to the incoming crew-4 crew chief (CC2), in the MOC office. The verbal handover detailed the oil-scavenge line replacement, the need for the clamps to be installed, and the presence of the rag under the engine. The unlatched fan cowlings were not mentioned. During the briefing, the day-shift MOC coordinator interrupted and mentioned that the missing clamps had been identified during a previous inspection and were back-ordered through stores. After completing this task, AME1 went home. Before going home, CC1 confirmed with CC2 that the briefing given by AME1 was understood.

The morning shift (0700 to 1900) includes between one and three aircraft maintenance engineers, depending on the day, month, and flight schedule. On the morning of September 13, CC2 was the only member of crew 4 required to be in for 0700. One of the aircraft maintenance engineers (AME4) reported to work at 0900. CC2, aware of the missing clamps and knowing they were back-ordered, decided to concentrate on locating equipment to safely gain access to the top of the fuselage to replace the ADF antenna. After locating the appropriate equipment, CC2 and AME4 attempted the ADF antenna change, but were unsuccessful due to a damaged screw on the new antenna.

C-GTDC was scheduled to be towed to the gate at 1200 for a 1600 departure. In preparation for the tow, both CC2 and AME4 did a walkaround check. A walkaround check is carried out before any planned movement of an aircraft. It consists of a visual and physical inspection of the aircraft, looking for any obvious damage, open panels, open doors, and obstacles that could affect the safe operation or movement of the aircraft. During the walkaround check, CC2 picked up the rag under the left-engine drain mast and a piece of cardboard in the exhaust of the right engine.

While towing the aircraft to the gate, about 100 feet before reaching the gate, the towbar sheared off, and the aircraft had to be taxied to the gate using the right engine. After arriving at the gate, CC2 checked the nose landing gear for damage and, finding no faults, went for lunch. After lunch, CC2 and AME4 returned to the aircraft, and each conducted a separate

walkaround check, with no findings. AME4 signed the maintenance daily inspection, which includes line item 24. b): “Perform a general visual inspection of power plant, nacelles and pylons from ground,” and placed the logbooks in the flight deck.

At 1500 the flight crew arrived at the aircraft, was verbally briefed by AME4, and began the preflight checks. The captain checked the journey logbook and noted that there were no outstanding minimum equipment list or deferred maintenance items, and that the maintenance daily inspection had been completed. According to standard operating procedures, the pilot not flying, who was the first officer, carried out the pre-departure walkaround check and found no discrepancies.

CC2 and AME4 observed the starting of both engines and the pushback from the gate. During the pushback, the aircraft was turned to the right, and no abnormalities were observed by either CC2 or AME4. The aircraft taxied to runway 23 and began a normal take-off run. At rotation, a loud bang was heard and a simultaneous shudder was felt. An electronic centralized aircraft monitoring (ECAM) aural warning sounded, but information on the ECAM display remained suppressed until 1500 feet above ground level (agl). The ECAM, through a series of sensors and computers, monitors the condition of the engine and aircraft systems. The information is displayed to the flight crew via a multifunction display in the flight deck. The ECAM also commands the actions required by the flight crew if a system fails. Airbus suppresses a variety of non-critical ECAM messages above 80 knots and below 1500 feet agl; this enables the flight crew to concentrate on flying the aircraft during the critical stages of take-off and landing.

Once through 1500 feet agl, numerous ECAM messages began to display. The messages were as follows:

Time	System	Fault
1613	ENGINE 1	EIU FAULT
1613	ENGINE 1	FADEC A FAULT
1613	AUTO FLIGHT	AUTO THROTTLE OFF
1613	ENGINE 1	REVERSER FAULT
1613	ELECTRICAL	GENERATOR 1 FAULT
1613	ENGINE 1	EIU
1613	ENGINE 1	REVERSER UNLOCKED
1615	ENGINE 1	BEARING 4 OIL SYSTEM
1625	ENGINE 1	REVERSER UNLOCKED
1625	ENGINE 1	EIU FAULT (2)
1625	ENGINE 1	FUEL VALVE FAULT
1625	ENGINE 1	REVERSER FAULT

The captain flew the aircraft with the autopilot and flight directors off, and the left engine at the ECAM-commanded power setting of idle. The first officer transmitted an emergency message to air traffic control (ATC), requested radar vectors back to runway 23, and completed all the ECAM actions and applicable check lists, including the overweight landing checklist. The captain made a brief announcement to the passengers and informed them the aircraft would be returning to Toronto. The first officer called Skyservice flight operations and informed them of the emergency and requested a gate assignment. One of the passengers informed a flight attendant of the fan cowl loss, which was relayed to the flight deck.

The aircraft landed above the certified maximum landing weight of 64 500 kg. During the landing roll, the captain manoeuvred the aircraft around several pieces of debris, which were later identified as the fan cowlings of the left engine. At the end of the landing roll, the left engine was shut down. ATC suggested that the aircraft exit at the end of runway 23 and wait at the holding bay for runway 05 to allow emergency crew the opportunity to inspect the aircraft for potential unseen hazards. After the emergency crew assessed the aircraft and found no hazards, the aircraft was released, and ATC cleared the aircraft to taxi to the gate. During the taxi to the gate, emergency crew following the aircraft noted a small amount of smoke emitting from the left engine and suggested the right engine also be shut down. The flight crew complied with the suggestion, and the aircraft was towed the remainder of the way to the gate.

Damage to Aircraft

The aircraft was substantially damaged because of the left-engine fan cowlings separating during take-off. The outboard fan cowling sheared off just below the attachment points and received minor impact damage to the rear bottom edge. There was no damage to any of the four adjustable eyebolts. The inboard fan cowling sheared off just below the attachment points and broke into several large pieces. The two forward cowling latches received minor impact damage, but were still operable. The two aft latches were undamaged. The engine pylon suffered damage, at the fan cowl attachment points, in the form of buckling of the cantilever structure and pre-cooler area of the pylon. The electronic engine control wiring harness on the left engine was found to have electrical connector pins pulled out of the cannon plug connector. Also, the mechanism, which locks the cannon plug onto the electronic engine control, was damaged. Left-wing leading-edge slats 1, 2, and 3, including slat track 7 (the inboard track of slat 3), were damaged by impact from the fan cowlings.

Personnel Information

	Captain	First Officer
Age	41	43
Pilot licence	Airline Transport	Airline Transport
Medical expiry date	February 2001	March 2001
Total flying hours	9137	7000
Hours on type	2637	2000
Hours last 90 days	204	95
Hours on type last 90 days	204	16
Hours on duty prior to occurrence	2	2
Hours off duty prior to occurrence	86	528

The flight crew was certified and qualified for the flight in accordance with existing regulations. All maintenance personnel were certified and qualified in accordance with existing regulations. There was no evidence that incapacitation or physiological factors affected the crew's performance.

Aircraft Information

Manufacturer	Airbus
Type and model	A320-232
Year of manufacture	1994
Serial number	496
Certificate of Airworthiness	18 January 1995
Total airframe time	21 157
Engine type (number of)	International Aero Engine (IAE) V2527-A5 (2)
Maximum allowable take-off weight	77 000 kg
Maximum allowable landing weight	64 500 kg

Fan Cowls

The fan cowling of each engine includes two semicircular fan cowl doors fitted between the engine intake cowl and an aft-fixed cowl. Each door is approximately 4.7 feet wide and 10 feet high. They are of bonded sandwich construction, with carbon fibre composite skins, and an aluminum honeycomb core. The left door weighs 93 pounds, and the right door 103 pounds. The doors are mounted at the top, 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. The hook is operated by an over-centre linkage in the latch, driven by a pivoted stainless steel handle, which is locked with a spring-loaded catch. Maintenance manual procedures require eyebolt adjustment to produce a latch handle closure load of 45 to 55 pound feet.

Each latch assembly is mounted on a pivot pin attached to the right door. When engaged, the latch assembly fits flush with the bottom 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 degrees.

The doors have approximately 27 inches of ground clearance, and it is usual to lie on the ground beneath them to operate the latches. Swinging the doors open (to position the support stays) and lowering them closed (after disconnecting the support stays) have 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 is not specified in the aircraft maintenance manual section dealing with fan cowl door operation.

To secure the doors closed, they are lowered with the latches closed. Then each latch is opened, in turn, to manually engage its hook with the respective eyebolt. Finally, the latch handle is closed until the catch engages. There is no flight deck indication system to warn of unlatched fan cowl doors. The fan cowl doors, including the latch arrangements, are the same

for all the types of V2500-powered Airbus aircraft (A319, A320, A321) and generally similar for the CFM56-powered versions of these types.

Tests and Research

Worldwide, there have been nine other occurrences of fan cowling separation since the Airbus single-aisle aircraft series, powered by the IAE V2500 series, entered service in 1991. Four of these incidents were in 2000. All of the occurrences happened at rotation, and in every instance the engine cowls had been opened prior to the occurrence flight. To minimize the likelihood of recurrence, Airbus and IAE developed the following four improvements:

Painted latches: incorporated on production aircraft in July 1999, aircraft manufacturer serial number (MSN) 1042 and on. Available for V2500-A1/A5 engines, via service bulletin (SB) V2500-NAC-71-0227 issued in May 1999.

Caution decals: incorporated on production aircraft in May 1999, aircraft MSN 1022 and on. Available for V2500-A1/A5 engines, via SB V2500-NAC-71-0235 issued in March 1999.

Anti-swivel plates: incorporated on production aircraft in October 1999, aircraft MSN 1098 and on. Available for V2500-A1/A5 engines, via SB V2500-NAC-71-0256 issued in May 1999.

Hold-open device: incorporated on production aircraft in December 2000, aircraft MSN 135 and on. Available for V2500-A1/A5 engines, via SB V2500-NAC-71-0259 issued in October 2000.

C-GTDC was fitted with the painted latches and caution decals, but had not been fitted with the modified anti-swivel plates or hold-open device.

Analysis

Introduction

The flight crew was qualified for the flight, the maintenance crew were qualified for the maintenance activities, and the aircraft was determined to have been serviceable for the flight. Consequently, the analysis will focus on human factors, operations procedures, and fan cowl position indication.

Decision Making

Normally, when the maintenance crew is finished with the aircraft, the cowls would be closed and locked, in accordance with maintenance manual reference 71-13-00-201. The decision by CC1 to close the fan cowlings, but leave them unlatched, was an intentional adaptation, his reasoning being that it would make things easier for the next crew and meet the local security requirements, as the cowlings appeared closed. Leaving a job incomplete before a crew change is not unusual, and there are industry standard practices to ensure that it is obvious that the job has not been completed. Besides the handover briefing and leaving the cowlings open, it is also standard practice to attach a warning flag or tag to the affected part, and, often, an additional warning note is placed in the cockpit. The crew did not consider the consequences

of leaving the cowls closed and unlatched, or of not placing the standard warning indicators. There was likely a degree of complacency, exacerbated by the fact that they had worked outside all night.

Ordinarily the relieving crew chief would be briefed by the outgoing crew chief. This time, it was AME1 who briefed CC2. His briefing included the requirement to clamp the oil line, and he specifically included the required action of removing the obvious rag underneath the engine, but he omitted the requirement to latch the cowls. CC2 was aware that the clamps required to secure the oil line were not available and assumed that the engine was secure, based on a signed work card report and the journey logbook entry. When CC1 inquired if CC2 understood the work that had to be done, he did not itemize or reiterate what he was referring to, nor did CC2 when he confirmed that the briefing had been understood. This non-specific communication might have been adequate had the handover book been used, but, based on the verbal transfer of information, it was inadequate.

Five walkaround checks were completed by three qualified personnel before the aircraft departed, but none noticed the unlatched cowlings. This included CC2 picking up the rag underneath the left engine. All of the personnel associated with the aircraft before its departure were aware of the need to check the latches. They were also aware of the placards directing this action; however, none of them could identify the location or number of the placards.

Operation Procedures

Procedures call for the job to be signed off on the work card report after the work has been completed. In this occurrence, the detailed work was complete, except the relatively minor task of clamping the lines to prevent damage from re-occurring. It is not considered good maintenance practice to complete a detailed task and have another engineer, not involved in the job, sign for the work, as this would entail a lengthy check by the engineer who was not involved with the work. Also, it is not considered good maintenance practice to sign off a job on which work is yet to be done by another engineer, even though the work may seem insignificant, as in this instance the installing of clamps. To avoid either situation, the desired method of transferring outstanding work would be to:

a) enter the outstanding work into the journey logbook,
b) create a new work card report for the outstanding work, and
c) enter the details of the outstanding work in the handover book.

In this instance, the work was signed off as complete, although it was not. An entry was made on the work card report: “line replaced, leak check serviceable,” and a similar entry was put in the journey logbook. This led both the CC2 and the captain to believe that the engine was secured. At the time of the accident, there was no procedure requiring the unlatching and latching of fan cowl doors to be recorded and confirmed by a separate inspection.

Fan Cowling Indication

The fan cowling has four latches that connect at the bottom of the engine. The fan cowling doors are heavy and designed such that, when hanging unsupported, they fair flush, giving the appearance of being locked, even if they are not latched. Normally, the latches can be in three possible conditions (see Appendix A):

a) latches fully locked and will appear flush with the cowling;

b) latches closed, but cowling not locked. In this condition, they will protrude about one inch underneath the cowling. This is the normal condition of the latches after maintenance opens the cowling, until the latches are re-locked; and

c) latches fully open and cowling unlocked. This is considered a temporary condition after unlocking the cowls. According to industry standard, the latches are immediately closed because the fully unlocked latch presents a personal injury risk to maintenance engineers. Fully unlocked latches protrude down about four inches from the bottom of the cowling.

Because of the circumference of the engines and their proximity to the ground, a proper visual inspection of the latches requires an individual to get on hands and knees, go underneath the nacelle, and look up at the latches. The latches are out of view to a person standing within about 10 feet of the engine, and difficult to see from a greater distance because they are relatively small and inconspicuous.

The aircraft modification issued by the engine manufacturer to apply instructions to the fan cowl doors: “Caution Make Sure That The Fan Cowl Doors Are Fully Latched When Closed,” was ineffective. The service bulletin requires the placard to be placed low, on both sides of the fan cowling. This increases the visibility of the placard when the fan cowlings are open and supported. However, when the fan cowlings are closed, the low placement of the instructions and the wide circumference of the fan cowlings decrease the visibility of the instructions, reducing the likelihood of drawing attention to the latches (see Appendix B). Additionally, none of the personnel associated with the aircraft before departure could identify either the number or locations of these placards.

The available modification to prevent the doors from initially closing fully when lowered was not installed on the occurrence aircraft. This modification provides a visual cue of an unlatched condition. However, this modification, while being incorporated onto new production aircraft, is only a customer option on older aircraft and is not a requirement. Furthermore, the device would not prevent the doors from being fully lowered and left unlatched, as in this occurrence. The fan cowlings were in the process of being locked; therefore, the blocker would have been activated to allow the fan cowlings to close for latching, rendering the safety feature ineffective. Misunderstanding of the status of the doors, that could result from the incorporation of the modification on some aircraft and not on others, could be prevented by requiring the modification for all relevant aircraft.

While the aircraft damage, in this case, did not suggest an obvious catastrophic hazard to the aircraft from this failure, the possibility cannot be dismissed. In addition, some other cases of

fan cowl door loss involved A319, A321 and A330 aircraft, and available information indicates that the fan cowl doors and their latching arrangements for these types were the same as for the A320. While measures to assist maintenance personnel and flight crew to ensure the doors are latched and to improve the visibility of unfastened latches may assist, they are unlikely to be fully effective. The occurrence aircraft was not equipped with any kind of indicator for unlatched fan cowlings, either on the flight deck or mechanical. Such indicators are provided for many other access panels on this aircraft type and on others in its class.

Findings as to Causes and Contributing Factors

1. The left-engine fan cowlings were closed, but the latches were intentionally not locked. This situation led to the aircraft departing with the fan cowls unlocked, resulting in damage to the aircraft.

2. Standard operating procedures and maintenance practices were not adhered to, leading CC2 and the captain to believe that the engine was secure.

3. The verbal handover during shift transfer was inadequate. Therefore, CC2 was not effectively made aware of the need to complete clamping the oil-scavenge line and secure the left-engine fan cowlings during his next shift.

4. During separate walkaround checks, CC2, AME4, and the first officer did not observe that the fan cowling latches were unlatched.

5. The positioning of the fan cowling caution placard is inadequate, in that it is not easily seen when the fan cowlings are closed and unlatched.

Findings as to Risk

1. The available modification to prevent the doors from initially closing fully when lowered was not installed on the occurrence aircraft. This modification provides a visual cue of an unlatched condition.

2. Indication of fan cowling condition is inadequate, in that the latches are relatively small and difficult to see. The occurrence aircraft was not equipped with any type of flight deck indicator or mechanical indicator of unlatched fan cowlings that could alert the flight crew or the ground crew and prevent damage to the aircraft.

Safety Action

Action Taken

Operator-Initiated Action

After this occurrence the operator incorporated the following changes in their operating procedures:

1. Handover for physical work is conducted on-site, not in the office.

2. The handover book is always used and is carried to the workplace to ensure information is accurate and complete.

3. MOC is given a copy of the maintenance handover book at the end of each shift.

4. The fan cowlings are closed, latched, and locked, or open on the support stays.

5. Cowling closures are required inspection items.

6. Both maintenance and flight operations personnel have been instructed to do tactile inspections of the fan cowling latches.

7. If non-standard practices are adopted, MOC must be informed immediately.

8. The daily check sheets have been modified to facilitate arrival and pre-departure checks.

9. Tagging and flagging of incomplete work or work in progress is now a standard operating procedure.

10. Incorporation of service bulletin V2500-NAC-71-0256 Latch Modifications.

11. Incorporation of service bulletin V2500-NAC-71-0259 Fan Cowl Hold Open Device.

Transport Canada

Following the occurrence, Transport Canada issued Service Difficulty Alert AL-2000-06. The alert was targeted at all operators of large jet transport aircraft in Canada. The findings and recommendations are not based solely on Airbus aircraft powered by the IAE V2500 series of engines. The alert states:

> Ongoing investigation by Transport Canada and the Transportation Safety Board of Canada into the recent loss of engine fan cowlings from Airbus aircraft operated in Canada has brought to light several findings which may affect the safe operation of these and other large jet transport aircraft:

1. The loss of fan cowls in flight poses a significant safety risk to the aircraft and its occupants.

2. Failure to follow the manufacturer's instructions for operation of the cowling latches may lead to the latch handle opening in flight.

3. Many of the recent occurrences followed a maintenance action in which the cowl was opened, indicating that possibly not all persons involved with the operation of these assemblies are following the manufacturer's instructions for their operation.

4. During several engagement tests, the latch handle reached full travel before the trigger/safety latch could engage completely, rendering the latch ineffective. The subtle offset of the trigger/safety latch may be difficult to detect in an operational environment.

5. The audible "click" of the trigger/safety mechanism engaging is difficult to detect under operational conditions. A convenient procedure for determining handle security is not clearly stated in the Airbus publications.

6. Eighty per cent of the Airbus latches inspected were found to be below the manufacturer's specified minimum latch tension.

7. Retention springs were observed to be broken or missing on several latch assemblies.

8. In some installations, the handle latch pins were found broken. This appeared to be due to improper assembly and installation.

9. An unsecured cowling latch handle or trigger mechanism may not be readily identifiable due to its location on the bottom of the cowl.

In light of these findings, Transport Canada strongly recommended the following:

1. Operators of large jet transport aircraft should ensure that all personnel approved to operate the cowl latches have read and understand the instructions contained within the manufacturer's appropriate publication and have received adequate training in the operation of the cowl closure system.

2. Readily visible portions of cowl latches should be visually inspected whenever they are operated, and any abnormalities should be rectified before flight.

3. Operators of aircraft with cowling latches not readily visible should consider the marking of these handles with a contrasting colour to help make an unsecured handle more conspicuous.

4. Operators and maintainers of large transport category aircraft should have in place a procedure to ensure security of engine cowls before flight.

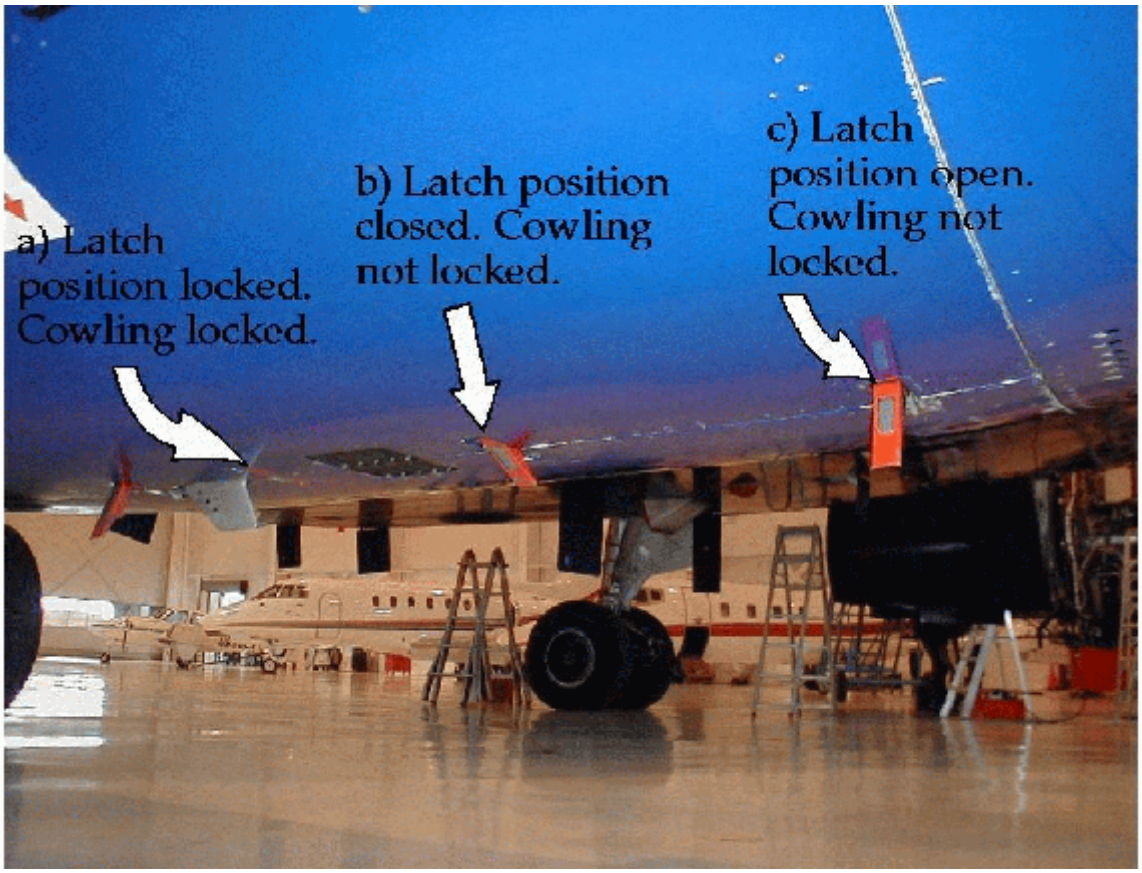
5. Ensure that all personnel involved with the maintenance of these latches have all the necessary documentation for correct installation, e.g., Aircraft Maintenance Manual, etc.

French Direction Générale de l'Aviation Civile

The French Direction Générale de l'Aviation Civile issued Consigne de Navigabilité (Airworthiness Directive) 2000-444-156(B). The modification of the anti-swivel plates IAE V2500-NAC-71-0256 is now mandatory.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 25 September 2001.

Appendix A - Latch Position



Appendix B - Caution Placard

Appendix C - List of Service Bulletins

The following Service Bulletins were issued by International Aero Engines:

V2500-NAC-71-0235 - Nacelle - Powerplant - Fan Cowl Doors - Application of Caution Markings

V2500-NAC-71-0227 - Nacelle - Powerplant - Fan Cowl Door Latch Handles - Application of Fluorescent Paint

V2500-NAC-71-0256 - Nacelle - Powerplant - Right Hand Fan Cowl Door - Modification to Latch Assembly

V2500-NAC-71-0259 - Nacelle - Powerplant - Air Inlet Cowl - Installation of a Hold Open Device

Appendix D - Glossary

ADF	automatic direction finder
agl	above ground level
AME	aircraft maintenance engineer
ATC	air traffic control
CC	crew chief
CDF	central de-ice facility
ECAM	electronic centralized aircraft monitoring
EIU	engine interface unit
FADEC	full authority digital engine control
FBO	fixed-base operator
IAE	International Aero Engine
kg	kilogram(s)
MOC	maintenance and operations control
MSN	manufacturer serial number
SB	service bulletin
TSB	Transportation Safety Board of Canada