REPORT

Accident Investigation Board Norway
P.O. Box 213
NO-2001 Lillestrøm
Telephone: +47 63 89 63 00
Telefax: +47 63 89 63 01
http://www.aibn.no
E-mail: post@aibn.no

Date: 14.12.2006
SL Report: 31/2006

This report has been translated into English and published by the AIBN to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.
This investigation is limited in its extent. For this reason, the AIBN has chosen to use a simplified report format. The report format indicated in the ICAO annex 13 is only used when the scope of the investigation makes it necessary.

All times given in this report are local time (UTC + 1 hour) unless otherwise stated.

Aircraft:		
- Type and reg.:	Cessna 208B, LN-PBF	
- Year of manufacture:	1996	
- Engine:	PT6A-114A	
Operator:	Benair	
Radio call sign:	HAX33	
Date and time:	Thursday 19 January 2006 at time 0750	
Place of incident:	Approx. 14 NM east of Florø, Norway, 25 NM south of reporting point SOVIG (61°30'50"N 005°29'58"Ø)	
Type of occurrence:	Serious incident, loss of altitude in icing conditions	
Type of flight:	Commercial, non-scheduled (freight)	
Weather conditions:	Low pressure north of Iceland. Front in the North Sea moving towards the west coast of Norway. Local icing forecast. 0 isotherm at ground level	
Light conditions:	Darkness	
Flight conditions:	IMC	
Flight plan:	IFR	
No. of persons on board:	2 pilots	
Injuries:	None	
Damage to aircraft:	None	
Other damage:	None	
Crew:	Commander	First Officer
- Gender and age:	Male, 38	Male, 32
- Certificate:	CPL(A) IR	CPL(A) IR
- Flying experience:	2,500 hours, of which 1,500 hours on Cessna 208	1,500 hours, of which 150 hours on Cessna 208
Information sources:	Report from Avinor, reporting form NF-148 from Commander, report from DNMI and AIBN's own investigations	

FACTUAL INFORMATION

The crew started the day's work at Bergen Airport Flesland (ENBR) at 0330. The assignment was the transport of newspapers. The Commander checked the weather via the Internet and used the company planning tool to plan the trip, while the First Officer checked the aircraft and received the freight. The first flight was to Stavanger Airport Sola (ENZV) returning to Flesland. There were indications of icing underway, without this causing problems. According to the crew, no de-icing was necessary before the next departure.

At 0715 the crew took off from Flesland after taking on board newspapers destined for Ålesund Airport Vigra (ENAL). The Commander piloted the aircraft. The planned route was direct (via SOVIG) at cruising altitude FL110 (approx. 11,000 ft). According to the crew, the takeoff mass was close to the maximum limit of 4,060 kg. The centre of gravity was approximately at the centre of the approved area.

The climbout initially progressed normally at approximately 700 ft/min at 110-115 KIAS. The autopilot was engaged. Climbing ability during climbout was gradually reduced as a result of icing, and the Commander allowed the aircraft to climb at a speed of 105-110 KIAS. After approx. 20 minutes they reached FL110. The available de-icing systems were on. LN-PBF was equipped with "Known Icing Equipment", i.e. among other things pneumatic "boots" on the leading edge of wings, tail surfaces, wing struts and landing gear as well as electric heating of propellers, pitot-static tubes and left front windshield. A weather radar was installed, but was not in use.

At approx. 0745, when they were approaching the mountains east of Florø, 25 NM south of the SOVIG reporting point, icing quickly became considerably worse. The crew observed that ice was building up in the underside of the wings, and that the "boots" were not removing this. Flight speed was decreasing, and as they entered mountain waves and lost altitude it became impossible to return to FL 110.

The commander immediately decided to turn around. He disconnected the autopilot and flew manually. He was conscious of not allowing the speed to fall below 105 KIAS, and with full engine power this resulted in a descent rate of approximately 700 ft/min. The Commander performed a gentle turn to the left, and according to the First Officer, vibrations in the fuselage were felt during the turn. No stall warning was heard. The First Officer assisted in navigation and reported to the air traffic control service that they were turning around and that they couldn't maintain the given altitude due to icing. They considered landing at Florø Airport (ENFL), but when it became apparent that they could maintain FL90, they decided to return to Flesland. Full engine power was still required to maintain 105-110 KIAS. According to the crew, normal cruising speed at cruise power is 135-145 KIAS. As a consequence of the strong head wind, ground speed dropped to 57 kts for a period. The ice did not break off until they descended to 1 000 feet during the approach to runway 17 at Flesland. A normal landing took place at 0830.

According to information in "Caravan Safety Awareness Program" one can experience that aircraft speed may be reduced from 165 KIAS to 105 KIAS after repeatedly using boots in icing conditions, while the stalling speed increases significantly, from 78 KIAS to 92 KIAS.

Printout of radar data from Avinor confirms the route flown, altitude loss and ground speed.

Fig. 1 Map of the area where the icing problems arose

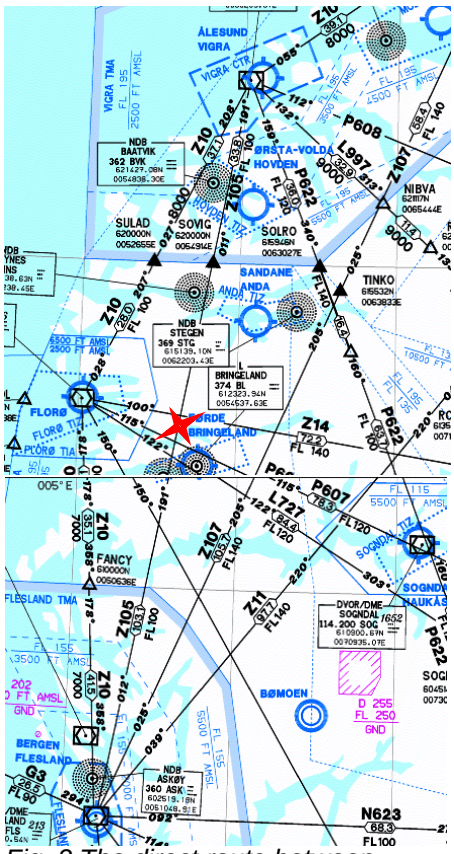

Fig. 2 The direct route between Bergen and Ålesund

The Norwegian Meteorological Institute has described the general weather conditions as follows:

> *"South-western air current with a low pressure north of Iceland. A front in the North Sea is moving towards the west coast of Norway. These weather conditions provide large amounts of humid air which is forced upwards due to topographical reasons. This gives a high probability of freezing rain droplets and thereby the risk of icing.*
>
> …
>
> *The first ice message was issued on 18 January at 2247 UTC (period of validity 190400-190800 UTC). Local MODERATE icing was forecast below Flight Level 140. The 0 isotherm (freezing level) was at ground level. The next ice message was issued on 19 January at 0347 UTC (period of validity 190400-190800) with the same wording.*

TAF (Aerodrome forecast in meteorological code)

Florø:
190500Z 190515 13025G38KT 8000 –SNRA FEW 010 BKN020 TEMPO 0515 2000 SNRA VV006=

METAR (Aviation routine weather report in meteorological code)

Flesland:
190520Z 15015G25KT 110V190 7000 FEW012 BKN018 01/M02 Q1011 TEMPO 2000 SN VV008 RMK WIND AT 1200FT 13040G47KT=
190550Z 15019G30KT 120V180 7000 -SN FEW011 BKN020 01/M02 Q1011 TEMPO 2000 SN VV008=
190620Z 15020KT 9000 -SN FEW012 SCT024 BKN035 01/M02 Q1011 TEMPO 2000 SN VV008=
190650Z 15019G29KT 9999 FEW012 SCT020 BKN030 02/M03 Q1010 TEMPO 2000 SN VV008=

Florø:
0650Z 12018G28KT 9999 FEW015 SCT 018 BKN 030 03/M02 Q1008=

Vigra:
190515Z 17018G28KT 9999 FEW030 BKN050 PROB30 TEMPO 0615 4000 -SNRA VV014=
190550Z 17012KT 9999 SCT030 BKN050 05/M04 Q1004=
190620Z 18013KT 9999 FEW030 BKN050 06/M05 Q1004=
190650Z 18012KT 9999 FEW030 BKN050 06/M04 Q1004=

The AIBN has previously investigated two accidents in Norway concerning Cessna 208 aircraft where icing was a factor. Both accidents took place at Gardermoen. On 4 December 1994 one person was killed when LN-PBC crashed after take-off due to icing on wing and tail surfaces (RAP). 04/1995). On 24 February 2000 substantial damage occurred to OY-PBF when it stalled and fell onto the runway after take-off. (RAP. 47/2002).

The United States Federal Aviation Administration (FAA) has issued two Airworthiness Directives related to icing issues with Cessna 208 aircraft in the period 1996-2005. (AD 96-09-15 and AD 2005-07-01). The Norwegian Civil Aviation Authority (CAA-N) routinely made both mandatory in Norway.

The accident investigation authorities in the US (National Transportation Safety Board, NTSB), Canada (Transportation Safety Board, TSB) and Russia (Interstate Aviation Committee, IAC) have recently performed thorough investigations and analyses in connection with icing accidents concerning Cessna 208 aircraft. In one of the accidents, the aircraft was equipped with a Flight Data Recorder (FDR). Data from this accident has been used to support new recommendations that were presented in January 2006:

TSB:

> *Recommendation A06-01*
> *That the Department of Transport take action to restrict the dispatch of Canadian Cessna 208, 208A, and 208B aircraft into forecast icing meteorological conditions exceeding "light," and prohibit the continued operation in these conditions, until the airworthiness of the aircraft to operate in such conditions is demonstrated.*
>
> *Recommendation A06-02*
> *That the Department of Transport require that Canadian Cessna 208 operators maintain a minimum operating airspeed of 120 knots during icing conditions and*

exit icing conditions as soon as performance degradations prevent the aircraft from maintaining 120 knots.

Recommendation A06-03
That the Federal Aviation Administration take action to revise the certification of Cessna 208, 208A, and 208B aircraft to prohibit flight into forecast or in actual icing meteorological conditions exceeding "light," until the airworthiness of the aircraft to operate in such conditions is demonstrated.

Recommendation A06-04
That the Federal Aviation Administration require that Cessna 208 operators maintain a minimum operating airspeed of 120 knots during icing conditions and exit icing conditions as soon as performance degradations prevent the aircraft from maintaining 120 knots.

NTSB:

Require all operators of Cessna 208 series airplanes to maintain a minimum operating airspeed of 120 knots during flight in icing conditions, even if a descent is required to do so. (A-06-01) Urgent

Prohibit all operators of Cessna 208 series airplanes from conducting flight into any icing conditions determined to be more than light icing. (A-06-02) Urgent

Require all operators of Cessna 208 series airplanes to disengage the autopilot and fly the airplane manually when operating in icing conditions. (A-06-03) Urgent

The accident investigation boards were of the opinion that the manufacturer's recommended minimum speed of 105 knots left too narrow a margin for stalling and they recommended 120 knots. They also recommended a prohibition on flight into any icing conditions determined to be more than light icing. TSB also recommended a restriction on flight into forecast icing meteorological conditions exceeding "light" until the airworthiness of the aircraft to operate in such conditions had been demonstrated, and NTSB in addition recommended prescribing manual flying in icing conditions. Background information and reasons for the safety recommendations can be found on NTSB's and TSB's websites.
(http://www.tsb.gc.ca/en/media/fact_sheets/A05C0187/recs_a05c0187_a0601_a0602.asp
http://www.ntsb.gov/recs/letters/2006/A06_01_03.pdf)

The safety recommendations issued by TSB and NTSB quoted above have, following publication of this report, been considered by the various aviation authorities. On 10 March 2006, FAA issued a new airworthiness directive (AD 2006-06-06) which came into force on 24 March 2006. The new directive requires the incorporation of new text into the Limitations section of the FAA-approved Airplane Flight Manual (AFM) and Pilot Operating Handbook (POH) for Cessna models 208 and 208B and the installation of placards in the cockpit. In the introduction to the airworthiness directive the FAA writes:

"We are issuing this AD to assure that the pilot has enough information to prevent loss of control of the airplane while in-flight during icing conditions"

The limitations in AD 2006-06-06 could be summarized as follows:

- *Continued flight after encountering moderate or greater icing conditions is prohibited*
  - *Moderate defined by one ore more of the following conditions:*
    - *Indicated airspeed in level cruise flight at constant power decreases by 20 knots*
    - *Engine torque required to maintain airspeed increases by 400 ft-lbs*
    - *Airspeed of 120 KIAS cannot be maintained in level flight*
    - *An accretion of ¼ inch of ice on wing strut*
- *Minimum airspeed in icing conditions, for all flight phases including approach, except takeoff and landing*
  - *Flaps up: 120 KIAS*
  - *Flaps 10°:105 KIAS*
  - *Flaps 20°: 95 KIAS*
- *Exception for flaps up*
  - *While climbing to exit icing conditions, airspeed may be reduced to 110 KIAS minimum*
- *Flaps must be extended during all phases (takeoff and landing included) at airspeeds below 110 KIAS*
  - *Except adhere to special ground deicing/anti-icing fluid procedures*
- *Revised notes on stall speeds and stall warning*
  - *Ice accumulation on the airframe may result in a 20 KIAS increase in stall speed and an increase of 400 foot pounds in engine torque required to maintain airspeed. Either buffet or aural stall warning should be treated as an imminent stall*
  - *WARNING - The aural stall warning system does not function properly in all icing conditions and should not be relied upon to provide adequate stall warning when in icing conditions*
- *Require the autopilot to be disconnected at the first indication of ice accretion. (AD notes that the limitation on autopilot use is an interim action until a low speed awareness system is implemented. Low speed awareness system certification is complete, beginning to install on field aircraft) (Source: Cessna Aircraft)*
- *Added placards consistent with above changes*

The updated status of FAA's response to recommendations issued by NTSB and TSB on 30 November 2006 shows that NTSB is of the opinion that FAA's directive AD 2006-06-06 fully meets the intent of the three safety recommendations they proposed. They refer to the introduction of a mandatory minimum speed of 120 KIAS in all phases of flight when the flaps are up in icing conditions, a prohibition on operating this aircraft type in icing conditions that are moderate or greater and a requirement that the autopilot be disengaged in icing conditions. The civil aviation authority in Canada (Transport Canada, TC) has implemented AD 2006-06-06 without introducing any additional requirements. TSB has concluded that the measures implemented fully address two of the four recommendations they proposed. Since AD 2006-06-06 does not introduce a restriction on flight into forecast icing meteorological conditions exceeding "light", the response to the two recommendations relating to this topic is assessed as "*Satisfactory in part*".

On 24 February 2006, CAA-N sent a letter entitled *"Cessna 208 and icing conditions – airworthiness instruction"* to Norwegian Cessna 208 operators. This was sent after the incident with LN-PBF and before FAA issued AD 2006-06-06. The letter states that NTSB's three recommendations (see above) shall apply as an airworthiness instruction for aircraft of this type operating at Norwegian AOCs (currently Benair and Kato Airline). Further: *"The instruction applies with immediate effect. The Civil Aviation Authority requests that the company's documentation be revised accordingly"*.

On 1 July 2006, FAA's AD 2006-06-06 came into force for Norwegian operators when the formal Airworthiness Directive Cessna -133, LDP 2006-046 *Revision of Airplane Flight Manual* was issued by CAA-N.

AIBN is aware that Cessna Aircraft plans to introduce a number of additional safety measures for its Cessna 208 models operating in icing conditions. Two particular areas on which the company is focusing are an improved stall warning system and the introduction of compulsory online training for Cessna 208 pilots who will be operating in icing conditions. The E-learning solution is already up and running and can be used for self-study (www.cessnaelearning.com).

The crew of LN-PBF have stated that, following this incident, the company's pilots are more inclined to select a route along the coast, or to climb in order to gain altitude before heading over the mountains when there is humid air and a westerly wind with the risk of icing. They have also become more conscientious about informing each other of weather conditions and requesting "PIREPS" (Pilot Reports, current weather observations from aircraft in the area) prior to takeoff.

COMMENTS FROM THE ACCIDENT BOARD

Mild winters with the influx of humid air towards the coast and mountains give rise to icing conditions that may pose a risk to air traffic flying according to instrument regulations at lower altitudes. Weather forecasts are not sufficiently accurate to predict exactly where icing will cause problems (e.g. loss of performance and potential loss of control), but AIBN considers it important that pilots learn to interpret weather warnings in view of the fact that there may be a danger of freezing rain. AIBN also believes that operators such as Benair, who regularly fly along the west coast and between Eastern and Western Norway using Cessna 208 aircraft, should be expected to acquire local knowledge about where icing problems and mountain waves occur and act accordingly.

AIBN also believes that it is important for Cessna 208 pilots to be sufficiently knowledgeable about relevant meteorology, aerodynamics and the functioning of the aircraft's systems and their correct use. Good training is therefore essential and AIBN sees Cessna's E-learning system as a potential aid in this respect. High pilot turnover is normal among these operators and there is a constant need for training new employees. It is also important to note that pilots with long experience in flying this aircraft type must now familiarise themselves with the changes that have been incorporated into the AFM and what prompted them. Examples of other general safety-enhancing measures are a low threshold for cancelling flights or turning back, selection of alternative routes and active acquisition of current weather observations, which Benair has stated it now practises.

AIBN considers that the crew turned back in time to give them margins, but that they were about to lose control of the aircraft. Information emerging from accident investigations in other countries has resulted in recent changes to authority-approved procedures for Cessna 208s. AIBN is of the

opinion that the introduction of AD 2006-06-06 will result in greater margins when operating Cessna 208s in icing conditions.

AIBN believes that CAA-N showed initiative by reacting quickly, ahead of FAA's response to the recommendations. However, now that FAA has issued AD 2006-06-06, which now also applies to Norwegian operators, AIBN thinks that CAA-N should consider whether there is still a need for the special Norwegian airworthiness instruction, which exists in the form of a letter dated 24 February 2006. AIBN believes that additional requirements should be specified, based on the authorities' requirements that now apply and that any additions to LDP 2006-046 should be announced in some other way than in letter form, to ensure that they also apply to future operators of this aircraft type.

On 5 December 2006, the Civil Aviation Authority made the following statement in response to AIBN's assessment of this case: *"We have reviewed the revised Cessna 208 POH, Section 9 Supplements, LIMITATIONS, ENVIRONMENTAL CONDITIONS, WARNING, and found that this revised version contains the requirements we defined for operating Cessna Caravans in icing conditions. We shall therefore withdraw the airworthiness instruction with reference to the revised POH"*.

AIBN has included the above statement in its assessment and has decided not to propose any safety recommendation following this serious incident.