AVIATION INVESTIGATION REPORT
A02P0021

IN-FLIGHT ENGINE NOSE DOME DETACHMENT

WESTJET AIRLINES
BOEING 737-200 C-FAWJ
ABBOTSFORD AIRPORT, BRITISH COLUMBIA
01 FEBRUARY 2002

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Boeing 737-200 C-FAWJ
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Summary

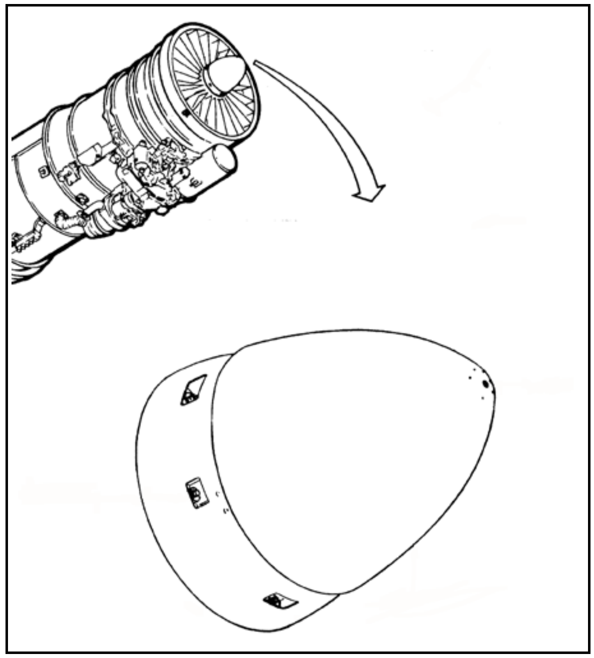
The Westjet Airlines Boeing 737-200, WJA 28, serial number 21770, departed Abbotsford International Airport, British Columbia, at 0632 Pacific standard time for Calgary, Alberta, with 5 crew and 52 passengers on board. Shortly after the aircraft passed through 1500 feet above ground level, the pilots heard a series of loud bangs similar to those of an engine compressor stall. The initial indications on the engine instruments showed abnormally high exhaust gas temperature and a declining power turbine speed on the No. 2 engine. The pilot flying levelled the aircraft at about 3000 feet above ground level and carried out the engine limit/surge/stall quick reference checklist. The pilots confirmed a problem with the No. 2 engine and reduced thrust to idle, where the engine appeared to operate normally. Flight attendants confirmed that there was no obvious visible damage to the engine. The pilots then notified Abbotsford Tower of their intention to return to Abbotsford International Airport and informed the passengers. The airport emergency response services were called out but were not required to attend the aircraft. The aircraft landed on Runway 25 at 0718 and taxied back to the terminal without further incident. There was no injury or fire.

Ce rapport est également disponible en français.

Other Factual Information

Engine performance and cockpit indications were normal during start, taxi, take-off, and the initial climb, until the loud bangs were heard. Passengers seated at the rear on the right side of the aircraft saw flames coming from the exhaust in conjunction with the loud bangs. The captain advised the passengers that they had experienced a technical problem with the No. 2 engine and were preparing to return to Abbotsford.

After the engines were shut down, maintenance personnel found that the extended nose dome assembly (see Figure 1) of the No. 2 engine had detached and jammed into the engine inlet guide vanes. The nose dome had broken away from the magnesium engine accessory support to which it is normally attached with four nuts. The nuts are threaded onto steel studs on the accessory support. Examination found that the four nuts had remained attached to the studs, but that the studs had pulled out from the accessory support, and a section of the support near the number-three stud was missing. The nose dome showed secondary impact damage and deformation as a result of contact with the inlet guide vanes. This damage included deformation of the tip, separation of one of the acoustic panels and partial delamination of another, and deformation of the aft edge of the nose dome.



The engine nose dome is removed during certain engine inspections and replacement of engine components. The nose dome had been removed on 9 January 2002 to facilitate the troubleshooting of an engine pressure ratio problem.

A search of the Transport Canada Service Difficulty Reporting database revealed that nose dome separation had occurred before. Pratt & Whitney, the engine manufacturer, and Boeing Commercial Airplanes have launched awareness campaigns for operators and maintenance facilities. However, nose dome mounting failures continue to be reported at the rate of about two per year.

Maintenance personnel removed the No. 2 engine, a Pratt & Whitney model JT8D-17, serial number 702614, from the aircraft at Abbotsford and shipped it to Calgary, Alberta, for overhaul and repair. Since the last overhaul, the engine had accumulated 5376 hours and 6366 cycles. The engine nose dome, part number 65-85369-12, serial number RR 359, and the accessory support, part number 633759, revision H, were sent to the TSB Engineering Branch for structural and metallurgical analysis. The part number on the accessory support indicated the time of manufacture to be between 1976 and 1978.

TSB Engineering Branch report LP 08/02 stated the following:

1. The studs from the front accessory support had pulled out and remained with their respective nuts in the nose dome assembly. The attachment points of the nose dome were subsequently removed and then sectioned to extract the stud/nut assemblies intact. The coarse thread of stud number one was heavily smeared with significant damage to the thread crests. The coarse thread of studs number two, three and four were filled with material from the front accessory support. The surface of the pulled-out front accessory support material on studs two and four appeared smoother than that of the material in the thread of stud number three. Also, stud number three was slightly bent.

2. The thread in stud boss number one had been completely removed to the depth of the stud engagement and the bore appeared somewhat polished. The thread in stud bosses two and four were similar in that, although the thread had been removed, the thread roots were still distinguishable, and the surfaces where the crests had been removed showed some rub damage. The thread in stud boss number three showed only partial crest removal.

3. Longitudinal sections taken from the front accessory support at stud bosses one and three were mounted for metallurgical analysis. Examination of the mounted sections showed that nine thread crests had been sheared off in each case, with axial deformation consistent with stud pull out. The fracture faces of the sheared thread from stud boss number one were more planar than those of stud boss number three suggesting that: a) stud boss number one had failed earlier than stud boss number three and had been working for some time and b) stud boss number three failed in a combined angular/axial fashion. Longitudinal sections taken through studs one and two were mounted for metallurgical analysis. Significant thread crest damage was observed on the first four threads of stud number one. Flow lips observed either side of the affected thread crests are consistent with rotational interaction with a harder material. Direct Rockwell hardness testing of the stud material averaged 29 Rockwell (HRC) for both studs examined. These results are typical for this particular application and within the specified hardness range of 26-32 HRC.

Analysis

The findings of the TSB Engineering Branch report suggest that the coarse thread of stud number one was significantly damaged prior to installation in the thread of the stud boss. Installation of stud number one resulted in damage to the thread of stud boss number one. Eventually, the remaining thread material in stud boss number one could no longer maintain the required hold down stress, failed in shear, and began to work in the stud boss, polishing the bore as observed.

The loss of clamping force at stud number one resulted in a disproportionate load on studs two and four. Eventually, the stud boss thread holding studs two and four in the front accessory support weakened and failed in shear, again followed by some working in the bore, generating the rub damage observed. Finally, the total hold down clamping force provided by studs one, two and four was insufficient to resist the applied loads, and the nose dome levered stud number three out of the front accessory support, bending stud number three and breaking off stud boss number three in the process.

The damage to stud number one was most likely a result of rotational engagement with a harder material. As the front accessory support is manufactured from a cast magnesium alloy, which is a significantly softer material than the stud material, and there are no threaded inserts in the front accessory support, stud number one could not have been damaged during installation. Damage as a result of previous installation in a heli-coil repaired stud boss was initially suspected; however, the symmetrical nature of the thread crest damage to the stud and the large number of affected thread crests suggests that this was not the cause. Possible scenarios which would lead to the type of thread damage observed on the stud include rotation of the stud while held in a vise or rotation of locking pliers around the threads of the stud.

Other operators of Boeing 737-200 that have experienced worked or damaged threads in accessory supports have initiated repair schemes to strengthen the stud boss by installing stainless steel inserts. This modification reduces progressive stud boss thread wear. If the incident accessory support had the strengthened stud bosses, it is possible that the nose dome would not have come loose, even with one damaged stud.

The loud bangs heard by the crew and passengers, combined with the engine indications presented to the pilots are indicative of an engine compressor stall. The compressor stall was created by the dislodged dome disrupting the airflow into the engine and thus the engine was not capable of producing full thrust.

Engine tear down confirmed that there were no signs of fire in the engine. Flames from the engine, seen by passengers in the aircraft, were likely the result of engine surges due to distortion of the inlet flow field.

The following Engineering Branch report was completed:

LP 08/02 - Nose Dome Detachment

Findings as to Causes and Contributing Factors

1. The engine suffered a series of compressor stalls resulting from the in-flight detachment of the inlet nose dome assembly.

2. The nose dome detached from the front accessory support as a result of loss of the hold-down clamping force.

3. The threads on stud number one were damaged before installation in stud boss number one.

Safety Action

WestJet Airlines is carrying out a fleet-wide campaign to replace all engine accessory supports (part number 633759) with modified accessory supports that have strengthened stud bosses. The modified accessory supports have the threaded stud bosses reworked and stainless steel inserts installed in accordance with MTU Maintenance Canada technical order 72-21-01-01.

As a result of this investigation, Transport Canada is communicating with the Federal Aviation Administration (FAA) regarding a possible Airworthiness Directive to have all engine accessory supports (P/N 633759) replaced with modified accessory supports that have strengthened stud bosses.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 May 2003.

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