Control problems in icing, Serious incident occurring 14 December 1998, 15 km westlich Cottbus, to Aerospatiale-Alenia/ATR 42-300.

Micro-summary: **This ATR 42-300 experienced flight control difficulties in icing conditions.**

Event Date: **1998-12-14 at 1109 UTC**

Investigative Body: **Federal Bureau of Aircraft Accidents Investigation (BFU), Germany**

Investigative Body's Web Site: **http://www.bfu-web.de/**

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Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accidents Investigation

Final Report

5X011-0/98
April 2001

Factual Information

Type of Occurrence:	Serious Incident
Date:	14. Dezember 1998
Location:	15 km westlich Cottbus
Aircraft:	Aircraft
Manufacturer, Model:	Aerospatiale-Alenia/ATR 42-300
Injuries to Persons:	no injuries
Damage:	Aircraft not damaged
Other Damage:	none

History of flight

The aircraft had departed at 11:09 UTC from Dresden to Posen (Poland). The temperature at the aerodrome of departure was +5°C (ATIS L 10:50 UTC). The first officer was the pilot flying (PF). During climb the aircraft entered the clouds at 2000 ft. At 3400 ft the autopilot (AP) was connected. The crew had preselected the climb out speed to 160 kt. The crew established light aircraft icing approx. from flight level (FL) 80 and moderate aircraft icing from FL 120. The anti-icing equipment as well as the airframe de-icing equipment were switched on at stage III. A visual check indicated to the crew that the deicer boots on the wings were functioning normally and had no ice accretion. On the unheated portion of the forward side windows of the cockpit rime ice was visible. During climb the PF pushed the touch control steering button several times in order to check the control surfaces for smooth operation. The climb rate decreased to approx. 500 ft/min. Thus the crew reduced the climb out speed by 5 kt to 155 kt, in order to maintain the climb rate and in the hope of being able to leave the clouds towards the tops. Approx. at FL 135 the climb rate, however, was only 200 to 300 ft/min (Attachment 1 shows the development of the climb rate with time). Due to this fact the crew decided to interrupt the climb to the planned flight level of FL 190 in order to make the airspeed increase again. For this purpose they activated the Altitude Hold Mode (ALT HOLD Mode). After a light increase to approx. 160 kt the airspeed again dropped to the initial value. Shortly afterwards at a speed of 155 kt the stall warning was activated suddenly and ‘quite unexpectedly’ for the crew and the AP was switched off automatically. The aircraft immediately banked heavily to the left and afterwards to the right. Now the bank attitude changed several times from left to right. The PF counteracted the bank attitude with full aileron deflections. The aircraft assumed an uncontrolled flight attitude. After the crew had regained control of the aircraft the pilot-in-command (PIC) declared an in-flight emergency to the responsible air traffic control unit and at 11:49 UTC performed a precautionary landing to Berlin-Schönefeld aerodrome without any problems.

Investigation

Crew

The crew statements concerning the course of the incident, which were made on December 23rd, 1998, on the occasion of an enquiry by the BFU in the presence of representatives of the operator, did not differ from the written report submitted by the PIC after the incident.

After they had observed icing and the resulting reduction of climb performance of the aircraft, the crew decided to discontinue the climb. The aircraft was to regain airspeed.

The crew declared that they were able to determine the kind of icing - rime ice. The crew assumed icing of mod-

erate intensity. The icing of the forward side windows in the cockpit was not defined as severe icing by the crew.

The transition into the uncontrolled flight attitude came quite unexpectedly for the crew. The instrument readings never indicated an impending stall. A mistrim could not be established.

The following remarks made by the PIC should be mentioned:

- After the onset of the incident the PF tried to keep the wings level by full aileron deflections. He tried to push the control column; when doing this he had the feeling that the aircraft did not react to elevator deflections.
- Unusual control forces were not realized.
- During the approach to Berlin-Schönefeld the ice separated almost completely from the aircraft. The wings were free of ice. After the landing only light ice accretion on the nose tip (approx. 0.5 cm) was found. At the time of the landing the temperature was +6°C.

By letter of December 18th, 1998, the operator informed the aircraft manufacturer that during the climb the first officer took two photos of the ice build up on the unheated portion of the forward side windows of the cockpit. The photos had been developed by the operator but without any result (Photos were blurred/unsharp).

The PIC had accumulated 4570 flight hours (approx. 1 year on the ATR) and the first officer had 2250 flight hours.

Aircraft ATR 42-300

The aircraft is certified in the transport category FAR and JAR 25 for day and night operations. It is a turboprop aircraft powered by two engines. The aircraft has the appropriate equipment and instruments required by the airworthiness provisions to be operated in icing conditions. A pneumatic de-icing system on the exposed critical parts (wing and horizontal tailplane leading edges, engine air intakes and engine gas paths), complemented by an electrical anti-icing protection for the parts on which a pneumatic de-icing device cannot be installed**,** i.e. rotating components (such as propellers), windshields, probes, flight control horns are installed.

In particular, the aircraft is equipped with extended de-icing boots on the outer wing, in front of the aileron.

Digital flight data recorder (DFDR)

The evaluation of the flight data recordings revealed essential findings concerning the course of the incident and the parameters having caused the incident. The evaluation made by the BFU was based on the raw data recorded by the DFDR which had been secured by the operator concerned.

The evaluation covered the period of time relevant to the incident, from the activation of the ALT HOLD Mode at FL 135 (11:26:20 UTC) until the crew had regained control of the aircraft (11:29:44 UTC(Attachment 2).

After the activation of the ALT HOLD Mode the aircraft flew with an indicated airspeed of 155 kt at 13 479 ft, the total air temperature (TAT) was -5°C. The AP was connected. Further important parameters were: Pitch angle +5° and vane angle of attack (AOA) +9.5°. Except for the AOA all of the parameters listed here are indicated to the crew in the cockpit.

At 11:27:30 UTC after 70 s in horizontal flight the airspeed had increased to the maximum value of 159 kt. This airspeed (159/158 kt) was maintained over a period of 42 s. Afterwards, however, the airspeed dropped again to its initial value of 155 kt. The pitch of approx. +5° remained almost unchanged during the whole period, when the aircraft was in horizontal flight.

The AOA did not change much either during the first phase of the ALT HOLD Mode. The AOA variied between +9° and +10°. Only 12 s prior to the occurrence the angle increased continuously from +10.0° to +11.9°.

At 11:28:25 UTC a light bank angle to the left (1°) combined with a light increase of pitch (+0.35°) and of the AOA was registered. At 11:28:52 UTC a roll to the right with a maximum of approx. 4° was recorded. Both turns were compensated automatically by corresponding aileron deflections. The AP was still connected.

Immediately afterwards there was a roll to the left. During this phase the AOA reached approx. +12°.

Shortly prior to the occurrence the following parameters were recorded: flight level 13 479 ft, airspeed 155 kt, left bank angle 10° and increasing, aileron deflection 5° to the right, rudder 0.5° to the left, pitch +5°, AOA approx. +12° and TAT -5°C.

According to the statements of the aircraft manufacturer the stall warning will be activated and the AP will be disconnected if the mean value of the right and the left AOA sensor reaches 11° or more.

At 11:28:54 UTC after 154 s of flight in the ALT HOLD Mode the AOA-threshold was exceeded so that the stall warning was activated and the AP disconnected. The yaw damper remained in circuit. Immediately the left bank angle increased, the pitch decreased and the aircraft assumed an uncontrolled flight attitude.

The subsequent uncontrolled flight attitude, which lasted approx. 50 s, was characterised by the following:

- High bank angles changing from left to right counteracted by opposite aileron deflections by the crew with almost identical frequency with extreme values of 103° to the right and 48° to the left, resulting in the so-called wing rocking.

- Rudder deflections coordinated with aileron deflections.
- The AOA did not decrease considerably during the first 43 s - in the meantime it increased to values up to 15° - only at 11:29:37 UTC AOA values below 10° were recorded.
- The elevator position remained nearly unchanged.
- The trim tab was not operated.
- The pitch decreased to a minimum of -17°.
- The airspeed increased to a maximum value of 221 kt.
- The vertical acceleration reached a maximum of +2.16 g.
- The speeds of the propellers remained constant at 86%.
- After 10 s of uncontrolled flight the crew increased the engine torque to approx. 107%.
- The loss of altitude was approx. 3800 ft.
- At approx. FL 110 the aircraft reached warmer air masses (TAT up to +1°C).
- The wing rocking stopped when the speed increase reduced the AOA below the critical value.
- There was no other conflicting air traffic.

At 11:29:44 UTC when the normal flight attitude had been restored and the crew piloted the aircraft into climb, the DFDR recorded the following parameters: flight level 9800 ft, airspeed 209 kt, pitch +10.5°, AOA +4° and TAT +1°C.

Aircraft Flight Manual

The LIMITATIONS SECTION - part ICING CONDITIONS (Chapter 2-06, pages 1 and 2, Dec 97) of the ATR 42 AFM contains a warning that the aircraft is not certificated for flights under severe icing conditions. It contains information about the visual cue for the crew to recognise severe icing of the aircraft as well as the prohibition to use the AP if there are signs of severe icing (Attachment 3).

Ice covering all or a substantial portion of the unheated portion of either forward side window, possibly associated with water splashing and streaming on the windshield, is considered to be a visual cue identified with severe icing.

If this visual cue exists, the icing conditions must be left immediately by changing the flight route or altitude.

The AP shall not be used at all, if the visual cue exists, unusual lateral trim requirements are established or AP trim warnings appear during flight under icing conditions.

The EMERGENCY PROCEDURES MISCELLANEOUS (Chapter 4-05, pages 5 and 6, Jan 97) describes secondary indications of severe icing of the aircraft. In addition the procedure for leaving the severe icing conditions is prescribed (Attachment 4).

Under the Section PROCEDURES AND TECHNIQUES ADVERSE WEATHER (Chapter 2.02.08, page 13, Mar 97), the Flight Crew Operating Manual (FCOM) prescribes a certain method to be applied in case of unexpected roll and/or in case of abrupt aileron force changes: The controls are to be held firmly at the desired position and control surfaces shall not be allowed to deflect by themselves. With the aircraft in the clean configuration the landing flaps are to be extended to 15° in order to reduce the AOA. And finally the engine power shall be increased.

Operator

In preparation for the winter period 1998/99 the flight operations manager of the operator issued the fleet information 09/98 dated September 16th, 1998. Under Section 1 - Winter Operation - the procedures to be applied under severe icing conditions were recalled. The actions to be undertaken by the crew prior to the flight as well as during flight are established in detail.

In paragraph 5.2.1.4.2 of the Flight Operations Manual (FOM) of the operator (Chapter 05, page 88, December 16th, 1997) the effects of icing during climb on aircraft performance are described. If icing conditions exist, a high airspeed should be maintained, in order to reduce the AOA. Furthermore the time of flight under icing conditions should be kept short.

Manufacturer AEROSPATIALE (ATR)

The incident prompted the aircraft manufacturer to hold a Severe Icing Operations Conference with all ATR operators (Flight Operations Managers) on March 9th, 1999 at Paris. On this conference the incident of December 14th, 1998 was described in full detail.

On this conference, the manufacturer also outlined planned design improvements for the ATR 42/72 as well as changes in the training and operational procedures. The whole ATR 42/72 fleet shall be equipped with ice evidence probes, the icing light flashing logic for the cockpit shall be modified and the median wings boots shall be extended.

The referenced design improvements are already part of the standard aircraft definition and accomplished in the new production aircraft. The retrofit of these modifications to ATR 42/72 fleet in service was decided after this incident and prescribed by the associated Airworthiness Directive (AD).

A specific procedure change was the direct result of this incident: the increase by 10 kt of the minimum icing speeds in case of inadvertent encounter with severe icing.

On April 21st, 1999, the French certification authority (DGAC) issued a corresponding AD no. 1999-165-077(B) for all model ATR 42 aircraft and no. 1999-166-041(B) for all model ATR 72 aircraft.

Furthermore the manufacturer accomplished performance calculations and simulations concerning this incident on the basis of the DFDR data provided.

The results were communicated to the BFU by letter of March 25th, 1999 (Note DAR/T/EG no. 557 5008/99). Noteworthy in the context of this incident were the statements concerning the changes of drag and lift. Section 3 PERFORMANCES contains the following explanations (original text):

3.1) Drag

- a continuous increase in drag for 20 minutes
- that the aircraft was flown in severe icing condition for at least 13 minutes (from airframe de-icing ON to AP disconnection)
- more than 100% drag increase at the AP disconnection

3.2) Lift

- five minutes after entering the clouds the loss of lift coefficient is -0.15
- this loss remains constant throughout climb whereas drag increases
- switching the airframe de-icing ON has no effect on lift

The investigation of incidents and accidents to ATR 42/72 aircraft caused by icing as well as test flights performed by the manufacturer revealed that in case of severe icing conditions ice accreted not only on the leading edges of the wings but that icing extended also beyond the boots (aft of the protected surfaces). Ice may accumulate on the upper as well as on the lower surfaces of the wings and cannot be dropped in flight by technical means. This very often results in a high drag, aerodynamic buffeting and in an early and sudden stall without any warning.

In September 1998 the manufacturer had issued a booklet of 32 pages with the title ‘All Weather Operations’ dealing exclusively with matters of icing accretion on ATR 42/72 aircraft. Among other things, this booklet addresses the recognition of conditions beyond the certification conditions.

French Certification Authority (DGAC)

By letter of January 13th, 1999, the DGAC issued an AD no. CN 1999-014-076(B) for all aircraft of the ATR 42 series and no. CN 1999-015-040(B) for aircraft of the ATR 72 series. This AD dealt with flying under icing conditions. The actions required were an immediate amendment of the Chapter EMERGENCY PROCEDURE SECTION and LIMITATION SECTION of the Flight Manual (AFM).

In this AD the visual cues for the recognition of severe icing by the crew, the conditions of ice accretion as well as actions to be taken after entry into severe icing conditions were described more precisely and in further detail.

By letter of April 21st, 1999, the DGAC issued another AD no. CN 1999-014-076(B) R1 dealing with flying under icing conditions. The Chapters LIMITATION**,** NORMAL PROCEDURE and EMERGENCY PROCEDURE SECTION were amended and modification 4222 was to be retrofitted**.**

Activities of the Luftfahrt-Bundesamt (LBA) as German Certification Authority

On April 22nd and on June 17th, 1999, the LBA issued an Airworthiness Directive (LTA-Nr. 1999-088 and 1999-088/2) on the basis of the AD of January 13th and April 21st, 1999, issued by the DGAC.

Meteorological Information

Prior to the flight the crew was provided with meteorological documentation issued by the German Meteorological Service (DWD) which was required for this flight. It was valid at the time of departure from Dresden.

The aeronautical meteorological forecast was a part of the briefing of the crew.

Among other things the forecast contained the statement that on the flight route the significant meteorological phenomena of light to moderate icing as well as moderate to severe turbulence had to be expected.

AIRMET (Airman meteorological information) no. 2 for the FIR (Flight Information Region) Berlin, valid for the lower airspace up to FL 100, the SWC (Significant Weather Charts) up to FL 100 as well as the SWC for FL 100 up to FL 450 (Attachments 5 and 6).

SIGMET (Significant meteorological conditions) no. 1 for the FIR Berlin valid from 12:00 UTC until 16:00 UTC with severe icing between 4000 ft and FL 180 had not been issued yet at the time when the ATR 42-300 took off. The incident was the trigger of SIGMET no. 1.

The DWD have an advisory centre for aviation at Dresden aerodrome. According to the statement of the PIC there was no reason to request additional forecasts for the planned flight route.

Meteorological Expertise

Since a connection between the weather conditions and the kind of incident was to be suspected, the BFU requested a meteorological expertise from the DWD.

It was to be concluded from the meteorological expertise that the location of the incident was on the frontside of a warm front moving eastwards. In the front area prolonged precipitations took place.

From the weather reports issued by the weather reporting office Dresden-Klotzsche at 10:50 UTC and 11:20 UTC it was to be seen that at the time of take-off time there was light rain at Dresden. The horizontal surface visibility was 7 km and the base of the lowest cloud layer was at 800 ft AGL. Above there were broken strato-cumulus clouds with a base of approx. 2100 ft AGL. There were multilayer bad-weather clouds. The surface air temperature was +5°C.

The radar pattern of the weather radar station Berlin showed at 11:30 UTC between Dresden and Berlin an extended strip of stratiform precipitation echoes whose front side at the moment of the incident was in the region of Cottbus. In this region there was locally light rain with drizzle. It may be supposed that also at the location of the incident there were multilayer bad-weather clouds at the time in question.

The tops of the compact frontal clouds were between FL 200 and FL 250. Thus the aircraft might have been in clouds almost during the whole climb up to FL 135.

The freezing level at the moment of the incident was between 3000 ft and 4000 ft. In the altitude interval up to approx. FL 100 the air temperature dropped to approx. -8°C. It may be assumed that light icing started with reaching the freezing level. During the further climb to FL 135 there was moderate to severe icing (rime ice).

According to the statement of the DWD at a meeting on February 5th, 1999 at Braunschweig, the weather forecast for the day of the incident had been correct. A different forecast for the region concerned was not possible. It is not possible to forecast directly as to where severe icing will occur. The meteorological service can only evaluate the conditions leading to it. For the warnings it is to be distinguished between forecasted and observed, the latter are only possible on the basis of a pilot's report (PIREP).

In the framework of the investigation the BFU also addressed an enquiry to ATC (air traffic control) as to the receipt of PIREPs. It was found out that up to the moment of the incident (11:30 UTC) no reports had been received. Only after the incident had occurred ATC addressed a corresponding enquiry to the crew of an aircraft (aircraft type Beech 350) flying near the location of the incident. In reply to this enquiry the pilot reported: "... moderate icing from level 150 and we have now at level 100 about -1 to -2 degrees".

Analysis

The analysis of the incident is based on

- the evaluation of the DFDR
- the statements made by the crew
- the evaluation of the radio communications between the crew and ATC Berlin
- a meteorological expertise

By the meteorological forecast documentation as well as an existing AIRMET it could be realised by the crew that light to moderate icing was to be expected on the planned flight route (FIR Berlin). Severe icing conditions had not been forecasted by DWD at the time of take-off.

There was no necessity for the crew to cancel the planned flight for meteorological reasons.

Analysis of the temperature and presence of cloud confirm that the atmospheric conditions required to encounter icing had been reached about 2 minutes after take-off.

From the meteorological expertise it is to be concluded that the conditions for moderate to severe icing (rime ice) were present and that the aircraft flew within clouds almost during the whole climb and horizontal flight.

The crew had realised moderate rime ice accretion on the aircraft. The icing of the forward side windows had not been connected with severe icing.

The side window cue as an indication of severe icing conditions was established in 1994 and widely published in ATR documentation including AFM (it is now also used for this purpose by most of the turboprop aircraft manufacturers). The validity of this cue to identify icing conditions beyond the certification envelope such as freezing drizzle or freezing rain is consolidated by 5 years of operation.

Generally, rime ice forms a granular deposit on the aircraft leading to a considerable reduction of the lift coefficient and an increase of the drag coefficient. This had also been shown by the manufacturer by analysis and simulations with respect to this incident.

According to the statements made by both pilots the change in flight attitude was totally unexpected without any warning (uncommanded and unexpected roll excursion). Prior to the incident the rate of climb and afterwards the cruise speed was within the allowable ranges but significantly different from normal values indicating the encounter of severe conditions. As a reminder the rate of climb was approx. 400 ft/min instead of 1150 ft/min, speed in level flight was 158 kt instead of 221 kt (a speed decay of approx. 60 kt). Monitoring of such parameters by the crew has to be considered as a part of basic airmanship, and the extent of the a.m. performance degradation should have alerted the crew.

As could be seen from the evaluation of the DFDR recordings, the vane angle of attack was the only parameter which remarkably changed prior to the incident. It increased from +10° to approx. +12°. Since the angle of attack was not indicated in the cockpit, this change remained unnoticed by the crew.

Due to the operation of the connected AP - it compensated several roll excursions just prior the incident - the crew was not in a position to realize that.

The course of the incident could be reconstructed as follows: In climb and horizontal flight the aircraft encountered moderate to severe icing conditions. Ice accreted on the aircraft outside the protected areas. As a result, the stall warning AOA threshold was exceeded triggering the disconnection of the AP. The heavy roll movement assumed immediately by the aircraft with a bank angle of more than 45° had been caused by a local loss of lift on the left wing induced by ice accretion probably located on the upper surface of the median wing. The aircraft assumed an uncontrolled flight attitude. The bank attitude changed several times as a result of PF over reaction to counteract the bank attitude changes with full aileron deflection. The aileron deflections which were made by the PF without any difficulties resulted in wing rocking.

In the subsequent flight phase the AOA did not change much over a longer period of time (43 s). If the crew had simply complied with the FCOM procedure for regaining control of the aircraft, i.e. pushing the control column forward or extending the landing flaps to 15°, the time of uncontrolled flight would have been reduced. The statement of the PIC that he had tried to push the control column forward cannot be reconstructed on the basis of the DFDR recordings.

The AFM and the FCOM for the ATR 42 contain the information required to have knowledge of the effects of icing on the aircraft.

According to the judgement of the Bundestelle für Flugunfalluntersuchung, the visual cues to identify severe icing of the aircraft as well as the avoidance and recovery procedures to be applied by the crew in case of unintentional entry into severe icing conditions are sufficiently described in the documentation.

Due to the flight experience it was to be expected that the flight crew was exercised and familiarised with the handling of the ATR 42-300 and were flying many hours a year under icing conditions.

The signs of icing registered by the crew were according to their statements not as severe as to immediately recognise an emergency situation, particularly since the ice protection and de-icing equipment installed on the aircraft worked without any recognisable errors.

Conclusions

The incident was caused by the fact that the crew lost the control of the aircraft after the aircraft entered and continued operation in severe icing conditions for which the aircraft is not certificated. The crew had failed to associate icing of the forward side windows with the severe icing phenomenon.

Safety recommendation

The issue of a safety recommendation could be waived since at a meeting held with the aircraft manufacturer and the French flight accident investigation bureau (BEA) on December 23rd, 1998, at Braunschweig the manufacturer and the BEA presented a series of actions, which in the opinion of the Bundesstelle für Flugunfalluntersuchung are suitable to prevent future incidents of this kind.

Investigator in Charge Krupper

Attachments

1: Development of the climb rate according to the DFDR
2: Flight data from the DFDR
3. Limitations under icing conditions
4: Emergency procedures in severe icing
5. SWC below FL 100
6. SWC for FL 100 - FL 450

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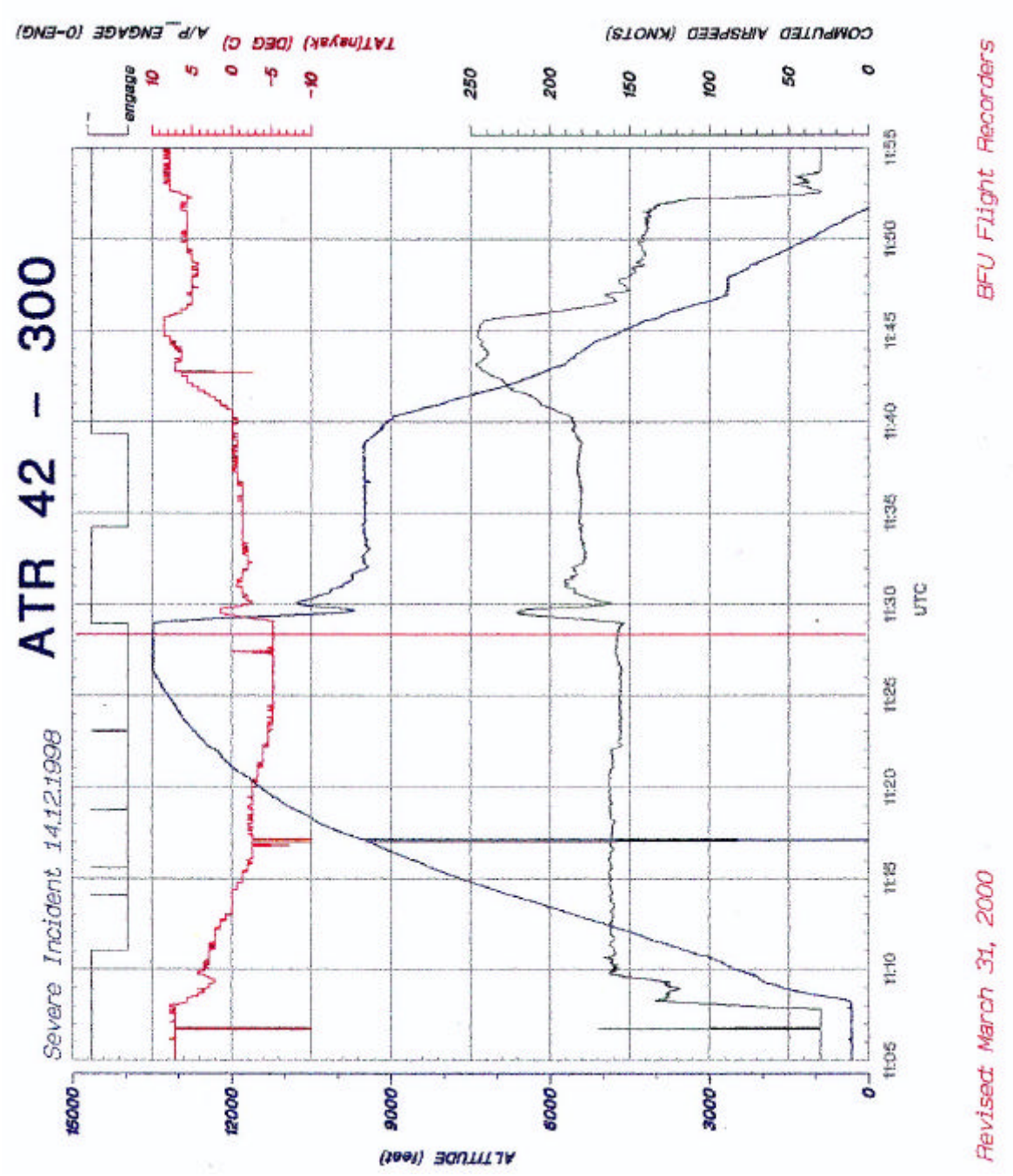
Attachment 1

Development of the climb rate according to the DFDR

COMP. TIME UTC	FLIGHT LEVEL FL	TAT °C	COMP. AIRSPEED kt	CLIMB RATE ft/min	REMARKS
11:08:11	350	+6	120	---	LIFT OFF
11:09:00	1 642	+3	123	---	
11:10:00	2 541	+3	156	899	
11:11:00	3 425	+3	160	884	
11:12:00	4 443	+2	162	1 018	
11:13:00	5 553	+1	161	1 110	
11:14:00	6 634	0	162	1 081	
11:15:00	7 701	-1	163	1 067	
11:16:00	8 557	-2	163	856	
11:17:00	9 421	-3	162	864	
11:18:00	10 334	-3	160	913	
11:19:00	10 973	-3	162	639	
11:20:00	11 471	-3	162	498	
11:21:00	11 962	-3	161	491	
11:22:00	12 299	-4	161	337	
11:22:03	12 321	-4	161*	---	
11:23:00	12 700	-5	156	401	
11:24:00	12 980	-5	156	280	
11:25:00	13 198	-5	156	218	
11:26:00	13 437	-5	156	239	
11:26:20	13 479	-5	155	---	ALT HOLD MODE
11:27:00	13 493	-5	157	---	
11:28:00	13 479	-5	158	---	
11:28:54	13 479	-5	155	---	STALL WARNING
11:29:44	9 800	+1	209	---	RECOVERY

* AT THIS TIME AIRSPEED IS REDUCED BY CREW BY 5 KT

Attachment 2



Attachment 3

2 . 06 . 01 – ICING CONDITIONS

- Atmospheric icing conditions exist when :
  - OAT on the ground and for take–off is at or below 5° C or when TAT in flight is at or below 7°C,
  - and visible moisture in any form is present (such as clouds, fog with visibility of less than one mile, rain, snow, sleet and ice crystals).
- Ground icing conditions exist when :
  - OAT on the ground is at or below 5°C,
  - and surface snow, standing water or slush is present on the ramps, taxiways and runways.

Take–off is prohibited when frost, snow or ice is adhering to the wings, control surfaces or propellers.

- Operation in atmospheric icing conditions :

  Flaps 45 setting is prohibited.

  NP setting below 86 % is prohibited.

  Refer to 3.02.01 for associated procedures and 6.06.02 for performance data.

  R | WARNING : Flaps 45 setting shall not be used after a flight in icing conditions, except if the aircraft is checked free of ice.

- Operation in ground icing conditions :

  Refer to 3.02.01 for associated procedures and to FCOM part 3 for advisory information on contaminated runways penalties.

- Severe icing :

  WARNING :

  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.

  –During flight, severe icing conditions that exceed those for which the airplane is certificated shall be determined by the following visual cue. If the following visual cue exists, immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the icing conditions.

  Severe icing is characterized by ice covering all or a substantial part of the unheated portion of either forward side window, possibly associated with water splashing and streaming on the windshield.

2 . 06 . 01 – ICING CONDITIONS (cont'd)

- Since the autopilot may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when the visual cue specified above exists, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the airplane is in icing conditions.
- All icing detection lights must be operative prior to flight into icing conditions at night.

NOTE : This supersedes any relief provided by the Master Minimum Equipment List (MMEL).

-The ice detector must be operative for flight into icing conditions.

Attachment 4

R

4.05.05 – SEVERE ICING

DETECTION

Visual cue identified with severe icing is characterized by ice covering all or a substantial part of the unheated portion of either forward side window, possibly associated with water splashing and streaming on the windshield.

THE FOLLOWING MAY BE USED AS SECONDARY INDICATIONS OF SEVERE ICING CONDITIONS :

- Unusually extensive ice accreted on the airframe in areas not normally observed to collect ice.
- Accumulation of ice on the lower surface of the wing aft of the protected area.
- Accumulation of ice on the propeller spinner farther aft than normally observed.

THE FOLLOWING WEATHER CONDITIONS MAY BE CONDUCIVE TO SEVERE IN–FLIGHT ICING :

- Visible rain at temperatures close to 0 degrees Celsius ambient air temperature.
- Droplets that splash or splatter on impact at temperatures close to 0 degrees Celsius ambient air temperature

PROCEDURES FOR EXITING THE SEVERE ICING ENVIRONMENT :

These procedures are applicable to all flight phases from take–off to landing. Monitor the ambient air temperature. While severe icing may form at temperatures as cold as –18 degrees Celsius, increased vigilance is warranted at temperatures around freezing with visible moisture present. If the visual cue specified in the Limitations Section of the AFM for identifying severe icing conditions is observed, accomplish the following :

- Immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the severe icing conditions in order to avoid extended exposure to flight conditions more severe than those for which the airplane has been certificated.
- Avoid abrupt and excessive maneuvering that may exacerbate control difficulties.

– Do not engage the autopilot.

– If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.

– If an unusual roll response or uncommanded roll control movement is observed, reduce the angle–of–attack.

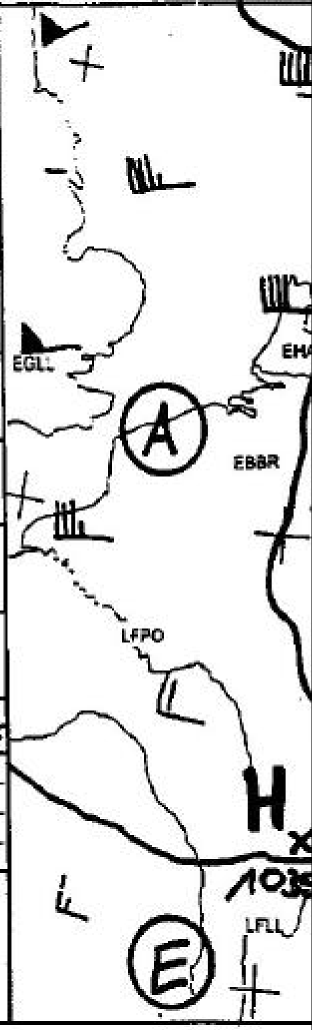
– If the flaps are extended, do not retract them until the airframe is clear of ice.

– Report these weather conditions to Air Traffic Control.

QGDD70 — FIXED TIME CHART VALID 09 UTC 14-12-1998

VARIANT	VIS	WEATHER	CLOUDS — TURBULENCE — ICING	0 °C.
AREA A	9	NIL	BKN/OVC ScAc LYR XXX/020	XXX
LOC	4	DZ/RADZ	OVC StScAc XXX/010	
S: LOC	500	FG		
AREA B	10	NIL	OVC ScAS XXX/020	S: 040
OCNL	6	RA/RADZ	OVC Ns XXX/010	W:
NPF LOC	3500	SN	OVC StScAs XXX/025	100
AREA C	10+	NIL	BKN/OVC AcAs XXX/080	N: 045
LOC	4	BR		S: 050 080
AREA D	10+	NIL	BKN ScCu 050/020	015
LOC	4	BR/DZ	BKN/OVC StSc 080/010	035
E: LOC	500	FG	NSC	
AREA E	6	NIL	SCT ScCu 050/025	085
OCNL	2000	BR		XXX
LOC	500	FG		
AREA				
AREA				
AREA				

SIGNIFICANT WEATHER BELOW [redacted]



WARNINGS AND / OR REMARKS

AREA A: SW-WIND WITH GUSTS UP TO 45/50 KT SFC
AREA D: NW-WIND WITH GUSTS UP TO 45/50 KT SFC

1. WIND ARROWS REFER TO 5 000 FT MSL
2. PRESSURE IN HPA AND SPEED IN KNOTS
3. VIS IN M OR KM (IN M ONLY IF LESS OR EQUAL 3 000 M) HILL FOG IMPLIES VIS 200 M OR LESS
4. ALTITUDE IN HECTOFEET ABOVE MSL, XXX = ABOVE 10 000 FT
5. TS AND CB IMPLY MOD / SEV ICING AND TURBULENCE

Anl. Zch. DW FAX 82 (98)

Attachment 5

Attachment 6