Accident
Investigation Board
Norway

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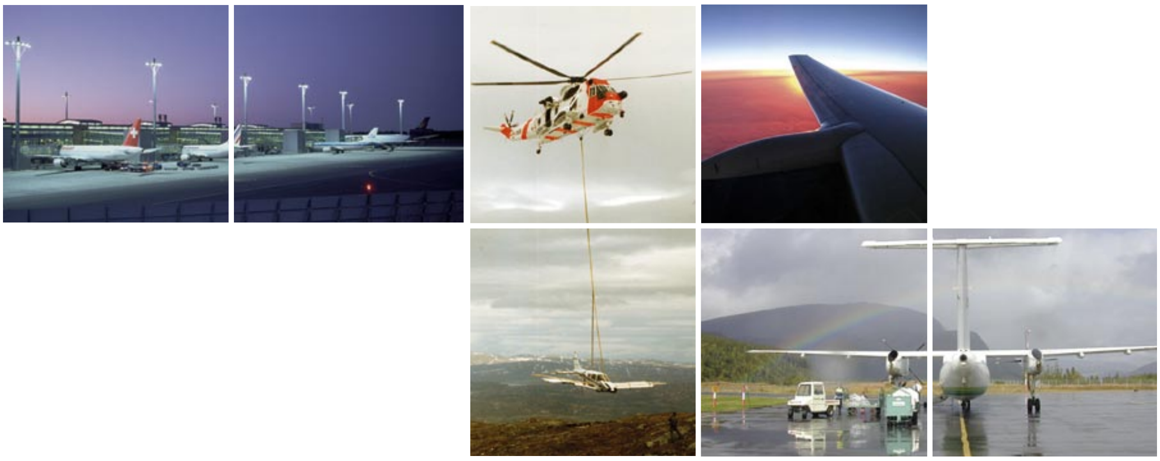
REPORT SL 2009/02



REPORT ON THE SERIOUS INCIDENT OVER GLACIER FOLGEFONNA, NORWAY ON 14. SEPTEMBER 2005 WITH ATR 42-320, LN-FAO, OPERATED BY COAST AIR AS

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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.

The Accident Investigation Board has compiled this report for the sole purpose of improving flight safety. The object of any investigation is to identify faults or discrepancies which may endanger flight safety, whether or not these are causal factors in the accident, and to make safety recommendations. It is not the Board's task to apportion blame or liability. Use of this report for any other purpose than for flight safety should be avoided.

Photos: AIBN and Trond Isaksen/OSL

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REPORT ON SERIOUS INCIDENT

Type of aircraft:	Aerospatiale SNI ATR 42-320
Nationality and registration:	Norwegian, LN-FAO
Owner:	Kystfly AS, Norway
Operator:	Coast Air AS, Norway
Crew	2 pilots and 1 member of cabin crew, no injuries
Passengers	24 passengers, no injuries
Place of incident:	Southeast of the glacier Folgefonna, Norway (59°55'N 006°31'E) at approx. 14,000 ft
Date and time:	Wednesday 14 September 2005, at 0720

All times given in this report are local time (UTC + 2 hours) unless otherwise stated.

NOTIFICATION

The Accident Investigation Board Norway (AIBN) received a report concerning the incident via the Civil Aviation Authority Norway (CAA-N) on 4 October 2005. Coast Air AS had reported the occurrence to the CAA-N almost two weeks after it occurred. The CAA-N assessed the matter as serious and ensured that the report was forwarded to the AIBN. The AIBN concluded that the matter was a serious incident, and an investigation was initiated.

In accordance with ICAO Annex 13 Aircraft Accident and Incident Investigation, the AIBN notified the accident investigation board in the country of manufacture, France, of the incident. The French accident investigation board (Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation civile (BEA)) appointed an accredited representative to assist the AIBN in its investigation as required.

SUMMARY

Coast Air’s flight 602 from Stord Airport Sørstokken to Oslo Airport Gardermoen had 24 passengers and a crew of 3 on board when it took off on the morning of 14 September 2005. A cold front had passed over the coast and was on its way east, and local moderate icing was forecast. While climbing, when passing flight level FL100 (approx. 10,000 ft), ice began to form on the aircraft. The aircraft’s de-icing systems were switched on and functioned normally. Nevertheless, more ice built up and, when passing through FL120, there was a marked reduction in the aircraft’s climb ability. At FL140 the autopilot disconnected, at much the same time as the aircraft entered an uncommanded roll to approx. 45 degrees to the right and began to lose height. When the crew believed they had regained control, the aircraft suddenly rolled uncommanded to the left in a similar

manner. Around one and a half minutes after the first uncommanded roll movement, the climb was stable once more. The flight continued to Gardermoen without any further problems.

The loss of altitude in the incident was approx. 1500 ft, and was not critical in relation to terrain height. No personal injuries or material damage occurred.

In addition to establishing how and why the control of the aircraft was temporarily lost, the AIBN has uncovered several latent contributing factors and safety problems in this investigation. These safety problems can roughly be subdivided into four groups:

- Operation of this aircraft type in icing conditions
- Serious deficiencies in the company's quality system and flight safety programme
- Insufficient follow-up and rule enforcement on the part of the CAA-N after it had disclosed serious deficiencies in the quality system and flight safety programme in its flight operations inspections of the company over several years prior to the incident.
- The company was assigned two new tendered routes despite the deficiencies in its safety management persisting.

In the opinion of the AIBN, this case illustrates the importance well functioning safety regulation has on aviation safety. The failure of the CAA-N follow-up contributed to deficiencies in the Coast Air quality system and flight safety programme not being corrected in time.

The Accident Investigation Board of Norway (AIBN) issued four immediate safety recommendations during its preliminary investigations of the incident. A further six safety recommendations are issued in this report.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The crew arrived at Stord Airport Sørstokken (ENSO) at 0615 to fly the Coast Air flight 602 (CST602) to Oslo Airport Gardermoen (ENGM). The weather was the subject of conversation that morning. There had been a landslide in Bergen during the night, and precipitation records had been set at several locations in western part of Norway.

1.1.2 As usual, both pilots and the cabin attendant went up to the tower to the AFIS duty officer[1] to gather current weather information and NOTAM (Notice to Airmen) announcements for use in planning the flight. It had stopped raining, but the air was still moist. There was a relatively strong westerly wind, and the crew anticipated some turbulence during the climb. The weather forecast was a moderate risk of local icing in western part of Norway up to flight level FL180 (approx. 18,000 ft), which is normal for the time of year.

1.1.3 CST602 took off from runway 33 at 0710. The aircraft was half full, with 24 passengers and a crew of 3 on board. The First Officer was flying the aircraft (Pilot Flying, PF). The autopilot was connected after a couple of minutes. While passing approx. 3,500 ft during

[1] *Duty officer working at an AFIS (Aerodrome Flight Information Service) unit – in the tower at a regional airport. Providing details such as local information about air traffic, and receiving and passing on communications between air traffic control units.*

the climb, the course was set to east toward the reporting point SOROX in compliance with clearance received from Flesland control. Initially cleared altitude was flight level FL090. After that, radio correspondence was transferred to Stavanger control, and CST602 was given clearance straight to Sigdal at FL190 (map Figure 1 page 8).

1.1.4 The crew has stated that they observed a build-up of ice on the aircraft, which is not an abnormal occurrence over the terrain in question. In compliance with current procedures, systems for electrically heating the probes and front windshield (level 1, ref system description in subpara. 1.6.2) were switched on prior to take-off, while systems for further de-icing (level 2) were switched on when ice was observed shortly after take-off. When warning light for icing came on approximately when passing through FL100 while climbing eastward, in accordance with procedures, they switched on the system to "level 3" for de-icing. The crew is certain that the systems were functioning as intended. At this point, the weather radar was not switched on. There was no significant turbulence, and the fasten seatbelts sign was switched off.

1.1.5 The Commander has stated that they gradually went into heavy rain, with large drops that splattered on the front windshield while the outside temperature (Static Air Temperature, SAT) was -10 °C. He saw significant ice formation on the evidence probe outside his window, and assessed the icing as more or less the same as the worst case he had experienced during the course of his 6 years of flying this aircraft type. The Commander has stated that the ice built up extremely rapidly. The side windows iced up, while the inflatable rubber de-icing boots appeared to keep the leading edges of the wings free of ice. From the cockpit it was not possible to see whether there was ice further back on the upper and lower sides of the wings. Neither the Commander nor the First Officer remembered afterwards whether they saw ice on the propeller spinners. The First Officer did not remember that it had been raining. He has explained that ice on the side window was not uncommon during "normal" icing conditions.

1.1.6 The crew has stated that the aircraft climbed more or less normally until passing FL120-125. After this, the ability to climb deteriorated significantly. When they approached FL140, the climb was marginal. To maintain a certain climb, they allowed speed to drop from 160 KIAS to 150 - 155 KIAS. The First Officer thought he remembered using the autopilot during this phase in the mode for maintaining indicated airspeed (IAS hold). Minimum speed in "standard" icing conditions for the relevant mass was 143 KIAS (stated in the speed booklet). This speed would be marked on the speed indicator by their having set the red "speed bug" in accordance with the procedure. Both the Commander and the First Officer were of the opinion that they had sufficient margins when they were at least 7 kt above icing speed. The speed of icing corresponds with the speed of maximum climb gradient, and normally therefore the selected speed would be favourable for gaining altitude as quickly as possible.

1.1.7 The anticipated positive effect of reducing speed down to the speed of best climb gradient failed to occur, however. The crew suspected mountain waves, but the First Officer felt that the ability to climb was reduced more than would normally be the case temporarily when entering an area with such downdraft. The Commander believed he remembered that it was dark, and that the aircraft was in cloud at this time (Instrument Meteorological Conditions, IMC). The incident time and calendar date however indicate that it would have been daylight. The fasten seatbelts sign was switched on again. The aircraft had reached FL140, but began to descend. The First Officer put his hand on the stick and felt the "stick shaker" come on. Just when he intended to disconnect the autopilot, it disconnected automatically. The First Officer believed he remembered that the aileron mistrim warning light came on. A second or two after this, the aircraft suddenly rolled uncommanded, approximately 45 degrees to the right, at the same time as the nose section dropped to approx. 7– 8 degrees below the horizon.

1.1.8 The First Officer has stated that he pushed the stick forward to keep the aircraft's nose down while he also set the engine controls (Condition Lever[2], CL and Power Lever[3], PL) to 100 % / Max Continuous Torque (MCT). He struggled to regain control of the aircraft and tried to rectify the bank angle. The bank angle moved from the right, straight over to the left before it gradually allowed itself to be straightened up. The Commander placed the speed bug at 160 kt. When the wings were in a horizontal position and the airspeed had reached approx. 170 – 175 KIAS, the First Officer pulled the stick back to stop the descent. He did not feel that this resulted in any significant g-forces, and felt that the situation had been cleared up. The crew estimated that they had lost just over 1,000 ft of altitude. The Commander called up Stavanger control on the radio and reported that they were requesting FL150 as their final cruising altitude since they had icing problems.

1.1.9 Just after the crew believed they had regained control, the aircraft's left wing suddenly dropped uncommanded. This wing drop was almost as powerful as the first, and the First Officer has stated that he used the same procedure to regain control. After this, the Commander again called up Stavanger control and informed them that they had had problems in maintaining FL150. He requested a block height of FL130-150. They were now located between two layers of cloud, and icing had stopped. The First Officer flew manually for a while, before again engaging the autopilot.

1.1.10 The Commander chose not to take over the controls himself when the aircraft went out of control. He justified this choice to the Accident Investigation Board by stating that the First Officer was experienced and had the knowledge about how the aircraft was trimmed and how it was responding to control input. The Commander also stated that he knew that such intervention by the commander had been criticised in conjunction with previous accidents.

1.1.11 According to Stavanger control there was no other aircraft in the area, and assigning block clearance was not a problem. Oslo control was informed about CST602 having reported icing problems. On the radar screen they could see that the aircraft was "moving up and down a little", but that it gradually stabilised on FL150. The occurrence was not assessed by the air traffic service as being a reportable incident, and no radar or communications data were impounded.

1.1.12 The cabin attendant stated that the take-off and climb went normally. There was no turbulence. She had brought out the serving trolley and was busy preparing to serve from the galley at the back of the cabin. Since the aircraft was only half full, she had plenty of time and was able to delay serving until they had levelled out at cruising altitude. Just as she was going to put some empty bottles into the cargo compartment at the rear of the aircraft, she felt some abnormal movements. The aircraft tipped suddenly over to the side, causing her to lose her balance and fall headlong into the cargo compartment. She was afraid the trolley that was in the aisle would start moving, and quickly got to her feet again to secure it. She took hold of the trolley and was busy putting it in its place when the aircraft tipped over for a second time. This time she held onto the trolley and avoided

[2] *Here: controls propeller revolutions*
[3] *Approx. equivalent to throttle*

falling. When the aircraft righted itself again, she got the trolley back to the galley and locked it in position. While this was happening, she registered a third, less noticeable wing drop.

1.1.13 When the aircraft was flying in a stable manner again, the cabin attendant walked forward in the cabin. The passengers were sitting still. She spoke for a little while with a woman who, before take-off, had told her she was afraid of flying. Some remarks were made about the poor weather that day. After that, the cabin attendant went back and sat in her place. After a minute or so, she called the pilots and asked whether everything was all right. She was invited to come to the cockpit, where the Commander explained there had been icing on the aircraft, but that it was now all under control. After she was back in the cabin, the Commander gave a passenger announcement. He stated that they had moved into some bad weather involving turbulence and icing, but that this was now over, so the flight would continue to Oslo as normal.

1.1.14 CST602 landed at Gardermoen at 0804. The Commander telephoned the company's Flight Operations Manager just after arrival. They talked about what had happened, and agreed that the return flight to Stord should be postponed for an hour. They were counting on the weather having improved by then and, in addition, the crew would have more time to relax and talk together about what they had gone through. The Flight Operations Manager decided to drive from the company's main base at Haugesund to Stord to meet the crew on arrival. There was no discussion at this point about notifying and reporting the incident to the AIBN or the Norwegian Civil Aviation Authority (CAA-N).

1.1.15 After the Flight Operations Manager had met the crew at Stord and gained a better insight into what had happened, he was convinced that the incident was reportable. He got the Commander to write a report and to send this to the CAA-N (as a less serious incident that was not subject to mandatory reporting to the AIBN). The Flight Operations Manager has since apologised for not having notified the AIBN immediately, and that they reported the incident in relation to a wrong category. The CAA-N received the report on 28 September and forwarded it to the AIBN on 4 October.

1.1.16 Normally, radar recordings from Avinor (RaADS) are stored for a minimum of 30 days, and they were not recorded over when the AIBN requested them. This meant it was possible to plot the altitude profile from take-off until the aircraft was established at its cruising altitude of FL150. The data show that control was first lost at 07:23:27. The aircraft was then at approx. FL144 directly southeast of the glacier Folgefonna, around 35 NM east of Stord (59°55'N 006°31'E). The minimum safe flying altitude (MSA) in the area was 7000 ft.

Figure 1: Map section Stord – Oslo (AIP Norway ENR 6.2-1) indicating positions of Folgefonna (red circle) and the incident (red star).

1.1.17 Radar data shows that, on the first occasion, the aircraft lost 1500 ft of altitude before beginning to climb again 28 seconds later (Figure 2: The flight profile for CST602 from take-off until the aircraft was established at cruising altitude (based on Mode C every 5 seconds). The period during which the incident lasted has been circled. See also figure 3.). The second loss of control is not shown quite so clearly.

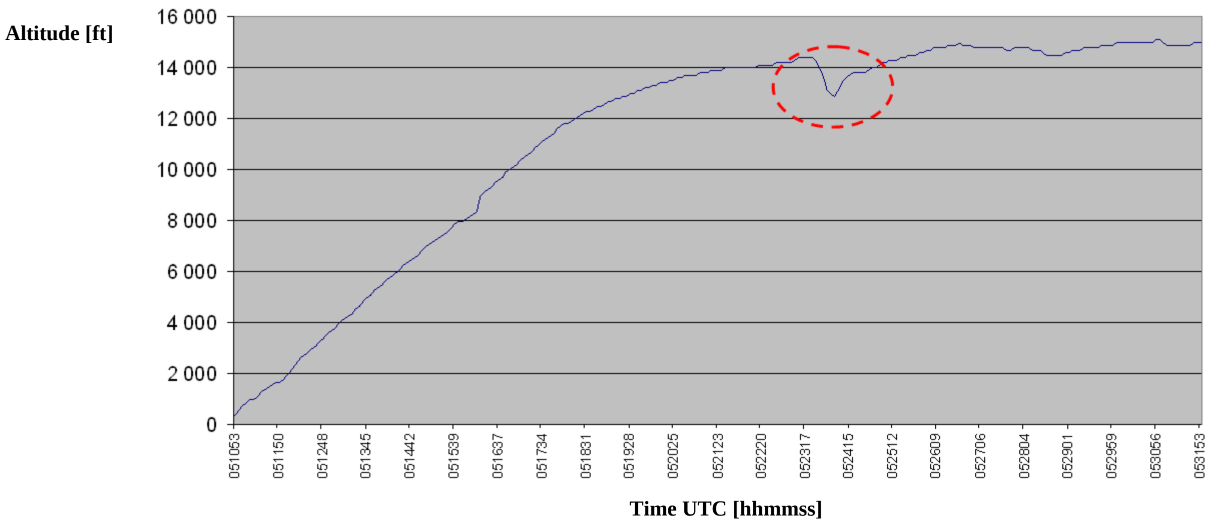


Figure 2: The flight profile for CST602 from take-off until the aircraft was established at cruising altitude (based on Mode C every 5 seconds). The period during which the incident lasted has been circled. See also figure 3.

1.1.18 An extract of the period when the incident occurred is shown in the figure below. Combined with the crew's explanation it is possible to establish that the aircraft lost approx. 1500 ft in height the first time the wing dropped. It is equivalent to an average descent speed of approx. 3200 ft/min for the 28 seconds that passed before the aircraft again commenced climbing. At its steepest, the descent was around 5000 ft/min.

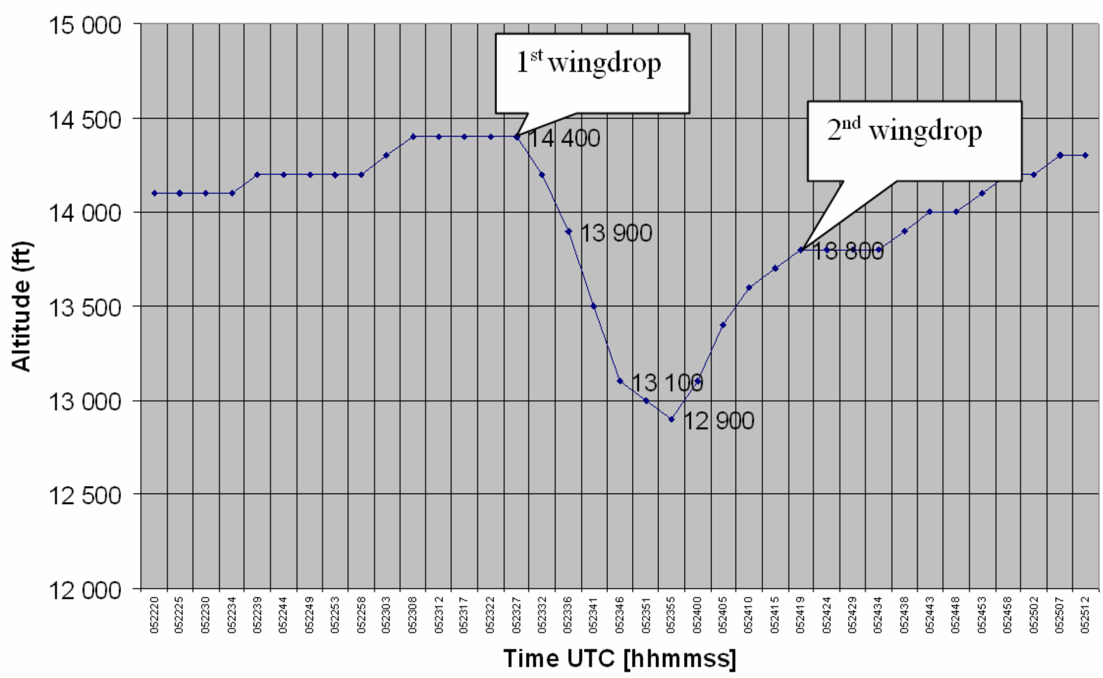


Figure 3: The flight profile for CST602 during the period 07:22:20 to 07:25:12 (based on Mode C every 5 seconds).

1.1.19 Once the descent stopped, the radar plot shows that the aircraft went into a relatively steep climb. According to the radar readings, it climbed 700 ft in the first 15 seconds, which corresponds to 2800 ft/min. Then the radar plot shows that the climb decreased somewhat during the following 10 seconds, before the aircraft maintained a constant altitude of approx. 15 seconds. Once it began to climb again, the climb rates were approx. 900 ft/min.

1.2 Injuries to persons

Table 1: Injuries to persons

	Crew	Passengers	Other
Fatal			
Serious			
Minor/none	3	24	

1.3 Damage to aircraft

None

1.4 Other damage

None

1.5 Personnel information

1.5.1 <u>Commander</u>

1.5.1.1 The Commander, male 39, started his flight training in the USA in 1987. He became employed by Coast Air in 1999. During his initial time with the company he flew

Jetstream (ref. subpara. 1.17.1.4), before he attended a training course and was granted type rating on the ATR 42 at the ATR Training Centre in Toulouse in the year 2000. He became a commander in summer 2001.

1.5.1.2 The Commander had a national air transport pilot licence (ATPL(A)) valid until 21 June 2011 and a class 1 medical certificate with no medical limitations. His last OPC/PC (Operator Proficiency Check/ Proficiency Check) was taken on 23 August 2005. The Commander was the company's flight safety pilot.

Table 2: Flying experience - Commander

	All types	On type
Last 24 hours	4	4
Last 3 days	7	7
Last 30 days	40	40
Last 90 days	120	120
Total	7 850	2 800

1.5.1.3 The Commander stated that he had slept well and had eaten breakfast on the morning in question.

1.5.2 First Officer

1.5.2.1 The First Officer, male 29, started his flight training in the USA in 1998. He became employed by Coast Air in 2003, and then attended a training course and gained type rating on the ATR 42 at the ATR Training Centre in Toulouse.

1.5.2.2 The First Officer had a JAR-FCL commercial pilot licence (CPL(A)) valid until 31 March 2009 and a class 1 medical certificate with a limitation concerning the need for spectacles (VDL Shall wear corrective lenses and carry a spare set of spectacles). His last OPC/PC was undertaken on 28 July 2005.

Table 3: Flying experience – First Officer

	All types	On type
Last 24 hours	4	4
Last 3 days	11	11
Last 30 days	31	31
Last 90 days	115	115
Total	2 980	1 350

1.5.2.3 The First Officer stated that he had slept well and had eaten breakfast on the morning in question.

1.5.3 Cabin Attendant

The cabin attendant, female 29, became employed by the company in 2001 based in Florø. She then attended the company's training course and had since served on aircraft type ATR 42. Her cabin certificate and medical certificate were valid at the time of the incident.

1.6 Aircraft information

1.6.1 General

Manufacturer and model: Aerospatiale SNI ATR 42-320

Serial no.: 148

Year of manufacture: 1989

Airworthiness certificate valid until 31 March 2006

Engines: 2 x turboprop engines of the Pratt & Whitney PW121 type

Maximum take-off mass: 16,900 kg

Relevant take-off mass: approx. 15,100 kg

Location of centre of gravity: Approx. 22 % MAC. (Limits for take-off: 15 - 36 %)

1.6.2 De-icing/anti-icing systems

1.6.2.1 Aircraft type ATR 42 has electrical and pneumatic systems for keeping critical areas free of ice. The following illustrations have been taken from the manufacturer's brochure "Be prepared for icing":

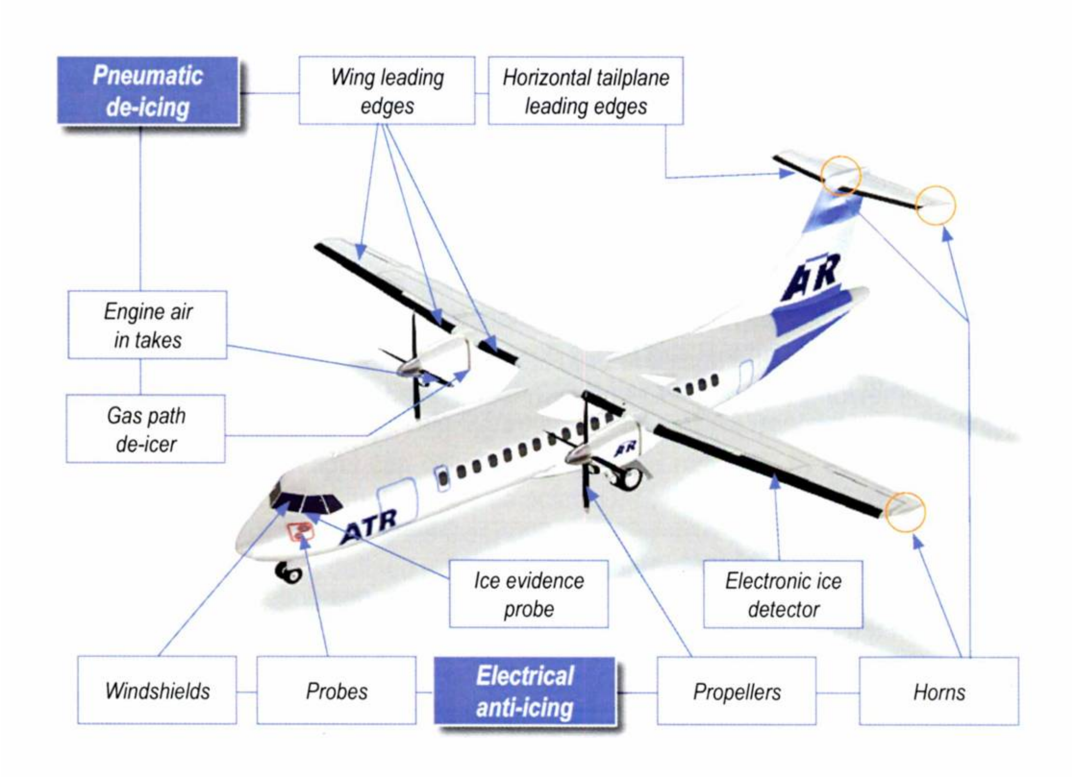


Figure 4: Example of standard system for protection against icing on ATR (The figure shows ATR 72-212A).

1.6.2.2 There is a description of the systems in the Flight Crew Operations Manual (F.C.O.M.) and Aircraft Maintenance Manual (AMM). The systems' structure and method of operation are generally typical of turboprop aircraft of this size and are not reproduced in detail here. Specialities to note are that if the anti-icing systems have not been switched on and the electronic ice detector on the wing registers ice, an "ICING" warning lamp flashes in the cockpit and an alarm sounds. The system has also been designed to ensure that the Angle of Attack (AOA), at which the stall warning is triggered in the form of the stick shaker and the autopilot disconnects, is lower when horn anti-icing is switched on. (11° instead of 18.1° in the en-route phase with flaps in). The purpose is to maintain margins for stalling when the wing profiles may be contaminated by ice. A green lamp displaying "Icing AOA" in the cockpit indicates that a lower AOA threshold value is active. The stick pusher is actuated at 20.1° when the flaps are in regardless of whether or not "horn anti-icing" is on.

1.6.2.3 The selector panel for the systems and a simple description of the systems' various levels and their use is contained in Figure 5.

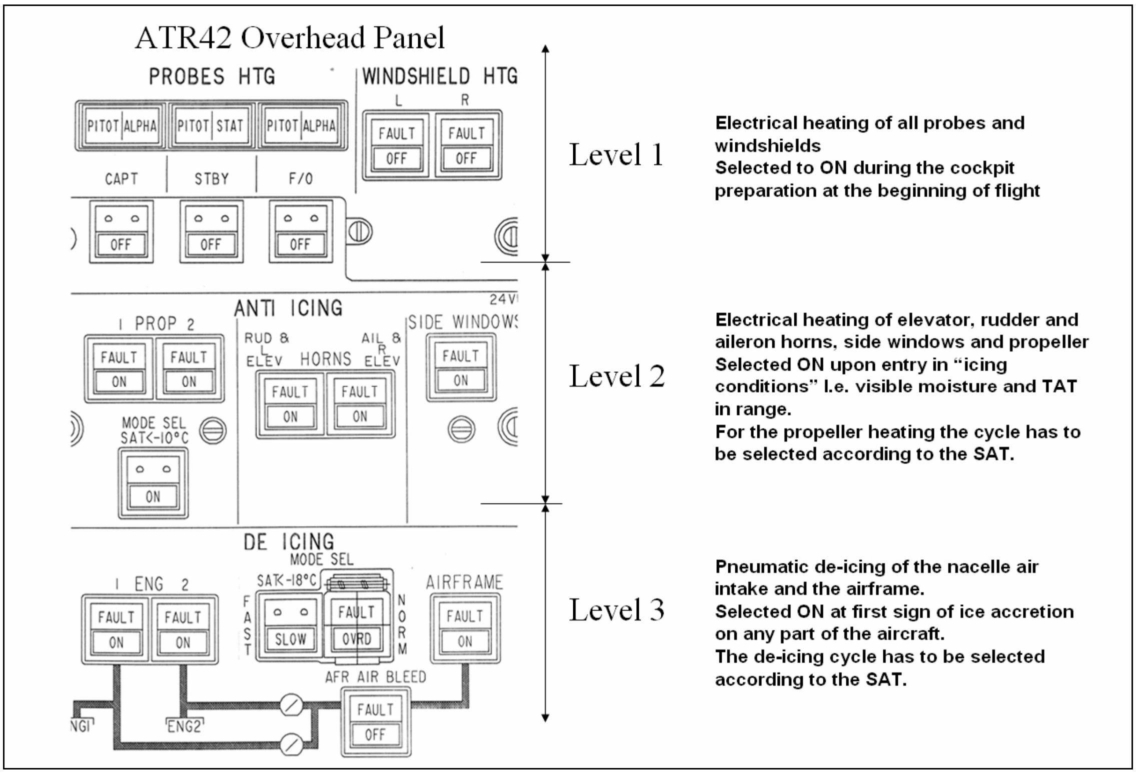


Figure 5: Description of anti- and de-icing systems levels 1, 2 and 3.

1.6.3 <u>New system for monitoring and caution of icing</u>

1.6.3.1 A new monitoring and caution system for icing has been developed at ATR. The system is called the Aircraft Performance Monitoring function (APM), and gained certification in 2005. APM differs from traditional ice warning systems by indicating the intensity of icing and its impact on aircraft performance, in addition to recording that the aircraft is in icing conditions. Individual aircraft of type ATR 42/72 which have installed the newest version of the Multi Purpose Computer (MPC) are already equipped with APM. (LN-FAO did not have this).

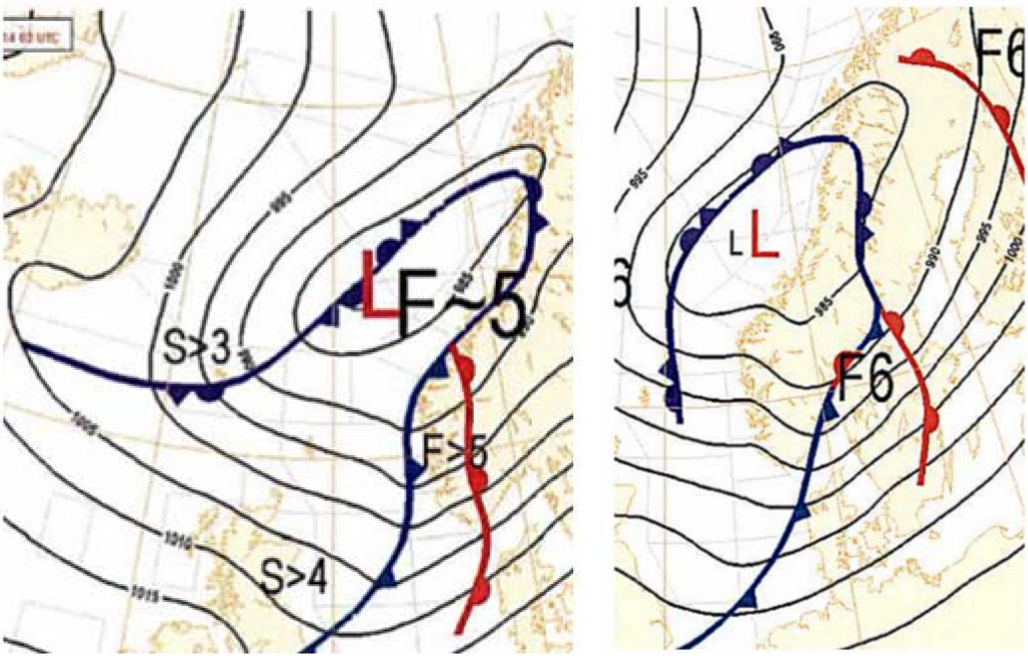
1.6.3.2 The system compares the aircraft theoretical drag with an “in-flight drag” computed with measured parameters. From this comparison, possible aerodynamic disturbances caused by icing can be detected and the crew will be alerted. APM also checks that minimum speed is maintained in severe icing conditions (“Red Bug + 10 kt”).

1.6.3.3 Different alarm messages will be activated in the cockpit depending on the scale of the difference between recorded and theoretical drag/airspeeds. The lowest level of APM warning is a light indicating “Cruise Speed Low”. It appears if the cruising speed decreases by more than 10 kt compared with the expected speed. The next level of APM warning is the “Degraded Performance” light combined with a “Caution” light and a ”Single chime”. This may be issued during climbing or cruising, and indicates either a loss of rate of climb capacity or speed decay. The third level of APM warning is the “Increase Speed” warning light combined with a flashing “Caution” light and “Single Chime”. It is activated if the speed goes below “Red Bug + 10 kt”.

1.7 Meteorological information

1.7.1 Information from the Norwegian Meteorological Institute:

> *“The weather situation on the morning of 14 Sept. 2005:*
> *A cold front had passed over western part of Norway during the course of the night. […] The front was followed by westerly winds with gusts and showers. In inner sections of western part of Norway there was still a relatively large amount of rain behind the front at 06 UTC. […] There was a great deal of precipitation during the night, new record levels in several locations, such as Bergen, which had 111 mm in 12 hours. Probing the air over Sola at 00 UTC on 14 Sept. shows high relative air humidity up to approx. FL 180. […], at 05 UTC most of the precipitation had passed the outer sections of western part of Norway, which there was still a lot of precipitation in inner sections. At 14,000 ft approx. 30 NM east of Stord at 0720 local time, the aircraft was most probably right at the back or at the front, which would explain the heavy rain they experienced. The METARs from Flesland, Stord and Haugesund show that there was rain early in the morning, then dry weather, followed by more rain again after the time in question.*
>
> *Forecast weather:*
> *During the night and on the morning of 14 Sept. an ICE MESSAGE was issued for Stavanger AOR valid up to 0630 UTC. The icing was expected to diminish once the cold front moved to the east. The TAFs for Stord, Haugesund and Flesland also show that the weather was expected to clear towards the morning. Based on these data, it would be reasonable to expect icing within this area. The conditions were probably relatively good at Stord, but when the aircraft began moving east, it came very close to or right up to the front zone with some icing (most probably moderate or more)”*
>
> …
>
> *“There was also some orographic precipitation with the westerly wind. The westerly wind lifted the moist mass of air, which again produced an increased concentration of supercooled water droplets. The temperature at 14,000 ft was most probably between -5 and -15 degrees C. Icing is often observed at these temperatures.”*



Analysis 14 Sept, 0300 UTC Analysis 14 Sept, 0600 UTC

Figure 6: Weather situation with location of fronts. The icing incident occurred at 05:23 UTC.

1.7.2 METAR (Aviation routine weather report) from Flesland

140350UTC	24017KT 210V280 3000 +RA FEW003 BKN006 13/13 Q0991=
140420UTC	30020G33KT 240V360 6000 RA FEW003 BKN012 12/11 Q0992 BECMG SCT008 BKN018 RMK WIND 1200FT AMSL 28040G56KT=
140450UTC	VRB15G25KT 7000 FEW005 BK012 12/11 Q0993 BECMG 27015G25KT 9999 SCT008 BKN018 RMK WIND 1200FT AMSL 27036G50=
140520UTC	27013G25KT 220V010 9999 FEW007 BKN012 12/11 Q0994 BECMG SCT008 BKN018=
140550UTC	26017KT 230V300 4000 RA FEW005 BKN010 12/10 Q0994 BECMG 9999 SCT008 BKN018=
140620UTC	26014G26KT 200V350 7000 -RADZ SCT009 BKN013 11/10 Q0994 BECMG SCT008 BKN018=

1.7.3 METAR from Stord

140350UTC	25028G41KT 9999 RA SCT006 BKN010 14/14 Q0993=
140420UTC	28023G44KT 9999 SCT007 BKN012 12/12 Q0995=
140450UTC	28022G34KT 9999 SCT008 BKN012 12/12 Q0995=
140520UTC	27019KT 9999 SCT009 BKN012 12/12 Q0996=
140550UTC	26016KT 220V300 9999 SCT009 BKN012 12/12 Q0996=
140620UTC	27017G27KT 210V300 8000 RA SCT007 BKN010 12/12 Q0996=

1.7.4 METAR from Haugesund

140420UTC	27033G45KT 9999 -SHRA FEW006 BKN010 13/11 Q0996=
140450UTC	28028KT 9999 FEW008 BKN015 13/11 Q0997=

140520UTC 27027G37KT 190V290 9999 SCT008 BKN015 13/11 Q0998=
140550UTC 27027KT 9999 -RA SCT009 BKN018 13/11 Q0998=
14060UTC 26027G39KT 220V290 9999 FEW009 SCT012 BKN020 13/11 Q0998=

1.7.5 ICE MESSAGE

ENSV ICE MESSAGE 01 VALID 140330/140630 ENVV –
NORWAY FIR LOC MOD ICE FCST LAN AND FJORDS BTN N5800 AND N6200 AND W OF E00730 BLW FL180. 0-ISOTHERM BTN FL070 AND FL090. WKN.=

1.7.6 TAF (aerodrome forecast) for Flesland, Stord and Haugesund:

ENBR 140200UTC 140312 20022G35KT 4000 RA SCT004 BKN008 TEMP0 0306 2500 +RA SCT002 BKN004 BECMG 0305 26015G30KT 9999 FEW010 BKN020 TEMP0 0612 SHRA SCT008 BKN012=

ENSO 140200UTC 140415 25025G35KT 9999 FEW006 BKN010 BECMG 0406 -SHRA SCT010 BKN018 PR0B30 TEMP0 0615 SHRA BKN014TCU BECMG 1214 25015G25KT=

ENHD 140200UTC 140412 27030G45KT 9999 -SHRA FEW010 BKN015 TEMP0 0406 BKN010 BECM 0609 29020G30KT TEMP0 0612 SHRA BKN014TCU=

1.8 Aids to navigation

Not relevant.

1.9 Communications

Nothing abnormal reported.

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

The aircraft was equipped with both flight data and cockpit voice recorders in line with current regulations, but the recordings had been recorded over when the incident was reported to the AIBN.

1.12 Wreckage and impact information

Not relevant.

1.13 Medical and pathological information

Not relevant.

1.14 Fire

Not relevant.

1.15 Survival aspects

Not relevant.

1.16 Tests and research

None

1.17 Organisational and management information

1.17.1 Coast Air AS

1.17.1.1 Coast Air was established in 1975 and had its main base in Haugesund. At the time of the incident, the company held a valid AOC (Air Operator's Certificate), a licence for commercial transportation of passengers, mail and freight by air, and operating permission for round-trips and photographic and advertising flights using aircraft (VFR and IFR). The company's AOC, based on JAR-OPS 1, was issued on 22 November 2000.

1.17.1.2 Coast Air was running at a considerable loss in 2001. In the following year, shareholders put in fresh capital to save the company. The company had contracts for the tendered routes Florø - Bergen and Florø - Oslo for a period of three years from 1 April 2000, and had established a secondary base in Florø. When the contract for the Florø routes was not renewed in 2003, the base was moved from Florø to Stord.

1.17.1.3 In 2004 there were major changes in the network of scheduled routes, the structure of ownership and key personnel. The company again had an injection of more capital.

1.17.1.4 At the time of the incident the company was operating ordinary scheduled traffic to nine destinations in Norway in addition to rental/charter flights. They then had two aircraft of the ATR 42 type at their disposal and six aircraft of the British Aerospace Jetstream 31 and 32EP types. The ATR 42 was used mainly on the route between Stord and Oslo, with a round trip on the morning and one in the evening every weekday.

1.17.1.5 On 23 January 2008, the board of directors at Coast Air resolved to petition for insolvency. The company was made subject to bankruptcy proceedings and all flights were cancelled with immediate effect.

1.17.2 The base at Stord

1.17.2.1 Stord was the company's technical base for the ATR 42. The company's cabin crew and pilots who only flew on the ATR 42 had in practice been based at Stord since 1 April 2003. In the premises that the company made available for operations personnel at Stord airport there was no PC available, and no occurrence reporting forms. After the incident, during an inspection at the main base in November 2005, the Civil Aviation Authority made the observation that Stord was regarded as a secondary base. In 2006, the facilities were improved. The company appointed a base manager, and applied for and was granted approval for Stord to become a secondary base.

1.17.3 Management and Nominated Post Holders

1.17.3.1 *Accountable Manager*

The responsible manager at the time of the incident was appointed and accepted as "Accountable Manager" for Coast Air in 2003. In the acceptance letter, it was cited that, as a precondition, he should familiarise himself with the conditions that apply to a licensed company and keep himself up-to-date on any changes in Norwegian aviation regulations and Norwegian aviation legislation. The CAA-N also wrote that they would later be calling him in for an interview. This interview had still not taken place at the time of the incident.

1.17.3.2 *Flight Operations Manager (Nominated Post Holder Flight Operations)*

During the period 2003-2005 the company had four Flight Operations Managers. The Flight Operations Manager at the time of the incident on 14 September 2005, took up this post at Coast Air in August 2005, and resigned from the job in November that same year. He had had 19 years of experience as a pilot on turboprop aircraft in three different Norwegian airlines, and came to Coast Air from a post as flight operations inspector in the CAA-N. At the CAA-N, for 3 years, he had been principal inspector for various small and medium-sized airlines. He had not been involved in the oversight of Coast Air.

1.17.3.3 *Training Manager (Nominated Post Holder Crew Training)*

The Training Manager at the time of the incident was taken on at Coast Air in 1997 and was among the first pilots in the company to be rated on the ATR 42 in Toulouse in 1999/2000. He became Training Manager in 2004, when the previous training manager retired. The Training Manager was an instructor and maintained valid ratings as a pilot on both the Jetstream and ATR.

1.17.3.4 *Quality Manager*

The Quality Manager took up the post in July 2004 and was formally approved by the CAA-N in November that same year. At the time of his appointment, she had recently qualified in HSE Engineering at University College at Haugesund and had 6-months of relevant work experience in shipping.

1.17.4 Company manuals

1.17.4.1 *General*

The following was the amendment status of various relevant documentation at the time of the incident:

Table 4: Documents and Manuals

Manual	Responsibility	Status
Quality manual	Quality Manager	New issue May 2005, not approved by CAA-N
OM Part A General/Basic	Flight Operations Manager	Rev. 9 10.03.2005

Manual	Responsibility	Status
OM Part B / Standard Operating Procedures ATR 42	Flight Operations Manager	Rev. 7 13.09.2002
OM Part B / Airplane Flight Manual ATR 42 (the flight manual approved by the authorities, issued by the manufacturer)	Engineering Manager	Rev. 24 Jan 2005
Flight Crew Operation Manual F.C.O.M. located in the aircraft (Manufacturer publication)	Engineering Manager	Rev. 33 01.04.2005
Quick Reference Handbook (QRH) located in the aircraft (Manufacturer publication)	Engineering Manager	Updated with current procedures by manufacturer
OM Part D Training	Training Manager	Rev. 2 18.12.2003 (New courses)
Flight Crew Operation Manual F.C.O.M. (Manufacturer publication without revision service)	The individual pilot	Was not followed up
Personal Quick Reference Handbook (QRH) for pilots (Manufacturer product without revision service)	The individual pilot	Was not followed up
OPS INFO Information document for pilots	Flight Operations Manager	Undated, revision status was not followed up

1.17.4.2 *Airplane Flight Manual ATR 42*

In October 2003, the manufacturer ATR issued a temporary revision to AFM for the ATR 42. The revision comprised of "boxing in" six items in the emergency procedures for handling a severe icing situation, which means that the flight crew has to know these items by heart. The layout was also adjusted, while the other content was unchanged since the version issued in 2002. This authority approved revised procedure was permanently incorporated in the AFM in January 2004 (Figure 7). In general, the emergency procedure should be executed as quickly as possible when entering severe icing.

The procedure makes it clear that the bug for minimum speed should be increased to 10 kt above the normal icing speed, the engine controls should be set to 100 % / Max Continuous Torque, the autopilot should be disconnected, one should escape from the severe icing conditions and the air traffic service should be notified. These elements should be known off by heart by the crew, so that they are not delayed by having to search out and read the checklist. If the situation develops such that unusual roll response or uncommanded roll control movement occurs, the stick must be pushed firmly forward, while flaps should also be extended 15°. (Maximum speed for flaps 15° is 170 kt). The point about setting the flaps has not been boxed in.

The following notice has been issued in conjunction with severe icing *(AFM Limitations 2.06)*:

> *"Severe icing may result from environmental conditions outside of those for which the airplane is certificated. Flight in freezing rain, freezing drizzle, or mixed icing conditions (supercooled liquid water and ice crystals) may result in ice build-up on protected surfaces exceeding the capability of the ice protection system, or may result in ice forming aft of the protected surfaces. This ice may not be shed using the ice protection systems, and may seriously degrade the performance and controllability of the airplane."*

In *severe icing*, therefore, it is necessary to change course and/or altitude instantaneously since the aircraft's anti- and de-icing systems cannot handle these conditions. A characteristic of severe icing is said to be ice formation on the side windows, and/or that there is an unexpected decrease in speed and climb rate. Water which splatters and streams on the front windshield and ice build-up at the back of the spinner and on the airframe in places where ice does not normally collect are given as secondary indications. In addition, it is stated that visible rain and large droplets with an outside temperature of around 0 °C could lead to severe icing.

The normal procedure for flight in icing conditions with visible ice build-up involves, among other things, setting NP (propeller RPM) equal to or higher than 86 %, all anti-/de-icing systems being switched on, continuous relight on the engines, bug marking of the minimum icing speed and monitoring of ice build-up to check whether the situation develops into severe icing. (AFM Normal Procedures 3.02.01).

AFM Procedures Following Failures, Systems, Autopilot 5.04.08 contains a description that includes a method of proceeding when a warning light indicates that the ailerons are out of trim (second bullet point in the procedure):

- If any unusual situations are observed such as:
  - excessive lateral trim is required
  - illumination of the AILERON MISTRIM message on the ADU
  - abnormal flight characteristics of the airplane

AP ………… DISCONNECT HOLDING FIRMLY THE CONTROLS AND FLY MANUALLY PRIOR TO ADJUSTING THE LATERAL TRIMS. The autopilot may be reengaged following adjustment of the lateral trims.

ATR 42 AFM	EMERGENCY PROCEDURES MISCELLANEOUS	4_05	
		PAGE : 5	001
		DGAC APPROVED	JAN 04

R

4 . 05 . 05 – SEVERE ICING

MINIMUM ICING SPEED	INCREASE RED BUG by 10 kt
PWR MGT	MCT
CL / PL	100% / MCT
AP (if engaged)	FIRMLY HOLD CONTROL WHEEL and DISENGAGE
SEVERE ICING CONDITIONS	ESCAPE
ATC	NOTIFY

- **If an unusual roll response or uncommanded roll control movement is observed :**

  Push firmly on the control wheel

  FLAPS 15

- **If the flaps are extended, do not retract them until the airframe is clear of ice**

- **If the aircraft is not clear of ice :**

  GPWS .... FLAP OVRD

  STEEP SLOPE APPROACH (≥4.5°) .... PROHIBITED

  APP/LDG CONF .... MAINTAIN FLAPS 15

  .... with "REDUCED FLAPS APP/LDG icing speeds" + 5 kt

  Multiply landing distance FLAPS 30 by 1.22

Figure 7: The manufacturer's published emergency procedure for severe icing (continued on next page).

ATR 42 AFM	EMERGENCY PROCEDURES	4–05	
	MISCELLANEOUS	PAGE : 6	001
		DGAC APPROVED	JAN 04

4.05.05 SEVERE ICING (Cont'd)

R **DETECTION**

Visual cue identifying severe icing is characterized by ice covering all or a substantial part of the unheated portion of either side window

and/or

Unexpected decrease in speed or rate of climb

and/or

The following secondary indications :

. Water splashing and streaming on the windshield

. Unusually extensive ice accreted on the airframe in areas not normally observed to collect ice

. Accumulation of ice on propeller spinner farther aft than normally observed.

The following weather conditions may be conductive to severe in–flight icing :

. Visible rain at temperatures close to 0°C ambient air temperature (SAT)

. Droplets that splash or splatter on impact at temperatures close to 0°C ambient air temperature (SAT)

Figure 7: The manufacturer's emergency procedure for severe icing (part 2)

1.17.4.3 *Standard Operating Procedures ATR 42*

Coast Air issued its Standard Operating Procedures (SOP) for aircraft type ATR 42-320 in February 2000. SOP was one of several elements which, in combination, made up the flight operations manual approved by the authority, Operations Manual Part B. The last revision recorded when the incident occurred was dated 13 September 2002 (rev. no. 7). All of the airline's ATR pilots had been issued with their own copy of the SOP. Systems were established for the pilots to acknowledge receipt and amendment of the SOP. The procedures for icing in Coast Air's SOP for the ATR 42 were not updated in accordance with the manufacturer's revisions. Section 4 Chapter 3 *"Expanded checklist if entering* *icing conditions"* referred to the Quick Reference Handbook (QRH): *"In case of severe icing, read checklist in QRH"*.

Section 5 contained *"Abnormal Operation and Emergency Procedures"*, and Chapter 2 dealt with flying in icing conditions. Among other things, the chapter contained system descriptions and several (other) checklists for flying in icing conditions. Here too there was reference to other sources of severe icing: *"BE ALERT TO SEVERE ICING DETECTION. In case of severe icing, refer to F.C.O.M. 2.04.05"*

At the time of the incident, Coast Air had no written policy on the use of weather radar. The CAA-N has confirmed that such a policy was established afterwards, and that the company updated its procedure for severe icing in Operations Manual Part B.

1.17.4.4 *Flight Crew Operations Manual*

Coast Air subscribed to three copies of Flight Crew Operations Manual (F.C.O.M.) from ATR. There was one copy in each aircraft. The Engineering Manager had responsibility for keeping this manual up-to-date. The pilots each got their copy of the F.C.O.M. without the revision service in conjunction with type rating training.

1.17.4.5 *Quick Reference Handbook*

There was a Quick Reference Handbook (QRH) in the aircraft that the Engineering Manager was responsible for keeping up-to-date. The pilots had their personal QRH, without revision services. This manual was also a compendium from the training course which every individual was able to retain, and which could gradually be supplemented with various pieces of useful information. According to the company, the QRH in the aircraft was updated with the newest procedure for "Severe Icing" when the incident occurred.

1.17.4.6 *OPS INFO*

In September 2005, the Flight Operations Manager discovered, by coincidence, that there were two-year-old revisions from the manufacturer, intended for Operations Manual (B), which had still not been implemented. The chief pilot ATR was ordered immediately, by the Flight Operations Manager, to check the aircraft's documentation on this point. It was shown that revisions had been made to the checklist for "*Severe Icing"* in the QRH on board the aircraft. The Flight Operations Manager stated that he ordered the immediate issue of information to the pilots about this important discovery.

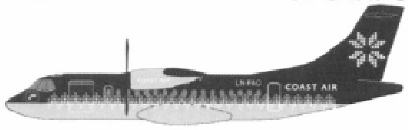
The day before the incident, the information was issued in the form of *"OPS INFO ATR 1/2005"* (Figure 8). The information document is undated. The text was taken from general informational material from ATR, and this explains why some figures were missed out (replaced by xx and yy). Page 2 in the manufacturer's procedures dealing with detection, in other words the characteristics that the pilots should be looking out for, were not included in this info document. The chief pilot concluded the info document with the comment *"Please study the […] procedure, and you may copy this into your personal Quick Reference Handbook."*

According to the standard text at the bottom of the form itself, OPS INFO should be inserted into the SOP and will be valid for the year of issue. After that it should be destroyed.

At the time of the incident, the company had no monitoring system as regards whether documents of this type had been received and read. The Flight Operations Manager has declared that the OPS INFO system at the time of the incident was being reorganised.

The crew of the CST602 thought they remembered having received OPS INFO in their pigeon-holes on the day before, the same day or the day after the incident occurred. However, they had not picked up particularly on details of the content or reflected in any concrete way on what the changes meant.

COASTAIR OPS INFO ATR 1/2005



NEW SEVERE ICING PROCEDURES

Please observe that a new procedure has been established in Quick Reference handbook, with 6 new MEMORY ITEMS!!!

SEVERE ICING

MINIMUM ICING SPEED .... INCREASE RED BUG by 10 kt
PWR MGT ....MCT (if needed)
CL/PL...... ....100%/MCT
AP (if engaged)FIRMLY HOLD CONTROL WHEEL and DISENGAGE
SEVERE ICING CONDITIONS ....ESCAPE
ATC.. NOTIFY

- **If an unusual roll response or uncommanded roll control movement is observed :**
  Push firmly on the control wheel
  FLAPS 15
- **If the flaps are extended, do not retract them until the airframe is clear of ice.**
- **If the aircraft is not clear of ice :**
  GPWS.. FLAP OVRD
  STEEP SLOPE APPROACH (≥4.5°) ....PROHIBITED
  APP/LDG CONF .... MAINTAIN FLAPS 15
  with "REDUCED FLAPS APP/LDG icing speeds" + 5 kt
  Multiply landing distance FLAPS xx by yy, depending on aircraft.

Please study the enclosed copy of the new procedure, and you may copy this into your personal Quick Reference Handbook.

XXXXXX
XXXXXXX
Chief Pilot

OPS INFO IS TO BE INSERTED IN SOP AND ALL OPS INFO IS VALID FOR THE YEAR IF ISSUE, AND SHALL THEREAFTER BE DESTROYED.

Figure 8: OPS INFO ATR 1/2005.

1.17.4.7 *Quality manual*

In May/June 2005, the company stated that it had submitted its new quality manual for approval to the CAA-N. In return, in August/September 2005, notification arrived that it had not been approved, without specification of what would have to be changed. After that the Quality Manager drew up a new draft in consultation with the Flight Operations Manager. The CAA-N stated that it did not have time to evaluate this ahead of the planned inspection of the company on 1 and 2 November 2005, so that a new submission could wait.

1.17.4.8 *Flight safety programme and occurrence reporting*

AIBN knows that, during its inspection in November 2005, the Civil Aviation Authority remarked that the company had not fulfilled the requirements for the flight safety programme in accordance with JAR-OPS 1.037. In 2002, one of the findings was that the company's flight safety programme did not appear to have been implemented sufficiently within the organisation, and that the system was very person-dependent. The CAA-N remarked then that regular information concerning hazards and preventive measures had only been issued on a small scale. Both in 2002 and 2004 remarks were made on the company's occurrence reporting scheme.

Since the quality system and flight safety programme were being redrafted when this incident was being investigated, the AIBN chose not to go into more depth in this area.

At an early stage of the investigations, the AIBN noted that Coast Air had relatively recently brought into operation an electronic deviation reporting system. Approx. 70 deviation reports were recorded in the system in 2005. There were no reports that dealt with the problem of icing before the relevant incident occurred. It was not possible to file reports anonymously in this system.

1.17.5 <u>Training, exercise and checking of the pilot's knowledge and skills</u>

1.17.5.1 Coast Air did not have approval as a type training organisation (TRTO) and therefore applied to the CAA-N for approval of individual courses when required, which is acceptable according to JAR-FCL. The CAA-N has stated that approval of individual courses involves, among other things, verifying that the programme contains both a theory part and simulator flight, and that the instructors being used have the necessary qualifications. The content is not evaluated in detail. During the period 2000-2005, according to the CAA-N, Coast Air held 4 individual courses with a total of 8 candidates on the ATR 42.

1.17.5.2 Coast Air purchased a technical course for pilots on the ATR 42 from Finnair in Helsinki. There, they also hired a simulator for type rating training, proficiency tests and proficiency checks. Training in the simulator took place under Coast Air's management with the company's own instructors/type rating inspectors.

1.17.5.3 The company has stated that the flight crews were given 4 hours in the simulator during the six-monthly proficiency checks. The training was carried out in one day, and the journey to and from Helsinki took place using discounted "stand by tickets", and therefore without confirmed seating. They started their journey in the morning and returned in the evening. Most of the simulator time was spent on going through the mandatory programme specified by the authorities. All technical systems were gone through on CBT (Computer Based Training) during the course of a three-year period.

1.17.5.4 The Training Manager stated that they took up relevant safety systems in conjunction with the periodic training courses/checks, and that they always practiced stall recovery in various configurations. The first items in the procedure when the stick shaker actuated in a clean configuration (gear up, flaps 0°), was that the person flying should say *"Stalling"*, immediately advance power, level the aircraft's nose 2-3° above the horizon and say *"Set max power – flap 15"*. The second pilot should do the manual actions and respond *"Max power set – flap 15° selected"*. (Coast Air SOP Section 5 Chapter 1 Page 12.0). The flaps should be selected up again once speed goes above bug speed (in icing situations this is the red bug, i.e. minimum icing speed flaps 0). The Training Manager has stated that it was common for the pilots to forget to extend the flaps in conjunction with this exercise. When this happened, the exercise was repeated.

1.17.5.5 The simulator was equipped with the "icing data package" from ATR, and was able to simulate four different icing scenarios. Two of the scenarios were related to the effect of deficient de-icing prior to take-off. The two others simulated "Standard Icing" and "Severe Icing", respectively, in the en route phase. "Standard Icing" shows what happens if the de-icing systems are not actuated. It leads to a stall warning followed by an asymmetrical stall. The "Severe Icing" scenario leads to a warning about ailerons being out of trim, after which the autopilot disconnects and the aircraft banks. As a result of ice build-up in connection with the ailerons, it is necessary to use a lot of power on the stick to regain a horizontal position and keep the wings level.

1.17.5.6 Training in handling icing was included in the type rating training for those pilots who went on the course in Toulouse, but not in the subsequent periodic training courses. Coast Air had not used the simulator in Helsinki for training on the icing scenarios mentioned before the incident occurred. The Training Manager has stated that the icing scenarios did not appear on the simulator's default menus, and that he was not aware that the option was available. According to Finnair, their simulator has had icing scenarios for several years. On their Internet page, they advertise that Airframe Icing is one of the ATR simulator's "Additional Capabilities". Finnair has also stated that ATR has tested the simulation and confirmed that it complies with data from the manufacturer.

1.17.5.7 The Flight Operations Manager ensured that the crew involved was given refresher training in the simulator as quickly as possible after the incident. In conjunction with this, the company became aware of the icing scenarios that were included in the simulator, and these were used. The cabin attendant and the operations inspector from the CAA-N were also present in the simulator. Everyone stated that this was realistic and extremely useful. After this, the icing scenarios were incorporated into the type rating course and inserted as a programme item in the OPC for all of the company's pilots.

1.17.5.8 Another measure on the part of the company was that they issued an information document to the pilots which reproduced the sequence of events for the incident in question. (OPS INFO ATR 4/2005 "A Reminder that icing conditions are starting now"). This information document contained the manufacturer's description of the characteristic signs of severe icing, warnings against flying at too low a speed in icing conditions, a recommendation to climb in a westward direction before setting course for the mountains and a request to use the weather radar more often. It was also stated that everyone would be given simulator training covering severe icing.

1.17.6 Supplementary information from the manufacturer

1.17.6.1 The manufacturer, ATR, has stated that they send out the information booklet “Be prepared for icing” with an associated CD, free-of-charge, to everyone who wishes to have this material. Among the items dealt with in the booklet are meteorology, interpretation of weather forecasts, description of relevant systems’ methods of operation, performance and severe icing. The CD contains several video clips from simulator flight, including one that shows what happens if the crew do not register that they have entered a severe icing situation before abnormal rolling movements occur. The crew in the video clip gain immediate control over the aircraft by selecting flaps 15°. After that, they carry out the items that should be known by heart on the checklist for “Severe Icing” and start a descent.

1.17.6.2 An instructor from the ATR Training Centre visited Coast Air in 2002 and provided information on new procedures in icing conditions. The “Be prepared for icing” booklet was then distributed to all of the company’s pilots. As mentioned, the manufacturer changed the procedure for severe icing in 2003, and in October 2003, the booklet in question was also revised. After the incident in September 2005, Coast Air approached ATR and was sent a number of new information booklets and CDs.

1.17.6.3 ATR has made the following comments to the AIBN as regards the stall warning system operating method and the procedure for stall recovery:

> *”The Stall recovery is considered as part of the basic training and basic airmanship as our aircraft has a classical behaviour (as similar twin engine turboprop) in such a condition. Furthermore the ATR is equipped with stall protection devices such as the stall warning, stick shaker and stick pusher. These devices are triggered at different angle of attack when approaching from the real AOA of stall. These thresholds are lowered in icing condition (upon selection of the horn anti-icing, the "icing AOA" is triggered), then these devices may activate before the clean aircraft thresholds. Then in normal conditions, the flight crew never experience stall as all the protection will be activate to prevent such occurrence. But in severe icing conditions (out of the scope of the certification), premature stall may occur if the flight crew do not apply the procedures for such conditions. For that reason we estimated necessary to include the stall recovery procedure within the emergency section of the AFM, and linked to the severe icing encounters.”*

1.17.6.4 In a comment about the item on setting flaps to 15° in the event of a roll upset not being boxed in (not being assumed that it should be learnt by heart), the manufacturer writes as follows:

> *”The "boxed items" are the ones to be performed rapidly in such unusual encounters and to prevent the occurrence of roll upset or premature stall. If correctly applied, the items out of the box would not then be used.”*

In addition, ATR has commented that the flap item cannot just be incorporated among “boxed items”, since abnormal roll movements do not necessarily occur even if severe icing is experienced.

1.17.7 Additional information from the French accident investigation authority

1.17.7.1 The French accident investigation authority (BEA) provided the information that they are investigating an icing incident involving an ATR 42 which occurred in 2007. In connection with this, BEA has also discovered that flight crews are not familiar with the paragraph covering flaps to be set to 15° if abnormal roll movements occur. BEA has been in discussions with the French aviation authority, DGAC (Direction Générale de l'Aviation Civile) as to whether this paragraph ought to be changed to be a "Memory Item". Also the APM system (ref 1.6.3.1) and the possibility of mandating this is being assessed by BEA and DGAC.

1.17.7.2 The latest information received by the AIBN is that, on 18 March 2008, the DGAC wrote a letter to the European Aviation Safety Agency (EASA) entitled "*Icing Concerns Relative to ATR Aircraft*". In the letter, the DGAC recommends that EASA mandate all ATR operators to retrofit their aircraft with the APM if they are not already equipped. They also recommend that EASA reconsider the flaps 15 degrees item as to being a memory item in case of loss of control.

1.17.8 Extract from relevant regulations

1.17.8.1 *Requirements for flight safety programmes etc.*

BSL JAR-OPS 1.037 *"Accident prevention and flight safety programme"* required:

"(a) An operator shall establish and maintain an accident prevention and flight safety programme, which may be integrated with the quality system, including:

> *(1) Programmes to achieve and maintain risk awareness by all persons involved in operations; and*
>
> *(2) An occurrence reporting scheme to enable the collation and assessment of relevant incident and accident reports in order to identify adverse trends or to address deficiencies in the interests of flight safety. The scheme shall protect the identity of the reporter and include the possibility that reports may be submitted anonymously; and*
>
> *(3) Evaluation of relevant information relating to accidents and incidents and the promulgation of related information, but not the attribution of blame […]"*

The introduction and first section of the regulation paragraph contained general conditions and basis for an accident prevention and flight safety programme, but did not provide more specific detail. For more detailed guidelines, reference was made to Advisory Circulars Joint (ACJ) OPS 1.037 in JAR-OPS Section 2 "Acceptable Means of Compliance and Interpretative/Explanatory Material (AMC & IEM), in which further reference was made to ICAO Doc 9422 (Accident Prevention Manual), ICAO Doc 9376 (Preparation of an Operations Manual) and CAP 739 as guidance documents for drawing up a programme of this type.

On 16 July 2008, BSL JAR-OPS 1, dated 1 March 2007, was replaced by EU-OPS as valid regulations for commercial aviation operations in Norway. The new regulation is based largely on the old rules in JAR-OPS 1, and paragraph OPS 1.037 still requires that an "Accident Prevention and Flight Safety Programme" are set up and maintained. The regulation paragraph is similar to the corresponding regulation paragraph in the previous regulation BSL JAR-OPS 1, with the exception of a minor adjustment to sub-paragraph (a) (4) about flight data monitoring programme.

A significant difference between the two regulations is that EU-OPS no longer contains "section 2" (guidance materials). The CAA-N has issued the following information about this: "*EU-OPS does not contain the guidance material that one are used to from JAR-OPS 1 Section 2. In this context, the EU Commission has stated that the national aviation authorities can use JAR-OPS 1 Section 2 in the cases in which EU-OPS does not constitute a complete rule, and that the use of this material does not come into conflict with the provisions of EU-OPS in any way. However, it should be noted that Section 2 will not be part of EU-OPS. Rights and obligations cannot therefore be based on Section 2 materials alone".*

The two ICAO documents, to which ACJ OPS 1.037 referred, are currently superseded or consolidated by ICAO Doc 9859 "Safety Management Manual". The factors emphasised in this manual include the significance of an operator carrying out risk or safety assessments of its own operations. In Chapter 13, it is maintained that: *"Safety Assessments provide another proactive mechanism for identifying potential hazards and finding ways to control the risks associated with them".*

Chapter 5.3.6 lists activities that are key to ensuring that organisations succeed in operating their safety programmes/management systems well in practice. These would include safety assessments in the event of any changes, 5.3.6 (b): *"Safety assessments: They systematically analyse proposed changes to equipment or procedures to identify or mitigate weaknesses before change is implemented".*

1.17.8.2 *Requirements for knowledge about icing on aircraft*

Requirements for a knowledge of theory for the air transport pilot licence (ATPL) and instrument rating (IR) relating to icing on aircraft are specified in JAR-FCL 1, Section 1, Chapter J, subparagraph 050 09 00 00 *"Risk elements connected with flying"* in the summary of tables. The elements of icing, weather conditions for ice accretion, topographical effects, types of ice accretion, hazards of ice accretion, and how to avoid the hazards are in the syllabus.

Previously, the textbook *Flymeteorologi* [Aircraft meteorology] were used at Norwegian flying schools (Dannevig, P. 1969). This textbook is no longer available. Today's textbooks on ATPL theory are usually in English and not as comprehensive as the book by Dannevig. The Flymeteorologi book was written for Norwegian pilots and deals with Norwegian flying conditions which are often linked to more extreme winter conditions than might be encountered in other countries. Among other things, the book has a chapter called *"Isingsforholdene langs vanlige flyruter"* [Icing conditions along common air routes] in which the Folgefonna area is mentioned. The following text is taken from the book:

> *"…Map showing precipitation in Norway shows a strong increase from the coast towards the mountain slopes, but then a decrease in toward the central mountainous part. We find this maximal zone as far north as in Troms, but it is particularly noticeable between Vestfjorden and Fosna and from Stadlandet to Rogaland. The distance from the coast may be 25 to 50 km, varying somewhat with the terrain conditions. Here annual precipitation can regularly be up to double, even triple in some places, of what we otherwise get along the coast. This*

is given particular expression in the major glaciers, which often reflect favourable terrain conditions for precipitation.

Now there is no direct link between icing and volume of precipitation. But the process resulting in precipitation, would also indicate icing at a certain stage. Where the clouds have been activated, they will be richer in supercooled water.

Many cases of icing having led to difficulties are known from the region from the Bodø area to Namdalseid, close to Stadlandet and around Folgefonnen…"

"…On the windward sides of mountains, stationary icing zones can be quite extensive. Ice can form at the same height over a longer time; the intensity is usually light to moderate. But when warm, unstable air rises, it can release large volumes of water leading to severe icing.

It can be particularly bad if an active cloud system intensifies towards the mountain. In this type of situation – which normally also results in heavy precipitation – at a certain stage it can become a mixture of black ice and white ice, often with a light covering of snow which becomes attached. This thick type of mixture can form a layer very quickly even if the temperature is fairly low. In this situation very difficult conditions may be experienced.

It will be particularly bad if the cloud system is orientated along the mountain and if the flight is also moving in this direction. It will be possible to avoid the worst areas by heading out over the sea or by maintaining a level of more than double the height of the mountain. However, the safest think is obviously to fly on the leeward side…"

1.17.8.3 *Regulations on operations manuals*

BSL JAR-OPS 1 Subpart P contained requirements for items such as structure, content, amendment, distribution and approval of manuals. 1.1040 *(k) General rules for operations manuals* read thus*:*

"An operator must ensure that information taken from approved documents, and any amendment of such approved documentation, is correctly reflected in the Operations Manual and that the Operations Manual contains no information contrary to any approved documentation."

1.17.8.4 *Regulations on notification, reporting and preservation of data after serious incidents*

The reporting obligation of the crew and the operator in the event of accidents and incidents was stated in BSL JAR-OPS 1.085 and 1.420 and the national regulation on mandatory notification and reporting of aircraft accidents, incidents, occurrences and similar events (BSL A 1-3).

In compliance with the current BSL A 1-3, incidents should be notified by telephone to the AIBN as quickly as possible, followed by a report in writing on the standard form indicated, within 72 hours. In the list of incidents for which there is a mandatory obligation to notify and report to the AIBN, the following examples were included:

"- Severe icing which has led to loss of altitude" and

"- System failures, weather phenomena, operations outside the approved flight envelope or other occurrences which could have caused difficulties controlling the aircraft".

According to BSL A 1-3, any company possessing a licence/operating permit from the CAA-N to operate a commercial aviation business is obliged to incorporate the content of the regulation into its operations manual.

BSL JAR-OPS also required the description of how an incident should be dealt with, notified and reported to be included in the company's manuals (JAR-OPS 1 Subpart P, 11).

After an incident for which reporting is mandatory, the operator should retain FDR data for 60 days unless otherwise agreed with the AIBN. This is published in the regulations on retention, submission and use of FDR data, ref. BSL JAR-OPS 1.160:

"(2) Unless prior permission has been granted by the Authority, following an incident that is subject to mandatory reporting, the operator of an aeroplane on which a flight recorder is carried shall, to the extent possible, preserve the original recorded data pertaining to that incident, as retained by the recorder for a period of 60 days unless otherwise directed by the investigating authority."

This requirement has been retained unaltered in EU-OPS.

1.17.8.5 *Joint European regulations on regulatory oversight of operations*

The Norwegian Civil Aviation Authority has stated that they have chosen to adhere to the joint European regulations on the authority's regulatory oversight of operators that have an AOC[4]. The regulations are described in *JAA Administrative & Guidance Material,* Section Four: *Operations,* Part Two: Procedures (JAR-OPS).

The policy and competence that the aviation authority must have when it comes to evaluating the operators' quality systems and flight safety programmes is described in Chapter 3, *NAA Operations Policy and Organisation*.

Chapter 3.1 *General*, subpara. 3.1.2 *Competency* reads thus:

The Authority's operations department must be competent to:

- Determine the adequacy, relevance and consistency of AOC holders compliance with the requirements;

- Assess the efficiency of operators' internal monitoring procedures and confirm the availability of sufficient resources and proper processes, as documented by AOC holders Quality System; and

- Verify, by means of inspections, compliance with the requirements and the effectiveness of AOC holders Quality System and Safety Management System (SMS)/Accident Prevention Programme.

[4] *Ref. pt. 3.5.2 in ICAO Final Safety Oversight Audit Report – Norway, dated February 2007*

The implementation is discussed in Chapter 5: *Procedure for assessing the continued competence of an AOC holder*.

Chapter 5.1, *General, subpara.* 5.1.4 reads thus:

> *"The Authority must continue to assess the operator's compliance with all the requirements in JAR-OPS including the effectiveness of the Quality System (and the Maintenance Approval Statement). If the Quality System, by being judged to have failed in its objectives, ceases to be "acceptable to the Authority", this is in itself a breach of the requirements which may call into question the validity of the AOC."*

Through its surveillance of operators, the CAA-N's duties must therefore include assessing whether the operator's quality system is working as intended. If the quality system stops being "acceptable to the authority" because it has been assessed as not having achieved its purpose, this is in itself a breach of the regulations of such a nature that it could be grounds for asking questions as to the extent to which the operator's AOC can continue to be valid.

Chapter 5.4, *Inspections*, subpara. 5.4.4:

> *"The number or the magnitude of the deficiencies identified by the Authority will serve to support the Authority's continuing confidence in the operator's competence or, alternatively, may lead to an erosion of that confidence. In the latter case the Authority will need to review, with the Operator's Quality Manager, any identifiable shortcomings of the Quality System."*

If the CAA-N begins to doubt the operator's competence, it must therefore, together with the company's quality manager, review the quality system with a view to uncovering errors and omissions.

The guidelines also describe the aviation authorities having to adapt both inspection intervals and focus on the basis of the status of the airline and the operations in which they are involved (Chapter 5.4 *Inspections*, subpara. 5.4.2 and Appendix 5 Continued competence of AOC Holder, subpara. 1.1).

Chapter 8: *Procedures for the variation, suspension and revocation of an AOC by the Authority,* 8.1.1 - 8.1.2:

> *"An AOC must be varied, suspended or revoked if the Authority can no longer be satisfied that the operation is safe. The circumstances which might lead the Authority to this course of action are too many or varied to be listed. The Authority's inspection and monitoring process may serve to confirm the Authority's continued confidence in the effectiveness of the operator's Quality System and his ability to conduct a safe operation. If the Authority is not satisfied, the operator must be informed in writing of the details of the conduct of his operation which are causing the Authority concern. The Authority will require remedial action to be taken within a specified period.*
>
> *In the event that an operator fails, in spite of warning and advice, to satisfy the Authority's concerns, a final written warning should, whenever possible, be given to the operator together with a firm date by which specified action to satisfy the Authority must be taken. It must be made clear that failure to satisfy the Authority may result in enforced variation or suspension of the AOC."*

Sanction options, if the CAA-N no longer has confidence in an operator's competence, would therefore include changing, suspending or withdrawing the company's AOC. Before the Authority takes such a step, the company must be given written feedback about what the problem is, and a deadline for implementing corrective action. If this is not adhered to by the company, the CAA-N must give a final written warning with a deadline and an indication of the concrete measures that will be required to avoid the AOC being changed or made invalid.

1.17.9 The CAA-N's oversight of Coast Air during the period 2002 - 2005

1.17.9.1 Through its surveillance, the CAA-N assesses whether the airlines are adhering to the conditions specified at the time of first approval (initial evaluation for approval). According to the CAA-N database, initial inspection for JAR OPS approval was carried out at Coast Air in autumn 1999 with no remarks. The CAA-N has stated that the following flight operative inspections were carried out at Coast Air during the period 2002-2005:

Date	Location	
22 August 2002	Secondary base Palermo, Italy	
22-25 October 2002	Main base Haugesund and secondary base Florø	
22-23 October 2003	Main base Haugesund	
01-02 September 2004	Main base Haugesund	
01-02 November 2005	Main base Haugesund	(6 weeks after the incident)

1.17.9.2 The topics reviewed during the inspections varied somewhat from one time to another. Organisation and management, quality systems/flight safety programme, Operations Manual (OM)/ other flight operations documentation and training of flight crews were assessed during all inspection at the main base. Other topics that came up at one or more of the five inspections were the flight duty time system, registration/monitoring, equipment, flight planning, flight authorisation, dangerous goods, ground operations, general safety procedures and inspection of aircraft.

1.17.9.3 The inspection reports give an introductory explanation of the purpose of and authority for inspections. After that there is an explanation of terms, from which the following quotation has been taken:

> ***"Finding ["Avvik"]*** *is a breach of, or non-compliance with, the aviation regulations in respect of which the operator has been approved. Findings must normally be responded to within 30 days. If the CAA-N considers that satisfactory feedback has not been given before expiry of the deadline, this may mean that all of the operation's approvals, or parts thereof, will be withdrawn.*
>
> ***Observation*** *is a minor deviation from the aviation regulations in respect of which the operator has been approved, or purely recommendations that have been put forward as proposed improvements. The observations do not need to be responded to, but the operator can still choose to comment on these.*
>
> ***Recommendation*** *is a proposal that is based on the collective assessment of individual remarks or comments in the report summary. The operator itself can choose to use the recommendation internally within its organisation. Recommendations do not need to be responded to nor commented upon.*

> ***Order ["Pålegg"]*** *should be regarded as a directive issued by the CAA-N concerning measures that the operator must implement within a given period of time. Orders must be responded to, with the exception of orders on responding to findings, in which a deviation form that has been signed for will be regarded as feedback."*

1.17.9.4 The following general comments linked to the company's quality system and documentation have been taken from the "prose section" (the formulations are not quotations of findings or observations) in the reports from the four inspections that the CAA-N carried out at the company's main base during the period 2002-2005:

October 2002

> *"The company's document management system cannot be said to be satisfactory, the lines of responsibility for documentation and corrections of the various manuals are unclear, and in parts the references between the various manuals are deficient and misleading."*

The CAA-N identified 6 findings and described 11 observations. The AIBN estimates that all findings and most of the observations are related to the quality system, flight safety programme and/or flight operations documentation.

October 2003

> *"The company was last inspected in October 2002, at which time the CAA-N pointed out a number of deficiencies in the company's documentation system and quality system. Special attention was devoted to these elements during this inspection. The impression gained by the CAA-N is that there are still deficiencies in these systems, a fact which in itself gives grounds for concern."*
>
> *"As regards the company's documentation system, this appears to be unclear and not satisfactorily coordinated."*
>
> *"It is clear from the Quality Manager's report that no deficiencies have been discovered during the company's operational activities other than those which were pointed out by the CAA-N in October 2002. The CAA-N finds this circumstance rather remarkable since, among other things, a number of deficiencies appear in the company's documentation system."*

The inspection resulted in 4 findings and 2 observations. One of the findings was that 6 previous remarks were insufficiently attended to in relation to the company's description of corrective measures. Another was that the quality system had not been implemented satisfactorily within the organisation.

September 2004

> *"The company was last inspected in October 2003, at which time the CAA-N pointed out a number of deficiencies in the company's documentation system and quality system. Special attention was therefore devoted to these elements during this inspection. It is still the CAA-N's impression that the company has not managed to deal with these elements in a satisfactory manner."*
>
> *"In the opinion of the CAA-N, the quality system has not been implemented throughout the whole organisation, and several elements have not been clearly*

described. The company does not adhere to all of the procedures described in the Quality Manual and the annual plan for internal revisions is not followed."

The inspection resulted in 5 findings and 1 observation. 4 of the findings were related to the quality manual, adherence to procedures and deviation management.

November 2005 (6 weeks after the icing incident occurred):

"In the opinion of the CAA-N, the quality system has not been implemented throughout the whole organisation, and several elements have not been clearly described. The company was unable to prove that meetings concerning the management's review of the quality system had been held."

"The company lacks a flight safety programme that is part of the quality manual. The flight safety programme must cover elements such as risk awareness, analysis of incidents and information about such occurrences. The CAA-N takes a serious view of the fact that the company does not have a flight safety programme, since this is part of the company's safety culture."

"The CAA-N perceives the company's operations manuals as extremely unclear and deficient, and is of the opinion that the company's system of manuals needs extensive tidying up."

"The CAA-N has the feeling that there is an expectation among the management that the flow of information within the company should come from the bottom up in the organisational structure "of its own volition", and if no information is coming up to the top in the company, it appears as if there is no tradition of the management feeling an independent responsibility of having to go down in the organisational structure to assure itself that the necessary resources are sufficient for the tasks that are to be performed."

"On the last inspection date, the inspection team were given the information that Coast Air had been assigned Public Service Obligation (PSO) routes by the Norwegian Ministry of Transport and Communications starting on 1 April 2006. This expansion could be of very positive significance to the company and its employees. The CAA-N has a clear feeling that the operational organisation does not today have a surplus of resources that could be transferred to preparation for this expansion. Such resources must therefore be brought in to the organisation."

The inspection resulted in 9 findings and 4 observations. At least 5 of the findings can be linked to the quality system/document control.

1.17.9.5 The Quality Manager has stated that she during the inspection in November 2005 had expected feedback regarding weaknesses in the quality manual submitted (ref. subpara. 1.17.4.7). She knew that remarks linked to the quality documentation had persisted since the CAA-N's previous inspection reports. However, the quality manual was only discussed to a minor extent, at the meeting on the first day, at which the Accountable Manager and the Quality Manager were present. The inspection team had not set aside any time for a particular discussion with the Quality Manager. She took the initiative herself to have a discussion with the team when the inspection was coming to an end without her having been interviewed specifically. The CAA-N then made time for this.

1.17.9.6 CAA-N has stated that they later changed their practice, such that the Quality Manager and Accountable Manager are now interviewed separately. They have also provided the following information as regards acceptance of the accountable manager:

"In accordance with current practice, no one may be accepted as the accountable manager for a company until conversations/interviews have been held. The technical, operational and legal departments participate in interviewing the candidate. An in-depth interview is held in which the candidate's skills and attitudes are also checked. On the basis of the interview, the CAA-N may conclude that the candidate is not acceptable. This has happened in several cases."

1.17.10 Handling of findings from the inspections

1.17.10.1 After the inspection in 2002, in which 6 findings were linked to the quality system/flight safety programme/operations documentation, Coast Air referred in its written statement that the findings would be taken care of by the introduction of regular meetings and future revisions. On the returned deviation form with appendices, they also commented on all observations. The findings were recorded on 25 March 2007 as "feedback received" in the CAA-N database.

1.17.10.2 After the inspection in 2003, in which items indicated included the fact that previous remarks had not been satisfactorily dealt with, Coast Air put forward several objections to the findings from the inspection and the CAA-N's assessment of the company's deviation reporting system. In addition, the company referred to the fact that plans had been made and that things would be corrected in future. For some of the measures, the company gave dates for when they would be in place. After this inspection, the CAA-N confirmed in writing that they had received the deviation report signed for by the company. Comments/objections from the company were "taken note of", while the CAA-N also noted that the company had not put forward these statements during the closing meeting after the inspection. The findings were recorded on 25 March 2007 as "feedback received" in the CAA-N database.

1.17.10.3 The statements from the company after the inspection in 2004 indicated that a new quality manual would resolve most of the findings. The quality manual would be submitted in spring 2005. One finding from this inspection was recorded on 25 March 2007 as being "closed/verified", while the others were recorded as "feedback received" in the CAA-N database.

1.17.10.4 In the follow-up of the inspection that was carried out in November 2005, six weeks after the icing incident the CAA-N responded in writing to each item in the statement from the company. On 25 March 2007, 5 of the 9 findings had been recorded as "closed/verified". The other 4 were "feedback received". The company applied for and was granted an extended deadline for the finding concerning the drawing up of OM part B. The CAA-N had directed that some of the findings would be verified at the next inspection.

1.17.11 Tendering for scheduled flights in Norway

1.17.11.1 November 2nd 2005, the Norwegian Ministry of Transport and Communications allocated Coast Air AS the exclusive right to operate the regional routes Andenes-Bodø, Andenes-Tromsø and Røros-Oslo using aircraft type ATR 42, and Fagernes-Oslo using the Jetstream 31/32. The allocation was valid for the three-year period 1 April 2006 – 31 March 2009. (The route between Stord and Oslo is not a route put out to tender).

1.17.11.2 In the prior tender invitation from the Ministry of Transport and Communications, paragraph 3, *Requirements for tenderers and associated documentation requirements*, it states:

"Tenders will be submitted to the Norwegian Civil Aviation Authority for a review of technical and operational conditions before selection of tenderers. In connection with this, the tenderer must be able to document that he has the necessary technical and operational preconditions to be able to operate the routes in question."

1.17.11.3 In a letter dated 2 September 2005, in which the Ministry of Transport and Communications submits the tenders to the CAA-N, it reads:

"Whenever possible, the CAA-N's feedback should indicate the tenderer's opportunities for operating the routes in question during the period stated. The CAA-N's assessments and recommendations should, as far as possible, provide the Ministry of Transport and Communications with amplifying, well reasoned and clear advice with regard to whether the companies can be recommended for the routes in question on a technical operational basis."

1.17.11.4 The CAA-N's written assessment of Coast Air's technical and operational conditions was signed on 3 October 2005. As to the type ATR 42 aircraft, the CAA-N wrote:

"This aircraft type may be regarded as being suitable for operating the respective tendered routes, both as regards performance requirements, safety and passenger comfort."

The company's operational organisation was then assessed as being suitable to take care of the tender operation concerned. It was noted that any allocation of all of the tender areas applied for would involve considerable changes in the operational organisation.

1.17.11.5 The conclusion in the assessment was as follows:

"An allocation of all of the tender areas applied for would involve, on the company's part, considerable changes in the organisation of its fleet and its area of activity, as well as allocating resources in conjunction with documentation and approvals of any engineering secondary bases. The total resource requirement is not considered to be greater than ought to be possible during the period of time from tender allocation to start date.

The company's opportunities for being able to start up all of the tender areas applied for before the start date, and to maintain an acceptable operation during the tender period, has been evaluated as 'probable'."

1.17.11.6 Coast Air started operations in Northern Norway on 1 April 2006, but chose to waive these due to low profitability on the routes. After consultation with the Ministry of Transport and Communications, the airline Widerøe's Flyveselskap took over the routes in question on 1 April 2007.

1.17.11.7 An evaluation of a company's financial solvency is included in the CAA-N's area of responsibility in conjunction with the issue of licences, and the CAA-N has stated that it also undertakes financial evaluations of tenderers.

1.18 Additional information

1.18.1 Issuance and monitoring of preliminary safety recommendations

1.18.1.1 In compliance with § 12-20 of the Norwegian Aviation Act, the AIBN shall keep the civil aviation authority continuously informed of circumstances that are brought to light in the course of the investigation, and of its own assessments thereof, to such extent as is deemed necessary for air safety. On 1 December 2005, the AIBN held a meeting with the CAA-N and provided information about current findings in this investigation. Six people from the CAA-N took part. On 2 December 2005, under the authority of the aforementioned paragraph, the AIBN issued four preliminary safety recommendations. The recommendations concerned the establishment of tailor-made departure procedures, theoretical and practical training for ATR pilots, implementation of emergency procedures for "Severe Icing" and procedures for notification and reporting of accidents and incidents. The recommendations read thus:

1) *"The AIBN recommends that the Norwegian Civil Aviation Authority should consider directing Coast Air to establish tailor-made departure procedures from the relevant aerodromes which are located close to elevated terrain in order to prevent the ATR 42 flying into icing conditions for which the aircraft is not certified. (SL 05/1753-1)*
2) *The AIBN recommends that the Norwegian Civil Aviation Authority should consider directing Coast Air to implement theoretical training and simulator training including going through the various "airframe icing" scenarios for all of the company's pilots on the ATR 42, so that they are given a better foundation for recognising the symptoms of severe icing. A deadline ought to be set for holding the training course. (SL 05/1753-2)*
3) *The AIBN recommends that the Norwegian Civil Aviation Authority verifies that Coast Air has implemented the manufacturer's current emergency procedures for "Severe Icing" in its manuals. (SL 05/1753-3)*
4) *The AIBN recommends that the Norwegian Civil Aviation Authority verifies that Coast Air has introduced procedures for the notification and reporting of accidents and incidents which fulfil all of the requirements in the current national and international regulations in its manuals. (SL 05/1753-4)"*

1.18.1.2 On 20 December 2005, the CAA-N issued an order for Coast Air to implement all four of the safety recommendations from the AIBN before 10 January 2006. The CAA-N also ordered that, at a later opportunity, the company's simulator training and theoretical training on the ATR 42-320 would be verified, and that route inspections would be undertaken. In addition, the CAA-N issued an information circular, AIC 02/06, concerning flight in icing conditions.

1.18.1.3 The letter of response from Coast Air is dated 5 January 2006. Orders to implement the four preliminary recommendations were responded to as follows:

1. New procedure for climbing out of Stord has been drawn up (dated 16 December 2005). The procedure has the following remark:

   "Moderate to severe icing conditions east of Stord: Climb in STD VOR sector west, to sufficient altitude before turning east."

2. A list of crews who have carried out simulator training with icing scenarios and a programme for remaining crew simulator training was drawn up.

3. Referred to the fact that OPS INFO 1/2005 was issued prior to the incident, and that OPS INFO 4/2005 was issued after the incident.

4. Transmitted existing "Company regulations" on notification and reporting of accidents and incidents from 1999, and referred to the fact that these would be revised on 10 January 2006.

The CAA-N accepted the statement, but noted that the letter should have been signed by the Flight Operations Manager and not the Quality Manager. The follow-up of the recommendations was also taken up at a later meeting between the CAA-N and Coast Air.

1.18.2 Some relevant accidents and incidents

1.18.2.1 *ATR 72, Roselawn, Indiana, USA*

On 31 October 1994, an accident occurred involving an ATR 72 in Roselawn, Indiana, USA. The aircraft suddenly rolled uncommanded while it was descending after having been in a holding pattern in icing conditions for around 30 minutes. Control was not regained and all 68 people on board were killed when the aircraft crashed. The accident was investigated by the American accident investigation authority, the National Transportation Safety Board (NTSB). They concluded that the loss of control was caused by ice forming behind the "de-icing boots" on the wing. This affected the airflow over the ailerons so that "aileron hinge moment reversal" occurred, which again led to the uncontrolled banking. As a result of the accident, the aircraft type underwent comprehensive testing and the systems for protecting against icing were improved significantly. In the wake of the accident, a debate also arose about whether the manufacturer and the aviation authorities had done enough to take care of their responsibilities concerning the airworthiness of this aircraft type, and whether certification requirements linked to flight in icing conditions were sufficient. Both pilots on the CST602 have stated that they were familiar with this accident.

The report from the NTSB (http://www.ntsb.gov/publictn/1996/AAR9601.pdf) which was published in July 1996 (last amended in September 2002) contained 35 safety recommendations. In the time that has passed since the accident at Roselawn, technical system improvements have been carried out on the aircraft and changes in procedures and training undertaken. However, the NTSB is not satisfied with the progress in Federal Aviation Authority (FAA) in the area of certification requirements linked to flight in icing conditions. This comes out in NTSB's "Most Wanted Transportation Safety Improvements Aviation" (http://www.ntsb.gov/Recs/mostwanted/aviation_issues.htm). The first item on the list is to reduce the risks linked to flight in icing conditions (ref. Appendix C). The FAA gave their comments on the problem in June 2007 (ref. Appendix D). Among other things, they refer to the fact that they have issued a series of airworthiness directives to ensure that flight crews on certain aircraft types must recognise severe icing conditions and leave the area immediately. The FAA regards this as an interim solution until the necessary research and regulatory work has been completed.

1.18.2.2 *ATR 42, Dresden, Germany*

On 14 December 1998, there was a serious incident involving an ATR 42-300 after taking off from Dresden in Germany, which has many features in common with the Coast Air incident. In this case, data from the Digital Flight Data Recorder (DFDR) was recovered and was of great benefit during the analysis of the incident. The report from the German accident investigation authority (Bundesstelle für Flugunterfalluntersuchung, BFU) (5X011-0/98 April 2001) describes that the autopilot disconnected when the AOA exceeded 11° at a speed of 155 KIAS in level flight, after the crew had given up trying to climb towards the planned cruising altitude. The aircraft banked steeply to the left, the nose section tipped down and the aircraft assumed an uncontrolled attitude that lasted for approx. 50 seconds. During this period, the wings rocked from side to side, according to the BFU because the pilots overcorrected with the ailerons. They did not extend the flaps, and the DFDR showed no indications that the stick had been pushed forward. The aircraft lost 3600 ft in altitude before they regained control. The crew declared an emergency situation and landed without problem in Berlin 20 minutes after the problems occurred. The ice disappeared during the approach. No one was injured during the incident.

As a direct result of the incident on 14 December 1998, the procedure for "Severe Icing" was changed so that the minimum speed would have to be icing speed + 10 kt. The conclusion of the report from the BFU was that the crew lost control of the aircraft after they continued flying when they entered an area with worse icing than the aircraft type was certified for. The crew did not perceive that they had entered "Severe Icing" despite the fact that ice had formed on the side windows. The report contained no safety recommendations, and the reason for this is that the manufacturer ATR and the French accident investigation authority, the BEA, presented a series of implemented measures that the BFU believed would prevent any future incidents of this type.

1.18.2.3 *ATR 42, Berlin, Germany*

On 28 January 2000, there was a serious incident involving an ATR 42-300 which entered an icing situation after take-off from Berlin-Tegel airport. This incident was also investigated by the BFU (EX001-0/00 October 2002). In this case, the crew adhered to the procedure by maintaining a speed of more than 10 kt above the minimum icing speed and left the area. They carried out a descent to an altitude that was lower than the minimum safe flying altitude for flight in compliance with the instrument flying rules (IFR). There the temperature was above freezing point and visibility was good enough for flying based on visual references.

1.18.2.4 *SAAB 340, Skien, Norway*

On 18 October 1999, a turboprop aircraft, type SAAB 340A, temporarily went out of control while climbing from Skien Airport Geiteryggen, when it stalled after having entered icing conditions (Rep. 81/2000).

1.18.2.5 *British Aerospace Jestream 31, Skien, Norway*

On 30 November 2001, a landing accident occurred at Skien airport Geiteryggen during a scheduled flight involving an aircraft of the type British Aerospace Jetstream 31. (Rep. 11/2005). The triggering factor for the accident was ice on the wings which destroyed the lift so that the landing was hard and the landing gear collapsed. The aircraft was a total write-off when it stopped against an earth embankment at the side of the runway. 3 out of the 13 people on board were seriously injured. The AIBN carried out an organisational system investigation of the Swedish operator, European Executive Express. One of the conclusions was that the company had, to a large extent, based its operations on minimum solutions, and that this gave rise to a number of weaknesses in organisation, procedures and quality assurance. These conditions led indirectly to the company operating the route Skien – Bergen with a crew that at times did not maintain the standard expected for scheduled flights carrying passengers. It was also discovered that the oversight of the company by the Swedish aviation authority had been deficient. On 17 September 2003, the company had an accident in Sweden in which an aircraft of the same type was totally written off.

European Executive Express participated in the tender invitation on scheduled flights in Norway for the period 1 April 2006 – 31 March 2009, but was not allocated any routes. In its assessment of the company, the CAA-N did not provide any information that would indicate that the Ministry of Transport and Communications ought to avoid allocating them any tenders. The company ceased operating in December 2005.

1.18.2.6 *Cessna 208 Caravan, Norway*

Icing-related accidents and incidents have also occurred in Norway with turboprop aircraft of type Cessna 208 (Rap. 31/2006) (Rap. 47/2002) (Rap. 04/1995)

1.19 Useful or effective investigation techniques

During this investigation no methods have been used which qualify for special mention.

2. ANALYSIS

2.1 Introduction

2.1.1 The AIBN considers this occurrence as a typical organisational incident, where it is not sufficient to analyse the flight crews "active errors" in order to explain why it happened. In his book *"Managing the Risk of Organisational Accidents" (1997),* James Reason describes how latent conditions in complex systems can exist for years before combining with local conditions and active errrors in such a way that the barriers against accidents are penetrated. The famous "Swiss Cheese Model" with several layers of defence barriers illustrates this phenomenon. The AIBN applied the barrier model as a tool when analysing how latent conditions and active errors combined and made it possible for this icing incident to occur. An outline is included in Appendix B.

2.1.2 After the accident at Roselawn in 1994, the manufacturer developed improved systems for detecting and handling icing on the ATR 72 and 42. The AIBN believes that this illustrates how an attempt is made to control a known hazard (here: severe icing), in order to achieve an acceptable risk during flight. Ideally, the hazard would be eliminated, but it is impossible to neutralise the meteorological conditions that cause icing. Improved systems for protection against icing are reducing the risk. In addition, procedures and training programmes were prepared to enable flight crews to recognise and avoid areas of severe icing. As a last barrier for avoiding an accident, the crews should learn how to behave if, despite the previous measures, they enter a situation with severe icing in which control is lost.

2.1.3 The following model can be used to illustrate a hazard:

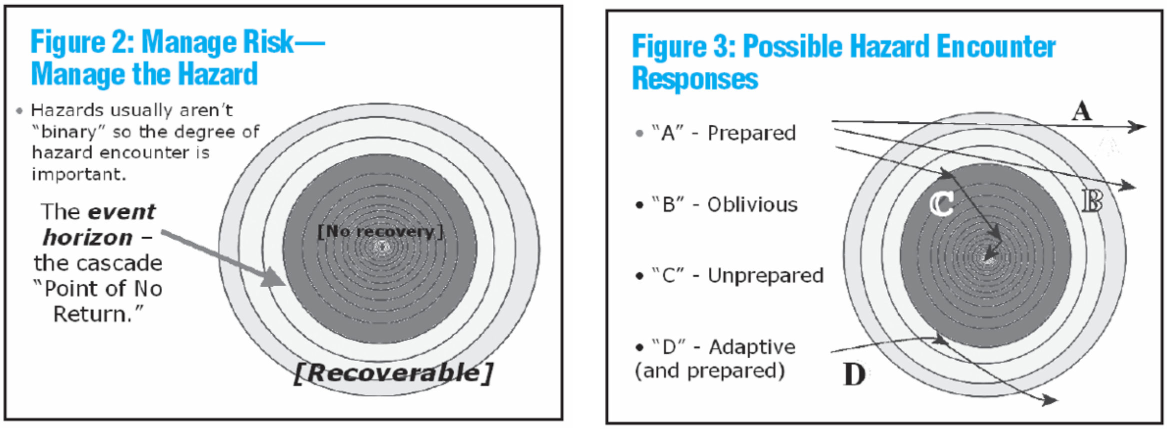


Figure 9: Hazard illustrated as astrophysical black hole. "A" - Prepared, "B" - Oblivious, "C" - Unprepared, "D" - Adaptive (and prepared). (Source: April–June 2007 ISASI Forum – "Accidents & Astrophysics" by Rick Clarke).

2.1.4 The idea behind this model is that a hazard can be compared to what is called a black hole in astrophysics. The hazard zone around the hole is illustrated as a funnel with its attractive force increasing as the centre is approached. If the subject goes too far down into the funnel, there is a risk of being caught up in the black hole. In case A, passage is inside the hazard area but high enough up in the funnel/at such a great distance, that there is no risk of being caught. This may be due both to planning and coincidence. In case B, passage is further down in the funnel, right on the limit of where it is possible to turn around (the event horizon, Point of No Return). Anyone involved who follows this track will probably not be aware that the hazard exists, or will be ignorant of the actual scale of the risk. In case C, a course is steered, unprepared, right down into the funnel and "disappears into the black hole" with a fatal outcome. In case D, the aircraft is about to do the same thing, but makes it through. This may be due to luck, but also to the fact that the crew had undergone some training and had implemented the correct countermeasures at the correct moment, and that the aircraft had the excess performance required. (Clarke, R. "Accidents & Astrophysics" April–June 2007 ISASI Forum Page 14).

2.1.5 The AIBN believes that this "black hole model" can be used to illustrate what happened to the CST602 when the aircraft flew into an area of severe icing. The path is indicated with red arrows in the following figure:

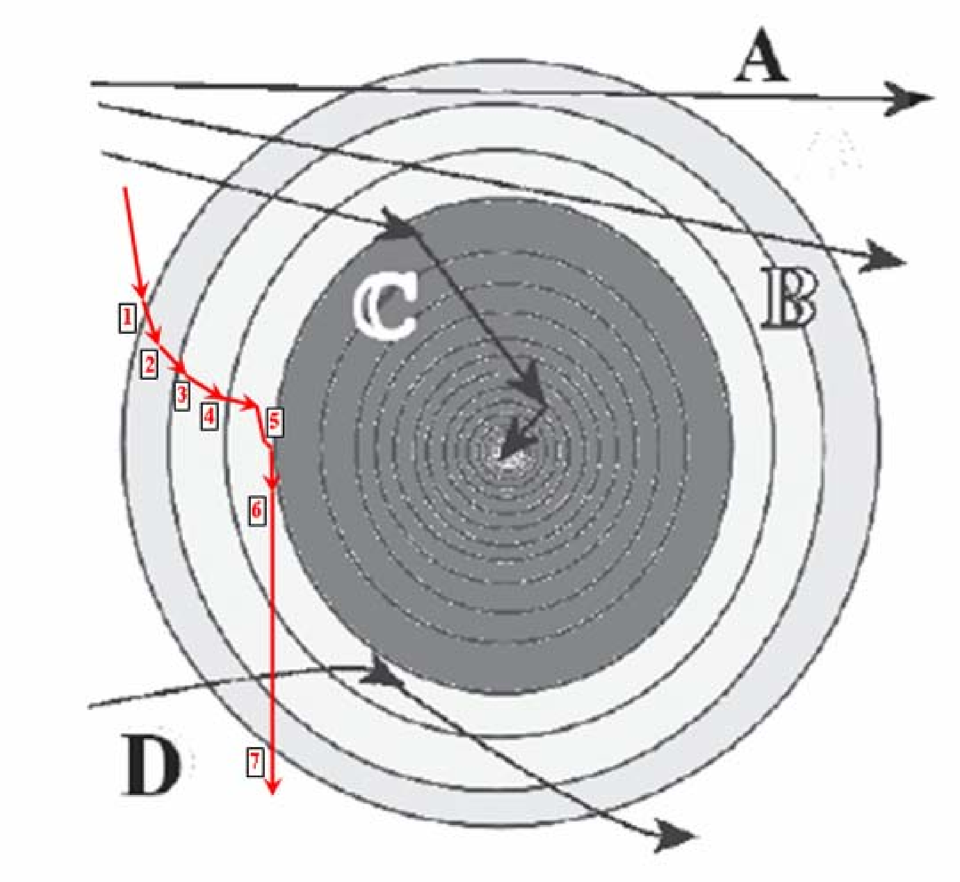


Figure 10: Plotting the course of the CST602 relative to the "black hole model"

2.1.6 In this analysis, the model is first used in conjunction with the actual sequence of events, focusing on *what* happened and *how* it happened. In addition, an analysis is made of several latent conditions/underlying factors that might contribute to explaining *why* this serious incident occurred.

2.2 History of the flight

2.2.1 Sequence of events up to loss of control

2.2.1.1 Based on the available information, it appears that control was first lost in the following manner (the references are to Figure 10):

2.2.1.2 During the climb eastward from Stord, the aircraft flew into moderate to severe icing (1 – 2). The icing constituted a serious risk factor, and the situation gradually got worse. Ice built up on unprotected areas of the aircraft's structure. It cannot be excluded that the aircraft, at times, was subject to such severe icing that the de-icing systems' capacity was exceeded, allowing ice to build up on areas that would normally have been protected by these systems.

2.2.1.3 The icing led to a reduction in ability to climb. The geographical area with severe icing intensity was so extensive that the aircraft did not pass through it while the speed was reduced in order to maintain climb (3). Instead, the situation got even worse; they went further down into the "funnel", on course for "the Event Horizon".

2.2.2 Loss of control

2.2.2.1 The reduced airspeed to maintain the climb resulted in the wing's angle of attack approaching the critical value. With that, the aircraft's stall warning actuated, and the autopilot disconnected. In this case, the wing profile's stall angle might have become reduced as a result of the accretion of ice on parts of the surface, causing the aircraft to stall before 20.1° and thus before the "stick pusher" was actuated (ref. subpara. 1.6.2.2). The right wing dropped and the aircraft went out of control, banking heavily to the right, at the same time as the nose pitched down. (Figure 10 4). The fact that the right wing suddenly dropped can be explained either by it having stalled before the left for example as a result of asymmetrical ice accretion, bank angle and/or aileron position at the critical moment. It might also have been a case of what the NTSB has described as "aileron hinge moment reversal" (ref. subpara. 1.18.2.1). Whether the "Aileron Mistrim" light that the flight officer believed he had noticed was triggered as a result of "aileron hinge moment reversal" or other causes has not been determined.

2.2.2.2 While the First Officer tried to regain control, the banking changed uncontrolled from right to left. The AIBN cannot determine whether this was due to any of the factors described above, or whether this banking was a result of the First Officer's overcorrection.

2.2.3 Handling of the loss of control

2.2.3.1 When the First Officer noticed that the "stick shaker" came on, stalling was imminent. The situation was serious; they were now approaching the "Point of No Return" according to the "black hole model". By immediately implementing correct, learned countermeasures, the aircraft could have removed itself from the hazard zone (path D). Here, however, the situation had developed so far that the aircraft rolled out of control. The countermeasures should have been immediately to have pushed the stick forward and set flaps to 15° to avoid stalling. Stick forward reduces the angle of attack, and 15° flaps would have contributed to lowering the nose attitude. The article *"Understanding the Stall-recovery Procedure for Turboprop Airplanes in Icing Conditions"* (Dow, J.P. Sr. Flight Safety Digest April 2005) includes a description of how important it is immediately to implement the correct measures when a stall is imminent in icing conditions.

2.2.3.2 The First Officer stated that he pushed the stick forward, but that he did not think of extending the flaps. The light for aileron mistrim may have been distracting as regards recognising an incipient stall. Calling out and the correct manual actions were not implemented here, despite the fact that training in preventing a stall had regularly been performed in the simulator. The AIBN believes that part of the cause of this can be traced back to the fact that the training did not focus on stalling in conjunction with icing.

2.2.3.3 The AIBN does not find any reason to criticise the Commander's decision not to take over the controls when the aircraft stalled. In the German incident referred to in subpara. 1.18.2.2, the loss of altitude was greater and the aircraft was out of control for a longer period than was the case for Coast Air flight 602. There, the stick was neither pushed forward nor the flaps extended. The best the Commander could have contributed in the critical situation that CST602 had flown into, would probably have been to extend the flaps in time. Control would have been regained more quickly then. By only pushing the stick forward, the speed would have to increase more before the angle of attack dropped below the critical value. Viewed in relation to the “black hole model”, the non-optimal technique led to the aircraft still heading for “the Event Horizon” (Figure 10 5).

2.2.3.4 When the aircraft had again achieved flying speed and responded to the control input, radar data shows that the energy from speed that the aircraft had built up in the dive was rapidly converted to a climb. Pulling out of the dive was undertaken without visual references, and was so pronounced that the wing’s angle of attack gradually exceeded the critical value so the aircraft stalled once more. (Figure 10 5). The radar plot shows that, with wing drop number two, the aircraft lost minimal altitude. The altitude loss that the crew noticed was most probably an illusion, due to the climb ceasing.

2.2.3.5 The fact that the crew did not register that the pull-out from the dive was excessive, can be explained by the fact that they were shaken by the experience in addition to the fact that they were in cloud and had to correct a most abnormal aircraft attitude based on information from the aircraft’s instruments. When located in cloud and without visual references, it is not possible for the body’s vestibular sense organs to distinguish between a lasting movement with constant speed which changes suddenly, and acceleration from a standstill. The direction of the forces to which a person is exposed is also easily misinterpreted. The fact that the barometric instruments of the altimeter and airspeed indicator show delayed deflection in the event of changes as rapid as those that occurred in this case, could also have been of significance to how the crew perceived and handled the situation.

2.2.4 Regaining control

2.2.4.1 According to the crew’s explanation, they used the same method to regain control when the wing dropped the second time. The fact that they succeeded in maintaining control this time may be linked to the fact that they had visual references then when they by coincidence came out of the clouds. (Figure 10 6). This might indicate that the “Point of No Return” was avoided as a result of a combination of countermeasures undertaken and pure coincidence. As soon as they were out of the clouds, the icing also diminished, and the problems resolved themselves (Figure 10 7).

2.3 Flight operations elements

2.3.1 Flight planning

2.3.1.1 Good planning allows a reassuring distance to be kept from the “black hole”, see path A in the model in Figure 9. The weather forecasts available to the crew before take-off indicated that there was a moderate risk of icing locally. Both TAF, METAR and the weather map indicated a cold front passing through during the hours of the morning. The front was stretched out north-south along the coast. In addition, an Ice Message was issued and with record precipitation during the previous 24-hour period and a strong westerly wind, there was reason to anticipate icing where the moist air rises up towards the mountains. On the windward sides of mountains, stationary icing zones can be quite extensive. The hazards have different significance for different operations and aircraft types. For turboprop aircraft this can be a factor to be taken into consideration.

2.3.1.2 The crew’s explanation indicates that they did not do anything actively to avoid icing, and nor did they prepare themselves mentally for the way they would act if they were subject to severe icing. The most obvious preventive measure would have been to climb to a higher altitude before setting course eastward. However, this was not the practice within the company, despite the fact that normal departure routes from Stord to Oslo go over the Folgefonna area which is known for icing.

2.3.1.3 Deficient awareness of risk elements can mean that flights are carried out in the hazard zone close to "black holes", see path B in the model. A lack of awareness here may be due both to a lack of knowledge about the threat actually constituted by severe icing, and a lack of vigilance. The AIBN believes that the introduction of joint European requirements and American textbooks in basic training in aviation meteorology may lead to pilots missing out on important knowledge of specific Norwegian conditions. Operators of propeller aircraft in western part of Norway and between this area and the eastern part of Norway should devote special attention to specialist fields such as meteorology, aerodynamic effect and reduction of the aircraft's performance in the event of ice accretion. Similarly, it is very important to have sufficient knowledge about the use, action and limitations of the aircraft's de-icing systems. The AIBN pointed out the same in a report on loss of altitude with a Cessna 208 in icing conditions east of Florø on 19 January 2006 (SL REP 2006/31). This type of special threat and the need to take action must be identified and managed by means of a well functioning flight safety programme.

2.3.1.4 Despite the fact that there had been warnings of local moderate icing along the route, the weather radar was not on when CST602 took off that morning. This may indicate that the crew had a low level of awareness of the importance of using the weather radar as an aid for avoiding severe icing. This could be quite understandable since, in ordinary use, the focus of weather radar is primarily the avoidance of areas subject to severe turbulence. The radar would however probably also have registered areas with heavy precipitation ahead. Information from the weather radar could thereby have made it possible for the crew to plan their route outside the cells with heaviest precipitation at greatest hazard of severe icing, and would therefore have been an important aid if it had been put to optimal use. A lack of knowledge about the use of weather radar has been identified as a safety problem in civil aviation. (Rosenkrans, W. "Surveillance Without Surprise" April 2007 Flight Safety Foundation Aerosafety World). The AIBN pointed out the same problem in a report concerning an accident after a lightning strike, Kato Airline Bodø on 4 December 2003 (SL REP. 2007/23).

2.3.1.5 The fact that, at the time of the incident, Coast Air had not drawn up a policy on the use of weather radar, indicates a low level of awareness about the hazards to which the company's operations were exposed. If the company had had a well-functioning flight safety programme, the icing problem would probably have been identified as an area on which particular attention would have to be focused. In that case, it is more probable that the need for a policy and thorough training in the use of this equipment would have arisen as risk-reducing measures.

2.3.2 Handling of the icing situation

2.3.2.1 The crew's explanation indicates that they did not perceive that they were entering severe icing after they registered ice accretion after passing through FL100. The time from when the ice accretion had a significant effect on the ability to climb until control was lost was about 3 minutes. They approached the boundary of the "Point of No Return" along a path corresponding to C or D in relation to the "black hole model", without any of them taking the initiative to do the checklist for severe icing or stating that they should turn around. This indicates a lack of knowledge about the hazards connected with icing. In accordance with the procedure, the minimum speed in severe icing should be 10 kt greater than in "standard icing", that is a minimum of 153 KIAS. The crew therefore did not have the safety margin they assumed since they had allowed the speed to drop to 150-155 KIAS. This indicates a lack of knowledge about the current procedures.

2.3.2.2 With hindsight, it is possible to see a series of conditions indicating that the crew should have interpreted the situation better and turned around in time (path D). Both pilots were familiar with the accident in the USA in 1994, and should have had greater respect for unusually rapid ice accretion and loss of climb performance. They did not use weather radar and did not interpret the ice on the side windows and the reduced climb rate as signs of severe icing which required action. In an analysis of why the crew dealt with the icing situation as they did, "situational awareness" becomes a key factor. "Situational awareness" covers the registration of incoming information, the understanding of the significance of that information in the current situation, as well as the consequences it entails. Good situational awareness means having an overview of the entire scenario, in order to be prepared to deal with any potential outcomes.

2.3.2.3 Both of the pilots were experienced and had flown the route between Stord and Oslo in icing conditions countless times with no problems. The pilots were used to the aircraft's systems handling moderate icing situations. A contributory factor to the crew's not reacting actively to the hazard signals may have been that the Commander had experienced a similar situation previously which resolved itself. The AIBN believes that flying along path B in the "black hole model" must have occurred previously. It may appear that the flight crew also anticipated that the problems here would resolve themselves by their exiting the icing area in time, which is something that gives the impression of complacency. Flight crews that fly on a daily basis on a monotonous and limited network of scheduled flights are at increased risk of complacency. This can lead, for example, to deficient planning and reduced awareness.

2.3.2.4 Another important element is that the hazard of icing was not given particular emphasis in the company's programme for training and flight safety. If the flight crews are weak in any knowledge about a subject, it is particularly unfortunate if the company's flight operations documentation is inadequate. The company's role is discussed later on in this report. The AIBN believes that the crew's handling of the situation must be interpreted in the light of deficient training, procedures that were not updated, and the company's deficient focus on hazards linked to icing. Deficiencies in the training of the company's pilots is discussed in paragraph 2.4 of this report.

2.3.3 <u>Notification, reporting and preservation of data after incidents</u>

2.3.3.1 Since this serious incident was not notified and reported in accordance with the current regulations, data that was of importance to the investigation was lost. The AIBN does not believe there should be any doubt that this was a serious incident which should be notified and reported to the AIBN. In addition, the AIBN believes that pilots ought to understand that data from the flight data and cockpit voice recorders would have been valuable in a subsequent investigation and should therefore have been safeguarded. The AIBN is of the opinion that both the Commander, the First Officer and the Flight Operations Manager should have exhibited more of a capacity for assessment. Criticism could also be given here because the company's manuals contained extremely old regulations in this field.

2.3.3.2 On the other hand, it must be noted that it was a good thing that the incident actually was reported to the CAA-N. Another positive thing was that the CAA-N, after assessing the matter, found grounds to forward the report to the AIBN.

2.3.3.3 The AIBN does not believe it was possible for the air traffic control service to know the seriousness of the problems that CST602 had, based on the information they had available. So they could not have been expected to record what occurred as a reportable incident. With no flight recorder data available, radar data from Avinor was useful in allowing the loss of altitude to be established and for analysing the sequence of events.

2.3.3.4 The AIBN considers the regulations in the area of notification and reporting to be adequate in all main areas, and that it was adherence to these that was the problem in this case. However, the impression gained by the AIBN is that it is not a well known fact that the regulation on flight data after reportable incidents states that this should be retained for 60 days unless otherwise agreed. The AIBN previously issued a recommendation to EASA that procedures for retaining recorded data should be included in the list of what a operations manual shall contain. (SL REP 8/2006). EASA has accepted the recommendation and assesses possible improvements.

2.4 Flight training within the company

2.4.1 Coast Air first became aware of the opportunity to train on realistic icing scenarios in the simulator as a result of this incident. In the opinion of the AIBN, the fact that they subsequently introduced a training course such as this into their type rating training course and periodic training course, provided considerably greater safety margins during flight in icing conditions. Training is one of the most important measures a company has in its preventive flight safety work, and the AIBN believes it is probable that this incident would not have occurred if the flight crew had regularly had training in handling severe icing in the simulator.

2.4.2 In relation to the “black hole model” relevant training could have made the crew react in a more resolute manner and implement the correct manual actions on “the event horizon”, with the aircraft following path D “up out of the funnel”. Another effect of training that is more pro-active and desirable because it provides greater margins, is increased awareness in the crew about the risk actually constituted by severe icing. This ought to have the crews endeavouring to fly on path A, thereby reducing the occurrence of flying along path B or even further into the hazard zone.

2.4.3 It was particularly unfortunate that the Training Manager at Coast Air was not aware beforehand that the simulator was able to simulate icing conditions. Finnair includes in its marketing material that the simulator possessed icing scenarios as an additional function, but would naturally not involve itself in what the customers use the simulator for. The AIBN believes that the ATR icing accident in the USA, climatic conditions in western part of Norway and the fact that Coast Air flew routes from the coast over the mountains several times a day, all indicate that the company should have placed great emphasis on the problem of icing in its preventive flight safety work. This finding is also involved in substantiating the importance of a well-functioning flight safety programme. It ought to be a matter of course for the training departments in all airlines to keep themselves updated on all informational materials from aircraft manufacturers. The content of the CD with “Be prepared for Icing” should have resulted in the manager at Coast Air actively taking steps to find a simulator with the icing scenarios previously discussed, and ensure that the crews were given this relevant training.

2.4.4 Despite the fact that extending the flaps in connection with arresting an imminent stall was regularly included in training in the simulator, this had clearly not become an automatic reflex in the members of crew involved. The training manager had recorded that it was common for pilots to forget this item, so that they had to go over the exercise again. In basic pilot training, recovering from a stall is normally done without extending the flaps. On some other aircraft types, there are warnings related to extending the flaps if icing is suspected. An incipient stall on the ATR could normally also be averted if flap extension is forgotten. The AIBN believes these circumstances may be part of the explanation for why the training had not had a greater effect. If they had been able to train in the simulator on stalling as a result of icing, overlooking the flaps would have led to a temporary loss of control and loss of altitude. By physically feeling the consequences of this on themselves, their awareness of the importance of following the procedures would increase, and the learning effect would have been greater.

2.4.5 Both pilots had attended a type rating training course at the manufacturer's premises, and the AIBN has not therefore gone any further into conditions linked to Coast Air's individual course. However, the CAA-N approvals should not be regarded as a guarantee of the content and quality of individual courses, if content is not evaluated in detail in conjunction with approvals of this type (ref. subpara. 1.17.5.1).

2.4.6 The AIBN has the impression that the quality of the periodic training under Coast Air's management was reduced in order to keep costs down. There was pressure of time in the 4-hour sessions in the simulator, and the additional stress resulting from the fact that the pilots were sent for mandatory training assignments on a day return flight with tickets that did not have confirmed seating. Such uncertainty and pressure of time can contribute to reducing the pilots' concentration in the simulator, thereby reducing the effect of the training. The AIBN believes this is an example of how pressure to keep cost levels down can have negative effect on flight safety.

2.4.7 During its investigations into accidents and incidents, the AIBN often hears operators complaining about the lack of time for any exercises other than those that are mandatory in periodic flight training. This was also the case with this serious incident. Some companies have taken the consequences of this, and occasionally allow an extra day for simulator training for all pilots. Others state that it is not applicable since it would be too expensive. It is perhaps these latter companies that are in greatest need of extra training. For example this could be highly relevant in conjunction with expansions and starting up routes to new destinations. With so many mandatory exercises, the periodic training fixed in the regulations ought, in the opinion of the AIBN, to be spread over two sessions on a permanent basis.

2.5 The aircraft's systems

2.5.1 There is nothing in the crew's explanation that indicates that the aircraft's systems for preventing, removal and warning of ice were not functioning as intended. The stall warning system was also functioning as expected, and indicates that the wing's angle of attack exceeded 11°. The fact that the stick pusher did not activate, indicates that the angle of attack was not as much as 20.1°, (ref. subpara. 1.6.2.2).

2.5.2 The ATR 42/72 has been subject to extensive testing and assessment, and possesses relatively sophisticated systems for protecting against icing. The newly developed APM system appears to be one more important step forward (ref. 1.6.3). This tool will make it considerably easier for flight crews to assess the intensity of icing and the effects of ice accretion during a climb and in the cruising phase. Traditional warning and ice protection systems are not as suitable for this. APM improves the decision-base and increases the probability of crews changing path in time, allowing serious icing problems to be avoided.

2.5.3 In France, there is a desire for EASA to assess whether APM should be mandated (ref. 1.17.7). The AIBN believes that APM systems which work as intended would be capable of preventing similar serious events or accidents in future, and is putting forward a recommendation to consider a requirement. An interesting question would be whether a potential requirement would apply only to the ATR 42/72, or whether there should be an order for equivalent systems also to be used on other turboprop aircraft. In this investigation, the AIBN has not assessed the characteristics of other turboprop aircraft types, and is therefore limiting its recommendation to apply to the ATR 42/72. In any case, this will not prevent the aviation authorities from choosing to include more aircraft types and/or other equivalent systems in their assessment. As described in subpara. 1.18.2 of this report, icing-related accidents and incidents have occurred with several types of turboprop aircraft in Norway during the past decade.

2.6 Aircraft manufacturer's procedures

2.6.1 Since October 2003, the manufacturer's procedures for severe icing have included six items that flight crews should know by heart to avoid ending up in situations in which control is lost. In addition, extensive training materials have been drawn up and icing modules introduced in the simulator which should contribute to the flight crews recognising the symptoms of severe icing and learning the procedures they should follow if they are exposed to this.

2.6.2 The manufacturer ATR maintains that, if the procedures are followed, no situation will ever develop that requires the actions of pushing the stick forward and extending the flaps. The AIBN is in full agreement that the most important factor for maintaining safety is to avoid flying in areas subject to severe icing. Planning the flight path, staying alert and turning in time are all essential. Then, APM could be a useful aid. Nevertheless, this serious incident is an example showing that humans sometimes fail to follow correct action patterns, and the AIBN believes it is not improbable that the same thing could happen again. That the NTSB has the item on reducing the hazards linked to operations in icing conditions at the top of its list of priorities concerning what ought to be done to achieve improved flight safety, also indicates that icing problems have to be taken seriously (ref. appendix C).

2.6.3 ATR refers to the aircraft type's stall characteristics and procedures for recovering from a stall being fundamental and typical for a twin-engined turboprop aircraft. The AIBN claims that extending the flaps is not included in an average pilot's automatic pattern of actions in the case of an incipient stall or control problems, possibly because it is not included in the basic training for pilots. The assumption that a pilot will not automatically remember to extend flaps also corresponds with what the Training Manager at Coast Air observed during stall exercises in the simulator. This incident also showed that it is not certain that abnormal rolling movements and warnings of "Aileron Mistrim" will be interpreted as imminent loss of control or stalling by a crew that has had no training in this scenario. In addition, pilots are trained to be careful with their use of flaps in icing conditions. The AIBN sees the possibility of this knowledge together with a respect for exceeding maximum speed with flaps extended, possibly leading to more pilots not extending flaps in a stressful situation such as the one in question. Abnormal rolling movements may then develop into a loss of control lasting a considerable time, risking a fatal outcome.

2.6.4 The number of checklist items that are to be learned off by heart should be kept as low as possible. The AIBN still issues a recommendation about setting flaps to 15° in the event of abnormal rolling movements being a “Boxed Item”. The reason for this is that it is too late to start looking things up on checklists when approaching “the event horizon” (see the model in subpara. 2.1.3), but a rapid reaction can in some cases contribute to rescuing the situation if it is dealt with correctly. In just this type of situation, learning checklist items by heart and establishing automatic reflexes are valuable measures.

2.7 The company’s flight operations documentation and flight safety programme

2.7.1 In this investigation, the AIBN has discovered major deficiencies in the company’s flight operations documentation, firmly linked to operations in icing conditions. The manufacturer’s procedures for operations in icing conditions were not included in the SOP, which conflicts with current regulations for operations manuals. The SOP was the only manual that had a revision service which was issued to the pilots. However, this has not been revised since 2002.

2.7.2 One correction that the manufacturer issued in October 2003 involving critical checklist items in the event of severe icing was only issued to pilots almost two years later, when the new Flight Operations Manager by chance discovered the existence of the procedure. The AIBN is of the opinion that it was then important to issue the information immediately, which the Flight Operations Manager took the initiative of doing. However, the company’s system for OPS INFO was not satisfactory. It was a “loose-leaf system” with no monitoring of the extent to which the notifications were received, read and complied with by the pilot corps. OPS INFO ATR 1/2005 was undated and did not contain a description of the symptoms of severe icing. That part of the procedure was only distributed after the icing incident. The first OPS INFO of the year on that aircraft type was issued in the middle of September, which might indicate a low level of activity in accident prevention work.

2.7.3 The flight safety programme shall act as a preventive measure and includes identifying risk factors (*hazards, threats)* and analysing whether the necessary protective mechanisms (*defences, barriers, controls*) are in place, or if anything will have to be done to ensure that the level of safety can be said to be acceptable. Within a company flying the ATR 42 in western Norway or in northern Norway, the AIBN is of the opinion that it should be expected that airframe icing would be one of the focus areas of the mandatory flight safety work. This should be reflected in training programmes and miscellaneous flight operations documentation.

2.7.4 Concrete factors such as turnover of key personnel, the division of responsibilities linked to the updating of manuals, a lack of competence and too little time set aside for administrative work appear to have badly influenced the company’s ability to cater for the requirements in the areas of quality systems and flight safety programmes. Deficiencies in the documentation, unsatisfactory quality systems and deficiencies in the flight safety programme were all repeatedly pointed out by the CAA-N in its reports after inspections of the company’s operations. This is discussed further in the sections below.

2.8 The role of the Norwegian Civil Aviation Authority

2.8.1 The regulatory oversight of Coast Air up to the time of the icing incident

2.8.1.1 During this investigation the AIBN has uncovered significant deficiencies in the quality system, flight safety programme and flight operations documentation which the investigation board believes are directly relevant to what happened to CST602. The AIBN would expect the CAA-N not just to have detected such fundamental deficiencies, but also to have ensured they were rapidly corrected by the company.

2.8.1.2 A review of the inspection reports showed that deficiencies in these areas had indeed been discovered. During flight operations inspections, the CAA-N had frequently expressed concern and had issued findings and required corrective actions, but had not monitored whether the company had closed these in a satisfactory manner. The company was allowed to continue operating without the CAA-N checking whether the conditions had actually been corrected. The inspection reports do not contain any evaluation of the company's level of safety or the ability to monitor or control its own safety development.

2.8.1.3 The AIBN believes the deficiencies discovered by the CAA-N in 2002, linked to the quality system and flight safety programme, were of such significance that it gives reason to question whether the initial inspection for approval of the company in 1999 can have been sufficiently thorough.

2.8.1.4 In this investigation, the AIBN went through the completed deviation forms that Coast Air had sent in to the CAA-N after each inspection. In its statements, the company referred to planned measures that they believed would correct the deviations. During the inspection in 2003, the CAA-N discovered that a series of remarks from the inspection of the year before had not been sufficiently complied with, and that the quality system had not been implemented satisfactorily within the organisation. The AIBN is of the opinion that this situation should have led to an extraordinary follow-up by the CAA-N. The first obvious action would have been to increase the inspection intensity in the areas concerned, as described in the JAA Administrative & Guidance Material (ref. 1.17.8.5).

2.8.1.5 In addition, the company's continuing problems in improving inspection remarks and implementing the quality system in a satisfactory manner should have led to the aviation authority undertaking a new review of the means at its disposal for enforcing the aviation regulations more effectively. Being able to identify and focus on most important problems within the inspected organisation, and enforcing the regulations so that improvements are undertaken within a reasonable time, are counted as being fundamental elements of systemic oriented or risk-based regulation regimes. In this case, identified findings of a serious nature remained uncorrected over a lengthy period.

2.8.1.6 Several of the findings and statements in the inspection reports that are reproduced, for example, in subpara. 1.17.9.4 in this report indicate that the CAA-N at a time after the initial approval appeared to have had little confidence in the quality system at Coast Air. The AIBN is surprised that the aviation authority continued to regard the system as "acceptable for the authority". Findings in 2003 about the quality system not having been implemented satisfactorily in the company, indicate that it has been assessed as not having achieved its purpose. According to the JAA Administrative & Guidance Material on operator surveillance by the authority, this breach of regulations is of such a nature that, in its most extreme consequence, could have meant revocation of the company's AOC (ref. subpara. 1.17.8.5).

2.8.1.7 The CAA-N has the duty to assess whether the airline still is adhering to the conditions specified at the time of first approval. SHT believes that the findings of this investigation indicate that the CAA-N devoted inadequate resources to monitoring the detected weaknesses in the Coast Air quality system during the period 2002-2005. According to the applicable regulations, weaknesses in the quality system should have been reviewed with the Quality Manager at Coast Air. If progress in the improvement work was unsatisfactory, the company should have been given a deadline and a warning that insufficient compliance with the regulations could have consequences on the approval.

2.8.1.8 In addition, the AIBN believes it is very important that the Accountable Manager of a company is familiar with the main issues of the regulations linked to the AOC. In particular, when the CAA-N has discovered major deficiencies, as in this case, it is important that the accountable manager has understood the seriousness and the consequences of non-compliance. It was unfortunate therefore that the CAA-N did not conduct an introductory interview with the Accountable Manager, as had been stated was the intention in the acceptance letter mentioned.

2.8.1.9 In this case, the regulations were not enforced to a sufficient extent. Therefore identified serious discrepancies remained uncorrected for a lengthy period. The investigation has revealed that the CAA-N did not use the means it had at its disposal and that the applicable regulations, in reality, were enforced in a fairly ineffective manner. The AIBN issues a safety recommendation in connection with this.

2.8.2 <u>A changing regulatory regime</u>

2.8.2.1 The AIBN would like to point out some of the oversight-related challenges that are linked to the transition from the traditional detailed regulations to more system- or function-oriented requirements. Quality systems and flight safety programmes or systems for safety management are such function-oriented requirements (ref. subpara. 1.17.8). The need for changes in the regulatory philosophy is incidentally also discussed in Chapter 3.6.1. of the Storting White Paper No 17 (2002-2003) “Om statlige tilsyn” [On Regulatory Agencies]. While a more system- or function-oriented regulatory regime probably is the most efficient, it demands high levels of competence, analytical ability (of the individual inspector and within the organisation) and the efficient use of resources in order to be successful.

2.8.2.2 Gradually, as the regulations become more function-oriented, it becomes more important to be able to verify that an air operator’s functions and systems are working as intended. This is a challenge for the aviation authority. It is one thing is to check and verify that an operation satisfies the stipulations by having a quality system or systems for safety management that contain the elements required by the regulations. It is something quite different to be able to evaluate how well such a system will work in practice and whether adequate safety or an *“acceptable level of safety”* can be achieved.

2.8.2.3 Immediately, when reviewing this case, it might be easy to adopt a biased critical position on the civil aviation authority’s lack of action and, in the opinion of the AIBN, the CAA-N did not handle the case in a fortunate manner. However, literature in this field describes several circumstances which make this conduct more understandable. The AIBN believes that this case shows several of the many and often complex challenges faced by modern regulatory authorities and their inspectors. These problems are astutely highlighted in Chapter 8 of *“The Regulator’s Unhappy Lot”* in the book *“Managing the Risks of Organisational Accidents*” (Reason, J. 1997), and in the book *“The Regulatory Craft”* with the subtitle "Controlling Risks, Solving Problems and Managing Compliance" (Sparrow, M 2000).

2.8.2.4 Both authors also discuss the highly complex assessments that ought to form the basis of regulatory enforcement. As a rule, the regulatory agency's "toolbox" contains many different means of upholding the regulations. These can vary from merely providing information about any regulatory discrepancies found, to strict sanctions such as closing down the business operation. It is very important that the regulatory authority always has a good overview of the means that are at its disposal and that it selects with care those which are most suitable on each individual occasion. It may be pertinent here to advise against going to extremes, such as passivity and consistent absence of the application of powers on the one hand, or the application of lines of confrontation and sanctions in all cases on the other. Both extremes would form obstacles to effective safety regulation in the long run.

2.8.2.5 The main purpose of the authority's oversight is to assess whether the inspection object still complies with the conditions specified at the time of first approval. Being able to identify and focus on the most important findings, and enforcing compliance with the regulations within a reasonable time, could be counted as being fundamental elements for success within a modern regulatory regime. The AIBN believes that the CAA-N would be well served by taking these elements into account in its further development of a regulation methodology that is moving in a more risk-based direction.

2.8.3 Allocation of tendered routes

2.8.3.1 The Ministry of Transport and Communications submitted the tenders to the CAA-N for a review of technical and operational conditions around the same time as the icing incident occurred. The AIBN believes there are grounds here for discussion on the tendering round, since organisational contributions including the role of the CAA-N are central to this investigation. Furthermore, the AIBN is obligated to point out any faults and discrepancies within the aviation system as a whole, if it is considered significant in promoting flight safety that such information emerges in the report (ref. Norwegian regulation regarding public investigations of accidents and incidents in civil aviation).

2.8.3.2 The formulation of the tender invitation which is reproduced in subpara. 1.17.11.2, may be understood to mean that the CAA-N, in addition to the assessment of whether the company has sufficient resources in the form of aircraft, maintenance organisation and available manpower for maintaining acceptable operations, is also expected to assess safety. The text in the tender invitation and transmittal letter (subpara. 1.17.11.3) from the Ministry of Transport and Communications to the CAA-N could however be considered relatively weak in this area. The fact that the word "safety" is hardly mentioned in the CAA-N's assessment, indicates also that the authority has hardly perceived the assignment from the Ministry as meaning that stress should be placed on safety assessments. This impression is reinforced by the one-sided focus on resource requirements and the probability of succeeding with start-up and operation in the CAA-N's main conclusion (subpara. 1.17.11.5).

2.8.3.3 The CAA-N is a specialist agency for aviation matters of the Ministry of Transport and Communications and its principal task is to contribute to increased aviation safety. It is not unnatural for the Ministry, without its own expertise on aviation technical or operations matters, to use its own specialist agency as adviser in allocating tendered routes. In an advisory role of this type, assessments of parameters such as passenger comfort, regularity and operational reliability would be important elements. The AIBN believes however that the technical and operational assessments of tenderers might be expected also to be carried out in the light of the CAA-N's principal task even if this is not specifically mentioned in the assignment. According to § 3 of the Ministry of Transport and Communications' instruction to the CAA-N, "on its own initiative and on request, the CAA-N shall provide advice to the Ministry of Transport and Communications in matters concerning aviation activities" (the AIBN's underscoring).

2.8.3.4 In the CAA-N's tender evaluation of Coast Air, safety was mentioned on one specific occasion. That was in connection with the assessments of the ATR 42 aircraft type, in which it emerged that the aircraft type was regarded as being suitable for the routes in question from a safety viewpoint (subpara. 1.17.11.4). It was not mentioned that the ATR 42/72 had a history of several serious accidents and incidents in icing conditions. The combination of an icing-sensitive aircraft type and operations in icing-exposed Norway implies special precautions and thus calls for a functioning quality system/flight safety programme. On the operations side, the CAA-N declared without reservation that they assessed the company as suitable to operate the tendered routes.

2.8.3.5 The CAA-N assessment thus contained nothing to indicate that the Norwegian Ministry of Transport and Communications should refrain from allocating tendered routes to Coast Air. The CAA-N afterwards maintained that the nature of the deficiencies in the quality system were not such that the company should be regarded as an unsuitable candidate. The AIBN is able to understand that the CAA-N did not have an easy task in determining how circumstances would develop in future, either for this or for other companies. For example, it is conceivable that allocation of the tendered route would have functioned as a positive stimulus, leading to internal improvements and reforms. In this case, however, there was documentation going back several years that indicated that this company had not fulfilled central regulatory requirements, and had not had, for a lengthy period, the ability to correct findings on these points. The AIBN finds it remarkable that the CAA-N placed so little importance on the persisting deficiencies within essential functions for achieving acceptable levels of flight safety.

2.8.3.6 The assessment of Coast Air is not a unique example of what AIBN believes is an insufficient flight safety focus when allocating tendered routes. The CAA-N did, for example, not provide any information in its assessment of the Swedish airline, European Executive Express to indicate that the Ministry of Transport and Communications ought to avoid allocating any tenders to this operator (subpara. 1.18.2.5). The AIBN believes this is alarming, considering that the company had had two accidents during scheduled flights in the period 2001-2003, and that the AIBN had recently issued a report that documented dubious safety standards within the company. In response to this observation the CAA-N has, among other things, commented that the routes the company was applying for were not very demanding, and that it would be unreasonable to overrule the Swedish aviation authorities. (The company held a valid AOC).

2.8.3.7 In conjunction with the hearing that was held ahead of the issue of this report, the Norwegian Ministry of Transport and Communications noted that it presumed that the airlines' safety levels are included in the assessments made by the CAA-N. It also stated that specialist proficiency and required organisation for the safe operation of an aircraft is a precondition for issuing an AOC, and that the safety of a company with a valid AOC consequently should be viewed as satisfactory.

2.8.3.8 The AIBN believes that it must be recognised that not everyone with a licence for commercial air transport and an AOC will automatically have an indisputable safety level. The ”President’s Message” entitled “Rules versus safety” in the August issue of the magazine AeroSafety World in 2008 supports this viewpoint (ref. Appendix E). In this, the President and CEO of the Flight Safety Foundation, William R. Voss, has written, among other things: *“Compliance does not equal safety”* and *“First, we have to acknowledge that while compliance with rules is important, it is not enough”*. This is linked to today’s function-oriented rules and the operation’s ability to monitor and control its own safety development.

2.8.3.9 The aviation authority’s ability to carry out an oversight that enables them to verify whether quality systems/flight safety programmes are working as intended, is also of significance here. Previous accidents, such as the accident involving European Executive Express, have shown that a series of minimum solutions which, viewed in isolation, satisfied the requirements, did not overall provide a satisfactory safety level. An acceptable level of safety is only achieved once operations are carried out with adequate safety margins in all relevant areas. To succeed in this, a company must work on safety in a determined, systematic and persistent manner. Important factors are competence, level of training, safety culture, type of aircraft, navigation equipment, procedures, aerodromes’ level of safety, etc.

2.8.3.10 The AIBN believes that it must be possible to use the specialist competence and the experience the CAA-N has had of the tenderers to indicate something about their ability to operate a tendered route with sufficient safety margins. For foreign tenderers, it ought to be possible for information to be acquired from the aviation authority of their country, supplemented by other sources such as international databases of accidents and incidents. The section entitled *“Introducing the safety space”* in the book *“Managing the Risks of Organizational Accidents”* (Reason, J. 1997) is about companies’ intrinsic resistance to accidents. This is what the AIBN believes should be taken into consideration.

2.8.3.11 It is the AIBN standpoint that as long as the company’s level of safety is not included in the assessments made before allocating a tendered route, the determining factor will in reality be cost. Those who choose minimum solutions will be rewarded. A company which, through its safety system, has identified a need for measures to be taken and invests in increased safety, risks pricing itself out of the competition. The AIBN believes that such a mechanism is very unfortunate and ought to be avoided. In assessing tenderers for flying scheduled routes, it is not just price and regularity that should be assessed, but also factors that have a bearing on safety. With regard to vital safety factors, airlines that operate with borderline safety margins should not be allocated any tendered routes, in the opinion of the AIBN.

2.8.3.12 The AIBN therefore believes that the Ministry of Transport and Communication ought to assess means by which to implement tender invitation procedures without rewarding safety-related minimum solutions. It ought to be practically possible to develop a system that would take into consideration safety in addition to other factors, such as price, regularity and comfort. A possible solution might be to require the tenderer to show how it intends to manage safety for each of the routes being applied for by submitting a safety assessment in accordance with ICAO Doc 9859 “Safety Management Manual” (or equivalent recognised guidelines). Requesting this type of documentation would be one method of verifying that an important condition linked to the operator’s AOC is continuously complied with (ref para. 1.17.8.1). In the view of the AIBN, carrying out a safety assessment at the initiation of a new route would thus form a natural part of an accident-prevention and flight safety programme in compliance with EU-OPS 1.037. A safety recommendation in this connection is issued.

2.8.3.13 Since Norway has implemented joint European regulations also for periodic training, it has become more difficult to introduce special national requirements. At the same time, we in Norway have more challenging weather conditions and terrain than many other European countries, and these challenges are often prominent in the network of scheduled routes that are put out to tender. The tendered routes are unique since special requirements may be set via the tender invitation process without resulting in an unfair competition. Ideally, it could be claimed that the function-oriented rules assume that the parties involved should see the need for additional requirements and take action accordingly, but this may mean that tenderers price themselves out of the competition. If special requirements are specified in the tender, all tenderers must include the costs of fulfilling these same requirements in their calculations. The AIBN believes that the quality and scope of flight crew training is of such great importance to flight safety that the Ministry of Transport and Communications should consider, in its tender invitations for flying scheduled routes in Norway, imposing special additional requirements beyond the minimum requirements of the regulations. A safety recommendation is issued in connection with this.

2.8.4 Follow-up of preliminary safety recommendations

2.8.4.1 The impression gained by the AIBN is that this incident was taken seriously by the CAA-N once it became known. Among other actions, the principal flight operations inspector participated as an observer when the crew of CST602 attended simulator flying. The CAA-N ordered the company to implement the preliminary safety recommendations issued by the AIBN. The AIBN believes the CAA-N's flight operations oversight of Coast Air in autumn 2005 seemed more thorough than the previous year. Short deadlines were set, and the correspondence to which the AIBN has had access, shows meeting activity and progress made.

2.8.4.2 The AIBN has not made a detailed assessment of developments within the company nor CAA-N's oversight of the company since this serious incident occurred in the autumn 2005. As described in subpara. 1.18.1.3, the CAA-N accepted Coast Air's account of how the preliminary safety recommendations from the AIBN had been followed up. The important undertaking of rapidly providing realistic training on icing for everyone and thereafter implementing it in the periodical simulator training programme appears to have been attended to. The CAA-N also ensured that the company's manuals were updated with correct procedures for severe icing and a policy for using weather radar. Of course, since Coast Air declared itself bankrupt before this report was published, there will be issued no safety recommendations pertaining to the company.

2.8.4.3 The AIBN regards a general reminder about climbing to an unspecified "sufficient" altitude in the sector west of Stord VOR before setting course eastward, such as Coast Air introduced onto their maps after this icing incident, as being less committing than a tailor-made procedure. The probability of crews planning an alternative route will be greater if a specific alternative route, which both pilots and air traffic service personnel are familiar with, is published. Different operators can be expected to fly icing exposed departure routes, and the AIBN sees a need to establish general alternative routes that are published in the AIP Norway. The AIBN is therefore issuing a new safety recommendation in this area. Avinor, which possesses skills in procedure construction, and personnel with necessary skills in meteorology, aircraft performance and local knowledge, must probably be involved, if the intended outcome of the recommendation is to be achieved. The recommendation is therefore directed towards the CAA-N, which has the authority to order members of the aviation community to implement safety recommendations from the AIBN (cf. Norwegian Aviation Act § 12-2). In the investigation of this incident, the AIBN has not assessed whether there is any need for alternative routes in order to avoid any danger of icing from airfields other than Stord airport. The AIBN, however, believes that it also would be natural to chart the need for corresponding alternative departure routes on other airports and assess whether the recommendation ought to be implemented more widely.

3. CONCLUSIONS

The AIBN believes that this investigation has proven a clear connection between the icing incident and latent contributing factors, such as deficiencies in the airline's quality system and flight safety programme. It is, in addition, the AIBN's view that this case illustrates how important a well functioning regulatory oversight is to flight safety. The failure of the CAA-N follow-up contributed to deficiencies in the operator's quality system and flight safety programme not being corrected in time.

3.1 Findings

a) The aircraft was registered in accordance with regulations and had a valid Certificate of Airworthiness.

b) The aircraft's mass and centre of gravity were within prescribed limits at the time of the incident.

c) In this investigation, the AIBN has not discovered any technical defects or malfunctions in the aircraft that could have contributed to the incident.

d) The aircraft's systems for preventing, removal and warning of ice were on and functioning as intended.

e) The stall warning system was functioning as intended.

f) LN-FAO did not have APM (Aircraft Performance Monitoring), a system that can detect aerodynamic disturbances as a result of icing conditions and give an indication of this in the cockpit. The system is not mandatory, but is installed on some of the ATR 42/72 fleet.

g) The crew members held valid certificates and ratings on the aircraft type.

h) The manufacturer's procedures for severe icing have been subject to revision, and the current issue has six items that the flight crews should know by heart to avoid getting into a critical situation.

i) In the event of abnormal rolling movements, the stick must be pushed forward and the flaps set to 15°. This is not included among the checklist items that should be known by heart.

j) The almost 2-years old manufacturer's procedure for handling severe icing on the ATR 42 had not been inserted into Coast Air's SOP.

k) The company had just issued OPS INFO ATR 1/2005 with information about "new" checklist items in the event of severe icing which should be known off by heart. The pilots received this close to the time at which the incident occurred, and had not had time to become familiar with its content.

l) The company's SOP did not contain any policy or procedures for the use of weather radar.

m) The company's SOP had not been revised since 2002.

n) The company had had significant changes of key personnel since 2002.

o) The members of flight crew had a lack of knowledge about the current procedure for severe icing.

p) Coast Air did not know that the flight simulator they hired offered the option of training on realistic icing scenarios, and this type of training was therefore not implemented in the company.

q) Pressure to keep down cost levels within the company may have contributed to reducing the quality of flight crew training.

r) The established departure route out of Stord to Oslo runs across the Folgefonna area which is well-known for icing.

s) Local moderate icing was forecast in western part of Norway on the morning in question.

t) The weather radar was not used as an aid for avoiding areas with high precipitation.

u) During the climb eastward out of Stord, the aircraft entered an area of severe icing when passing the Folgefonna glacier.

v) Despite all systems for the prevention and removal of ice being switched on and functioning, significant amounts of ice built up rapidly, considerably impairing the aircraft's climb performance.

w) The symptoms described in the item above was not interpreted by the crew as indicative of severe icing which required action.

x) Complacency as a result of the crew flying on a daily basis on a monotonous and limited network of routes and being used to the aircraft systems handling any icing, may have been a factor

y) The flying speed was reduced to maintain climb, and according to the crew's explanation, the speed may have been reduced to a value lower than the manufacturer's minimum speed in the event of severe icing.

z) At the low speed, the wing's angle of attack gradually exceeded the critical value. This resulted in a stall. "Aileron hinge moment reversal" may have occurred. The aircraft went out of control, banking uncontrolled first to the right and then over to the left while rapidly losing altitude.

aa) When the right wing dropped out of control, manual actions to counteract the stall were implemented, but the extension of flaps to 15° was missed out.

bb) After the aircraft had lost 1 500 ft in altitude, control was apparently regained, but in the subsequent climb, the left wing dropped suddenly.

cc) After the second wing drop, control was regained without a considerable loss of altitude, and the problems resolved themselves since the aircraft came out of the cloud and out of the area of icing conditions.

dd) The loss of altitude during the incident was not critical in relation to terrain height.

ee) The incident was not notified and reported to the AIBN in accordance with the regulations, and flight data recorder data, which would have been very useful in the investigation, were not secured.

ff) Through its oversight of the company, the CAA-N numerous times discovered considerable deficiencies linked to the quality system, flight safety programme and flight operations documentation.

gg) The quality system was found to be unsatisfactory during several of the CAA-N's successive annual inspections, without this leading to the CAA-N increasing either the frequency of inspections or their intensity, and no concrete warnings were issued about the possible consequences on the company's approval.

hh) The CAA-N had not reviewed the weaknesses in the company's quality system with the Quality Manager

ii) The CAA-N did not carry out an introductory interview with the Accountable Manager of Coast Air.

jj) In conjunction with the tendering round for flying scheduled routes in Norway in autumn 2005 the CAA-N did not make any statement to indicate that the Ministry of Transport and Communications ought to avoid allocating routes to Coast Air, despite the serious and persisting deficiencies in its quality system and flight safety programme.

kk) Conditions of importance to a company's inherent accident resistance were not included in the technical/operational evaluation that the CAA-N undertook of tenderers for flying scheduled routes in Norway. Except for requiring a valid AOC, the operators' level of safety was not among the criteria the Ministry of Transportation and Communications based their allocation of tendering routes on.

4. SAFETY RECOMMENDATIONS

The following safety recommendations are issued by the Accident Investigation Board of Norway[5]:

Safety recommendation SL no. 2009/02T

It is important to prevent turboprop aircraft from flying into icing conditions for which that aircraft type is not certified. Published instrument departure routes eastwards out of Stord airport lead into areas known to imply a risk of icing. The AIBN recommends that the CAA-N evaluates ordering Avinor to establish alternative routes that might be used when there is a risk of icing conditions along approach/departure routes in conjunction with Stord airport. There ought to be an analysis and assessment of whether the recommendation is relevant and ought to be made applicable also to more Norwegian airfields.

Safety recommendation SL no. 2009/03T

It is important that flight crews on the ATR 42 know by heart the manual actions to take if uncommanded roll movements occur during icing conditions. This is to avoid losing control of the aircraft, and/or to regain control more quickly. Experience has shown that crews forget to extend flaps to 15°. The AIBN recommends that the CAA-N should request EASA to reconsider the layout of the procedure in question in AFM in consultation with ATR. The item on setting flaps to 15° after losing control in icing conditions ought to be an item that should be known off by heart, and this should be reflected in the manufacturer's training programme.

Safety recommendation SL no. 2009/04T

Experience with aircraft type ATR 42/72 shows that it can be particularly vulnerable to severe icing. A new system has been developed that is better able to detect increased icing intensity and the effect of this (Aircraft Performance Monitoring, APM). The system warns the crew before the situation becomes critical, to allow the routing to be changed in time. APM is not currently mandatory. The AIBN recommends that the CAA-N should request that EASA assess the system's suitability and consider whether this or equivalent systems should be mandatory on all ATR 42/72 aircraft.

Safety recommendation SL no. 2009/05T

Before this serious icing incident occurred, the CAA-N appears to have devoted insufficient resources to the follow-up of significant deficiencies linked to the quality system, flight safety programme and flight operations documentation that were discovered during routine inspections of Coast Air. The AIBN believes this to be serious in view of the responsibility the CAA-N has for ensuring that the operators fulfil both the relevant technical/operational detailed rules and function-oriented safety regulations. The AIBN recommends that the CAA-N undertakes a review of its regulatory oversight methodology. Particular stress should be placed on assessing whether the operators' function-oriented systems are working as intended.

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[5] *The Norwegian Ministry of Transport and Communications ensures that safety recommendations are submitted to CAA-N and/or other ministries concerned for follow-up, cf. Regulation on public investigations of aircraft accidents and incidents within civil aviation, Section 17*

Safety recommendation SL no. 2009/06T

An operator's level of safety is not currently included in the assessments that are made in conjunction with the allocation of tendered routes. Over a period of time, this could lead to prioritising of operators which choose minimum solutions relating to safety. The AIBN recommends that the Ministry of Transport and Communications, in addition to the current criteria for assessing tenders, also should request that a safety assessment should be submitted for each route for which an application is being made, to verify whether the tenderer is still in compliance with the conditions of its AOC. These safety assessments should be included in the evaluation when assigning tendered routes.

Safety recommendation SL no. 2009/07T

Operators which provide flight crews with periodic training beyond the minimum requirements contained in the joint European regulations, will have to pay costs that could contribute to their losing out in the competitive tender. Norway has more challenging weather conditions and terrain than many other European countries, and these challenges are often prominent in the network of scheduled routes that are put out to tender. The AIBN believes that quality and the scope of flight crew training are extremely important bearing in mind flight safety in Norway. The AIBN recommends that the Ministry of Transport and Communications should assess whether to submit requirements for training exceeding the regulations' minimum requirements during tender invitations for flying scheduled routes.

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.

Accident Investigation Board Norway

Lillestrøm, 16. January 2009

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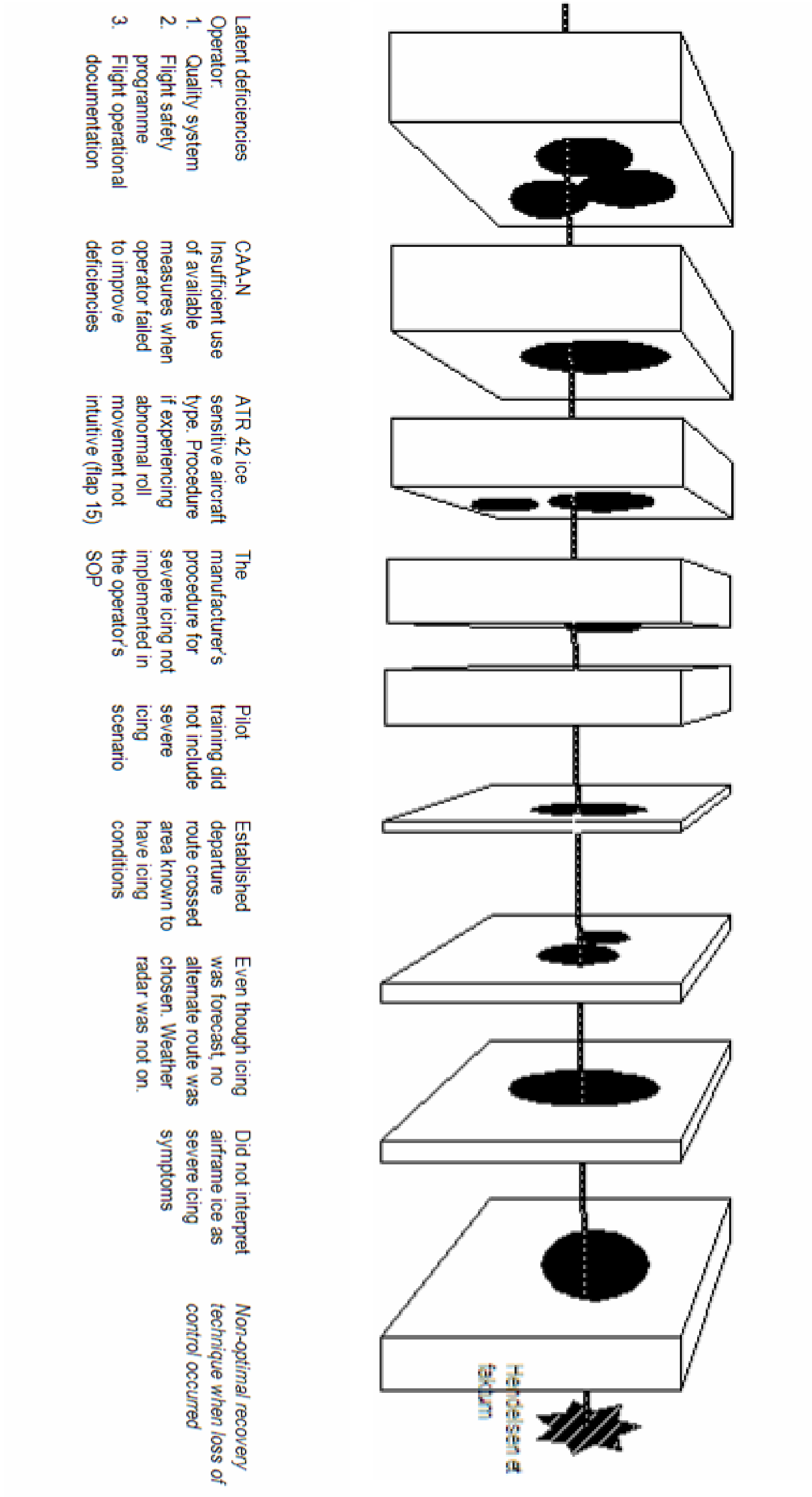
APPENDIX

ABBREVIATIONS

AIBN	Accident Investigation Board Norway
AFIS	Aerodrome Flight Information Service
AFM	Aircraft Flight Manual
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AMM	Aircraft Maintenance Manual
AOA	Angle of Attack
AOR	Aerea of Responsibility
AOC	Air Operator Certificate
APM	Aircraft Performance Monitoring
CAA-N	Civil Aviation Authority Norway
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
EASA	European Aviation Safety Agency
FDR	Flight Data Recorder
FAA	Federal Aviation Authority
F.C.O.M.	Flight Crew Operations Manual
PSO routes	Public Service Obligation routes
HPa	Hectopascal
IAS	Indicated Air Speed
ISA	International Standard Atmosphere
JAR	Joint Aviation Requirements
JAA	Joint Aviation Authorities
KIAS	Kt Indicated Air Speed
Kt	Knot(s), nautical miles per hour
MAC	Mean Aerodynamic Chord
METAR	Aerodrome routine meteorological report (in meteorological code)
MPC	Multi Purpose Computer
MSIS	Minimum Severe Icing Speed
NTSB	National Transportation Safety Board
OM	Operations Manual
OPC	Operator Proficiency Check
PC	Proficiency Check

PF	Pilot Flying
QNH	Altimeter set so that the altitude above sea level is indicated when standing on the ground
RWY	Runway
SOP	Standard Operating Procedures
TAF	Aerodrome forecast (in meteorolgical code)
UTC	Co-ordinated Universal Time
V_s	Stalling speed

Swiss cheese model -illustration of latent conditions and active errors that led to the incident



Recommendations & Accomplishments

Recommendations & Accomplishments

Most Wanted Transportation Safety Improvements

4.1.1.1 *Federal Issues*

AVIATION

Reduce Dangers to Aircraft Flying in Icing Conditions

Objectives

- Use current research on freezing rain and large water droplets to revise the way aircraft are designed and approved for flight in icing conditions.
- Conduct additional research with NASA to identify realistic ice accumulations and incorporate new information into aircraft certification and pilot training requirements.

Importance

The 1994 in-flight icing encounter and subsequent loss of control and crash of a commuter airliner in Roselawn, Indiana, which took 68 lives, prompted the Safety Board to examine the issue of airframe structural icing and conclude that the icing certification process has been inadequate because the process has not required manufacturers to demonstrate the airplane's flight handling and stall characteristics under a realistic range of adverse ice accretion/flight-handling conditions. The Federal Aviation Administration (FAA) has not adopted a systematic and proactive approach to the certification and operational issues of turbine-engine-driven transport-category airplane icing.

The consequences of operating an airplane in icing conditions without first having thoroughly demonstrated adequate handling/controllability characteristics in those conditions are sufficiently severe that they warrant a thorough certification test program, including application of revised standards to airplanes currently certificated for flight in icing conditions.

Summary of Action

Revise Icing Certification Criteria and Testing
As a result of the Roselawn, Indiana, accident, the Safety Board called on the FAA to revise the icing criteria and icing testing requirements necessary for an airplane design to be approved within the United States, and the operational requirements that specify under what icing conditions it is permissible to operate an aircraft. Ten years ago, this work was referred to an industry group that provides input to the FAA on new regulations (the Aviation Rulemaking Advisory Committee, or ARAC). The ARAC has recommended to the FAA changes to the design requirements for new airplanes to evaluate performance and handling characteristics in icing conditions. In March 2002, 6 years after it started this work, the ARAC approved a concept to revise the icing criteria in the design requirements for new airplanes.

Currently, there are five rulemaking activities concerning icing:

- A revision to Part 121, applicable to airplanes with takeoff weights less than 60,000pounds, that addresses when to activate the ice protection system and when the flight crew should exit icing conditions.
- A revision to Part 25that addresses when to activate the ice protection system.

(The next step for these two rules is for the FAA to prepare a regulatory evaluation. Because of the higher priority of other safety-related rulemaking activities, the FAA decided to delay development of the regulatory evaluations.)

- A revision to Part 25for evaluating airplane performance and handling characteristics in the icing conditions of Appendix C. The NPRM and AC were published in the *Federal Register* on November 4, 2005.
- The ARAC is developing Part 25 rules that include requirements to demonstrate that an airplane can safely operate in certain super-cooled large drop (SLD) conditions for an unrestricted time or can detect SLD and enable the flight crew to exit icing conditions. There will also be recommendations from the ARAC for mixed-phase icing rulemaking.
- The FAA plans to develop similar Part 23rules after completion of the Part 25rulemaking.

Thus, more than 10 years after the Safety Board issued these recommendations, the FAA has yet to issue any of the operational, design, or testing requirement revisions recommended. The NPRM issued on November 4, 2005 is progress but this is only an NPRM, and full implementation of the regulatory change may still be several years away. The FAA has indicated that because of other rulemaking projects, it is not working on the revisions to Parts 25 and 121 concerned with activating the ice protection system. The ARAC is still working on regulations concerning SLD and mixed phase icing for both Part 25 and Part 23. The FAA has not provided any projected dates for completion of the ARAC's work, let alone development and issuance of an NPRM and final rule. The pace of the FAA's activities in response to these recommendations is unacceptably slow.

Apply Revised Icing Requirements to Currently Certificated Aircraft

As a result of the Safety Board's investigation of the in-flight encounter with icing and subsequent uncontrolled collision with terrain of Comair flight 3272, an Embraer 120RT, near Monroe, Michigan, on January 9, 1997, in which all 29 persons onboard the airplane were killed, the Safety Board asked the FAA to review the icing certification of all turbopropeller-driven airplanes currently certificated for operation in icing conditions and to perform additional testing. On August 16, 2006, the FAA issued AC 20-73A, "Aircraft Ice Protection" which includes certification guidance relative to the effects and criticality of deicing boot intercycle and residual ice accumulations, and ice accumulations on unprotected surfaces aft of protected surfaces. The FAA and NASA conducted testing and research on these issues in 1999 and 2000, and stated to the Safety Board in September 2001 that additional testing and research were necessary to develop the needed guidance, and that it was developing and pursuing this research. In an October 26, 2005, letter, the FAA indicated that the revisions to the AC were based on the testing and research performed in 1999 and 2000. As part of its evaluation of the revised AC, the Safety Board has asked the FAA whether additional research and testing were conducted after the FAA's September 2001 letter.

The icing certification regulations and advisory material developed by the FAA are sufficiently developed to determine whether additional action is required for any airplanes currently certificated and in service. The FAA has stated that no unsafe conditions exist that warrant actions beyond those that have already been completed or are in the process of being completed. The Board is concerned that the FAA has reached this conclusion based on a lack of accidents or serious incidents. During the 1990s, a number of accidents occurred involving airplanes that had passed the certification standards and for which the FAA believed there was no unsafe condition requiring action. Before another accident or serious incident occurs, the FAA should evaluate all existing turbo-propeller driven airplanes in service using the new information available, such as critical ice shapes and stall warning margins in icing conditions.

Action Remaining
Complete efforts to revise icing certification criteria, testing requirements, and restrictions on operations in icing conditions. Evaluate all aircraft certified for flight in icing conditions using the new criteria and standards.

Safety Recommendations

A-96-54 (FAA)
Issued August 15, 1996
Added to the Most Wanted List: 1997
Status: Open—Unacceptable Response
Revise the icing criteria published in 14 [*Code of Federal Regulations*] CFR Parts 23 and 25, in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution, and temperature, and recent developments in both the design and use of aircraft. Also, expand the Appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions, as necessary. (Source:Report on the in-flight icing encounter and loss of control of American Eagle flight 4184, ATR 72-212, near Roselawn, Indiana, on October 31, 1994 [NTSB/AAR-96-01])

A-96-56 (FAA)
Issued August 15, 1996
Added to the Most Wanted List: 1997
Status: Open—Unacceptable Response
Revise the icing certification testing regulation to ensure that airplanes are properly tested for all conditions in which they are authorized to operate, or are otherwise shown to be capable of safe flight into such conditions. If safe operations cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flightcrews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification. (Source:Report on the in-flight icing encounter and loss of control of American Eagle flight 4184, ATR 72-212, near Roselawn, Indiana, on October 31, 1994 [NTSB/AAR-96-01])

A-98-92 (FAA)
Issued November 30, 1998
Added to the Most Wanted List: 2003
Status: Open—Unacceptable Response
With the National Aeronautics and Space Administration [NASA] and other interested aviation organizations, conduct additional research to identify realistic ice accumulations, to include intercycle and residual ice accumulations and ice accumulations on unprotected surfaces aft of the deicing boots, and to determine the effects and criticality of such ice accumulations; further, the information developed through such research should be incorporated into aircraft certification requirements and pilot training programs at all levels. (Source:Report on the in-flight icing encounter and uncontrolled collision with terrain of Comair flight 3272, an Embraer EMB-120RT, near Monroe, Michigan, on January 9, 1997 [NTSB/AAR-98-04])

A-07-15 (FAA)
Issued January 2007
Added to the Most Wanted List: 2007
Status: Open—Unacceptable Response
When the revised icing certification standards and criteria are complete, review the icing certification of pneumatic deice boot-equipped airplanes that are currently certificated for operation in icing conditions and perform additional testing and take action as required to ensure that these airplanes fulfill the requirements of the revised icing certification standards. (Source: Report on crash during approach to landing, Circuit City Stores, Inc., Cessna Citation 560, N500AT, Pueblo, Colorado, on February 16, 2005. [NTSB/AAR-07-02])

January 2007

FAA Testimony 6 June 2007:

Statement of Peggy Gilligan, Deputy Associate Administrator for Aviation Safety Before the Committee on Transportation and Infrastructure, Subcommittee on Aviation on the Most Wanted List of the National Transportation Safety Board

(Source: http://www.faa.gov/news/testimony/news_story.cfm?newsId=8928)
[…]

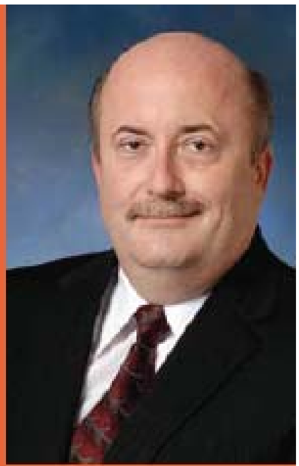
Icing
This is another area where the Board has recommended that the FAA design the solution, test the effectiveness of the solution, and then mandate the solution. As meteorologists will attest, simply understanding some of these icing phenomena is difficult and complex. And then determining how to address these phenomena to assure safe aircraft operations takes time.
That's why we have taken a multi-pronged approach to the icing issue by taking immediate safety actions, as well as performing longer-term research to improve our understanding of icing phenomena.

One of our most effective tools to address safety issues is the airworthiness directive (AD). We have issued over 100 ADs to address multiple threats from icing on over 50 different aircraft models. These ADs cover safety issues ranging from crew operating procedures in the icing environment to direct design changes. These ADs have had the effect of significantly reducing the icing risk to the overall fleet.

Following the issuance of ADs, the FAA conducts general rulemaking intended to institutionally prevent the same icing risk for future airplane designs that were averted by implementing ADs on specific models. FAA is presently in the process of two rulemaking efforts on icing. The first, which we anticipate publishing as a final rule, requires designers to demonstrate specific airplane performance handling qualities for flights in icing conditions. The second rulemaking is an NPRM, published on April 26, 2007, entitled Activation of Ice Protection, which would introduce requirements to ensure timely activation of ice protection systems (IPS). The proposed rule would require installation of an ice detector or activation of the IPS based on visible moisture and temperature.

The recommendation that we have not yet been able to address in rulemaking is related to a phenomenon known as supercooled large droplet (SLD) icing conditions. This phenomenon has been a challenge because conditions that result in SLD are difficult to forecast and detect. It is also not easy to reproduce in a test environment. So, to first forecast and characterize SLD, then reproduce it, and finally evaluate its affect on aircraft operations has required extensive research. Our research has engaged leading experts from academia, industry, and the government. Due to the technical complexity, our activities continue today. We are committed to identifying the right solution for long term design and operational requirements for the SLD threat. In addition, we have issued numerous ADs that direct the crews of certain airplane designs to monitor and detect early signs of the onset of SLD conditions and to exit the area immediately. These ADs serve as an effective interim measure until such time we complete our research on SLD and complete the necessary rulemaking.

RULES VERSUS Safety



I spend quite a bit of my time trying to explain modern safety concepts to a lot of important people. Many of them do not know aviation and have never contemplated the realities of human error. Gaining their comprehension is often an uphill battle, and I am beginning to realize that it is because I am glossing over a critical point that people often do not grasp: Compliance does not equal safety. The people who govern us assume that good rules and quick punishments can actually prevent crashes.

I guess we shouldn't be surprised; many of these people are in the "rules and punishment" business. Politicians get elected by being tough and demanding accountability. Reporters look for situations where rules are overlooked and they label it as corruption. Prosecutors enforce the rules with the heartfelt belief that rules will save lives if the right people are punished.

It is difficult to persuade these people that compliance can only take us so far. It sounds like a "sellout" to industry, even though it is really our best hope. It is an even worse problem for regulators who are trying to sell safety management systems. They live in a political world, and no politician expects to win popular approval by supporting voluntary reporting.

So let's take this issue on directly.

First, we have to acknowledge that while compliance with rules is important, it is not enough. If compliance guaranteed safety, we would only need one rule: "Don't crash." Obviously, it takes a lot more than that.

We have been writing rules in the name of safety for a long time, and that road has become a dead end. When I had to make the argument for a safety management system standard at the International Civil Aviation Organization (ICAO), I pointed out that the ICAO audit team had identified more than 10,000 international standards that states had to translate into local law. When the team counted all of the other recommendations and technical specifications that needed to be considered, the number of rules swelled to 30,000.

That's a lot of rules. I asked the question, "If we write another 1,000 standards, will it make things safer?" The consensus of the countries around the world was "probably not," and that more rules wouldn't necessarily give us more safety. It was time to look toward better safety reporting and better safety systems.

The international aviation community gets the point, but the rest of the world needs convincing. They need to understand that by taking on things like safety management, reporting systems and risk management, we are not turning our back on the rules. Rather, we are simply moving beyond them. Compliance is still important, but we can no longer allow compliance to lull us into complacency. We must continue looking for the next risk, the next potential error, whether it involves a rule or not.

I ask all of you to help us do a better job of communicating our intent to those in power and those in the news media. We are not an industry trying to free ourselves from regulations; we are an industry trying to free ourselves from the dangerous illusion that regulations are enough.

William R. Voss
President and CEO
Flight Safety Foundation