Accident Investigation Board Norway

PRELIMINARY REPORT ON SERIOUS AIRCRAFT INCIDENT

Submitted: 19 November 2013

Aircraft:	
- Type and Reg.:	Boeing 737-800 (B737-8JP) (s/n 39005) LN-DYM
Date and Time:	Wednesday 26 December 2012 at 10:29 a.m. local (0829 UTC)
Site of Incident:	During approach to Kittilä Airport, Finland (EFKT)
Operator:	Norwegian Air Shuttle ASA
Type of Flight:	Commercial, scheduled
Injuries to persons:	None
Damages to Aircraft:	None

HISTORY OF THE FLIGHT

On 26 December 2012 Norwegian Air Shuttle flight NAX5630 conducted a scheduled flight from Helsinki-Vantaa Airport (EFHK) to Kittilä Airport (EFKT) in Finland. A Boeing 737-800 delivered new to Norwegian in 2011 was used.

Prior to the flight in question the aircraft had been parked outdoors for three days at low temperatures. A snow layer of approximately 25 cm had accumulated on the fuselage, and in order to remove the snow, the aircraft was de-iced using type I 30-60 % glycol de-icing fluid. A total of 1,807 liters of warm water and 1,136 liters of type I glycol was used during de-icing. The company that carried out the de-icing has informed that their personnel was experienced and adhered to standard procedures for de-icing. The temperature at the airport during de-icing was -17 °C.

LN-DYM had a normal take-off, climb, en-route flight and initial descent. NAX5630 was established on a straight-in ILS approach to runway 34 in Kittilä with configuration: Flaps 5, gear up, autopilot channel A in use, Auto Thrust engaged and established on localizer. When the aircraft was about to enter the glide path at an altitude of approximately 3,250 ft, the elevator/stabilizer trim started actuating for approximately 12 seconds. The trim moved towards Nose Up. As a consequence of the elevation of the nose of the aircraft and the ensuing loss of airspeed, the aircraft Auto Thrust System initiated full engine power. The high engine thrust contributed to a further elevation of the aircraft's nose followed by rapidly decreasing airspeed. When the aircraft nose position rose above +20° both pilots started pushing with full force on the control column. The Flight Data Recorder (FDR) shows that the pilots used a combined force of 207 lbs in their attempt to take the aircraft out of the ascending path. The aircraft was at this time in clouds. The nose position eventually reached +38.5° and the airspeed dropped to 118 kt (TAS) before the nose position slowly started to decrease again. While control was being regained, the aircraft's Stick Shaker and Stall Warning actuated for four seconds. Calculations afterwards show that the stall at 1G for the given configuration is 121 kt. The reason why the aircraft still didn't stall was that the load on the wings was somewhat less than 1G. During the first phase, while the aircraft's nose went up unintentionally, no attempt was made to disengage the aircraft's autopilot, Auto Thrust System or to actuate the stabilizer trim towards Nose Down manually. One or more of these measures would have improved the situation. Also, to the knowledge of The Accident Investigation Board Norway (AIBN), the stick force applied should have made the autopilot switch off automatically.

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After the pilots had managed to regain control of the aircraft, they established the aircraft in a holding pattern. At this time they suspected that a strong temperature inversion might have been the cause of the incident. The aircraft had enough fuel to allow it to return to Helsinki. After half an hour in holding pattern while they verified that the relevant systems functioned normally, they decided to carry out a new approach. The approach and landing were uneventful.

An agreement was reached with The Safety Investigation Authority of Finland (SIAF) that the AIBN should lead the investigation. The US National Transportation Safety Board (NTSB) and SAIF have assisted the AIBN in the investigation.

PRELIMINARY INVESTIGATION RESULTS

- Exterior visual inspection of LN-DYM elevator and horizontal stabilizer including the associated fairings and hinges. No abnormalities revealed.

- Interior visual inspection of LN-DYM Tail Cone Compartment with special focus on any foreign object debris (FOD) and contamination on the aircraft's two Power Control Units (PCU) including the associated links to elevator and horizontal stabilizer. No abnormalities revealed.

- Jointly with the Flight Safety Department of Norwegian Air Shuttle, as well as Flight Data Services in the UK, the AIBN analyzed data from the Flight Data Recorder (FDR) for the flight to Kittilä. Aircraft manufacturer Boeing and the NTSB have also analyzed FDR data from the aircraft for the flight in question and flights prior to the flight to Kittilä. The above-mentioned analyses show that both primary and secondary input arms on the right-hand PCU were blocked when the aircraft's autopilot unintentionally elevated the nose of the aircraft.

- In view of FDR data showing that a PCU was blocked, Boeing recommended that both PCUs on board LN-DYM should be replaced. This replacement was made in the presence of the Accident Investigation Board Norway.

- In order to investigate whether there was any FOD inside the PCUs, the AIBN, in co-operation with the NTSB, arranged for advanced CT scans to be performed in the US of both units. The CT scans revealed a small foreign object inside one of the PCUs, but no such foreign object was found later when the unit was opened.

- Laboratory tests of accumulated dirt on the exterior of both PCUs were conducted. The laboratory tests showed traces of dried-up de-icing fluid. Furthermore, full function tests of both PCUs as well as cold chamber tests were carried out in the presence of the AIBN at the manufacturer's facilities in the US. The testing showed that both PCUs passed all function tests and met all specifications. Both units were then opened and all the individual components inspected in detail. Apart from some remarks about wear and tear on some components, there were no signs of any abnormalities.

- The AIBN commissioned Norwegian Defence Laboratories to analyze samples taken from the aircraft's hydraulic oil and miscellaneous hydraulic filters on both System A and System B. The analyses showed that the hydraulic fluid in both systems A and B deviated from the

specifications of the hydraulic oil but were within the specifications given by Boeing for use on B737 aircraft. Some mineral particles were found on the main hydraulic filters, but the AIBN considers that this was neither the cause of nor a contributing factor to the incident in Kittilä. All hydraulic fluids and associated filters on LN-DYM have since been changed. Moreover, on their own initiative the airline has taken samples of the hydraulic fluids of 10 % of the rest of the aircraft in their fleet to reveal whether the findings on LN-DYM also existed on any other aircraft. No abnormalities were revealed on the rest of the company's B737s.

- On the background of a revealed error code, the AIBN conducted a full function test of the Flight Control Computer (FCC) at the manufacturer's facilities in the US. This aircraft type is equipped with two FCCs, of which the one in position A was active during the approach to Kittilä. FCC (A) passed all function tests, but various error codes were revealed on the opposite computer FCC (B) in connection with automatic Mach Trim. Investigations into whether the revealed error codes might have been of significance to the sequence of events or if there is a need to perform a similar function test of FCC (B) are still ongoing.

- As a part of the examination of whether de-icing fluid can ingress into the Tail Cone Compartment in the direction of the total of four input arms of the PCUs on LN-DYM, the AIBN performed extensive simulated de-icing from different angles on the aircraft's horizontal stabilizer and elevator. The examination showed that at times even quite considerable amount of fluid ingress into the compartment. Under certain circumstances it is possible that the input arms may be exposed to fluid which in turn freezes solid and blocks the PCU input arms. Aircraft manufacturer Boeing was not aware that significant amounts of fluid could ingress into the compartment in question before the AIBN's examination revealed this.

- In view of the above, the AIBN has further conducted similar tests on another B737-800 Next Generation (NG) and a B737-300 Classic. The examinations showed that there had been ingress in the Tail Cone Compartments of all the aircraft and that this therefore is an issue concerning not only LN-DYM, but any B737.

- In a cold chamber test rig, aircraft manufacturer Boeing applied de-icing fluid onto a Power Control Unit and was able to simulate a comparable blocking of a PCU through de-icing fluid freezing solid on the input arms, thereby preventing them from having the freedom of movement that is necessary.

- Furthermore, the AIBN has conducted additional tests to determine the significance of different horizontal stabilizer trim positions for fluid ingress. The current procedure (published by Boeing and adopted by the airline) prescribes that the trim should be set in full forward position during de-icing. The AIBN's examination showed that by changing the trim position to the middle position (the one used during take-off), fluid ingress was reduced.

- In view of the AIBN's examinations, Boeing in October 2013 altered procedures in the Boeing 737 Aircraft Maintenance Manual (AMM) so that application of de-icing fluid should be carried out at an angle from the front and not from the side. Boeing also introduced new procedures into the Flight Crew Operations Manual (FCOM) prescribing that all B737 operators during de-icing should set the stabilizer trim to take-off position.

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Boeing has informed the AIBN that they have plans to modify all B737s to achieve better protection against the risk of the elevator system freezing solid. The AIBN plans to issue a safety recommendation in this regard.

The investigation of this incident continues. The plan is that further details of the case will not be made public until the final report with an analysis of the events and the AIBN's conclusions is published. The situation being as it is, with a large number of investigations underway and the number of new cases difficult to predict, the AIBN does not wish to indicate how long it is going to take before the final report will be available.

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