FINAL REPORT

HCL 37/02	**Incident**		
Aircraft Type:	Cessna 404	Aircraft Registration:	TF-JVG
Engine(s):	2 Continental GTSIO-520-M	Type of Flight:	Air Taxi, IFR
Crew:	2 – no injuries	Passengers:	9 – no injuries
Place:	App. 30 nm west of Kulusuk Airport (BGKK) at FL 130	Date and Time:	01.08.2002 1442 UTC

Synopsis

All times in this report are UTC.

The Area Control Centre at Copenhagen Airport, Kastrup (EKCH), notified the Danish Aircraft Accident Investigation Board (AAIB) on August 1, 2002, at 1700 hrs.

The Icelandic AAIB and the International Civil Aviation Organisation (ICAO) were notified on August 12, 2002.

The Icelandic AAIB had in accordance with ICAO Annex 13 appointed an accredited representative for the investigation.

During climb to and en-route at FL 130, the aircraft was most likely exposed to icing conditions. The flight crew lost control of the aircraft and it descended uncontrollably. At approximately 3000 feet, the flight crew regained control of the aircraft.

The incident occurred in daylight and under instrument meteorological conditions (IMC).

Summary.

The flight crew planned and performed a flight into an arctic area with forecasted risk of moderate icing conditions.

The icing conditions led to a sudden and unpredictable partial power loss on both engines. The unpredictable partial loss of engine power and the lack of appropriate emergency checklist actions resulted in an uncontrollable descent. Consequently, this incident is considered to be a temporary loss of control in flight, which resulted in a significant loss of altitude.

No safety recommendations were made during the course of this investigation.

1. Factual information

1.1 History of flight

The flight, during which the incident occurred, was an air taxi flight from Reykjavik (BIRK) in Iceland to Nuuk (BGGH) in Greenland. The passengers were nine fishermen.

Prior to the flight, the flight crew received an en-route weather briefing at the weather office in BIRK. An ATC flight plan for BGGH with two destination alternates (Kangerlussuaq (BGSF) and Maniitsoq

(BGMQ)) was filed. FL 100 was filed as the final cruising level. The flight crew prepared an operational flight plan and a mass and balance report.

The aircraft was refuelled (959 litres of aviation gasoline and 2 litres of isopropyl alcohol) and a pre-flight inspection of the aircraft was performed without remarks. The passengers arrived and the flight crew made an estimate of the masses of the passengers (each passenger 60 kg and total 80 kg of luggage). The flight crew made by hand corrections of 80 kg (reduction of passenger masses) to the computerised mass and balance report. After completion of the mass and balance report and in order not to overload the aircraft, the flight crew decided to leave approximately 40 kg of luggage behind at BIRK.

The aircraft departed BIRK at 1157 hrs. The Commander was the Pilot Flying (PF) and the First Officer was the Pilot non Flying (PNF). En-route, the Commander had manually control of the aircraft, because the autopilot was inoperative. The flight was uneventful until approaching the east coast of Greenland near Kulusuk Airport (BGKK). Approaching the east coast, the First Officer was the PF.

At 1420 hrs and at approximately 30 nm east southeast of NDB DA (377 KHz), the flight crew requested clearance to climb to FL 120, which was the minimum safe flight level across the ice cap at that time. Furthermore, the flight crew requested the latest weather information for BGGH.

At FL 120, the aircraft was still under IMC. For that reason, the flight crew at 1428 hrs and at approximately 13 nm east southeast of NDB DA requested clearance to climb to FL 130. The flight crew also requested weather information for the flight across the ice cap. Sondrestrom FIC (121.300 MHz) reported that they did not have any reported traffic at FL 130. But Sondrestrom FIC was not in possession of any weather information for the flight across the ice cap, since no traffic had flown on that routing that day. During the climb, the flight crew noticed a “greyish film of rime” on the front windshield and on the leading edges of the wings. The flight crew did not find the icing sufficient to activate the de-icing system. At 1431 still in clouds, the aircraft passed overhead NDB DA at FL 130.

At 1440 hrs and approximately 26 nm west of NDB DA, the flight crew experienced that the left engine began to run rough and they noticed that the manifold pressure of the left engine was decreasing. The aircraft yawed to the left and lost altitude. Consequently, the flight crew requested diversion to BGKK. The Commander took over the control of the aircraft. The First Officer enriched the mixtures on both engines. Still on a westerly course, the right engine started to run rough as well and partly quitted. The aircraft yawed to the left and right and the indicated air speed went down continuously. Data from the GPS indicated a decreasing GS from approximately 170 mph/148 knots to a GS of approximately 100 mph/87 knots. The aircraft lost altitude. The Commander tried to compensate by applying full right and left rudder respectively. However, the Commander had difficulties in controlling the aircraft. At approximately 1442 hrs and approximately 30 nm west of NDB DA, the aircraft suddenly banked to the left into an uncontrollable diving descent. The flight crew declared an emergency. Sondrestrom FIC expected an accident to occur and by phone, the FIC instructed BGKK AFIS to let an aircraft on a domestic flight depart as soon as possible in order to be prepared for a search and rescue mission. During the sequence of events, the flight crew did not perform any emergency procedures.

At approximately 3000 feet msl and in an approximately 60° left bank, both engines provided normal power and the flight crew got control of the aircraft. At that time, the aircraft was positioned over the sea approximately 30 nm west of BGKK. At 2000 feet msl, the aircraft was under VMC and the flight crew decided to continue inbound BGKK. No further incidents occurred. At 1458 hrs, the aircraft landed under VMC in BGKK.

Approximately half an hour later, an aircraft on a domestic flight departed BGKK on a westerly course. The flight crew reported icing conditions between 5000 and 11000 feet.

In the afternoon and once again in the evening, the Commander drained the fuel tanks. The fuel samples did not show any sign of water or contamination. Furthermore, the Commander made a thorough inspection of the aircraft. The inspection did not give rise to remarks. In the afternoon, the Commander phoned Sondrestrom FIC and stated that icing in the induction system of the engines and on the wings probably contributed to the sequence of events.

1.2 Injuries to persons

None.

1.3 Damage to aircraft

None.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 The Commander.

1.5.1.1 The Commander, male, 26 years, was holder of a valid Icelandic CPL (Commercial Pilot License) and had a valid Medical Certificate.

1.5.1.2 The Commander was licensed to the following classes and ratings:

Rating	Date of Check	Valid until
Night Qualification (NIT)	07.08.1998	31.08.2003
Flight Instructor (FI)	02.06.2000	02.06.2003
Class Rating Instructor (CRI (A))	24.04.2001	11.09.2003
ME piston (land)	31.07.2002	03.08.2003
Instrument Rating (IR (A))	31.07.2002	03.08.2003

1.5.1.3 Operator's Proficiency Check (OPC).

The Commander completed a JAR-OPS 1 OPC on July 31, 2002.

1.5.1.4 Flying experience.

a)

Aircraft Classes/Rating	Total (Hrs)	Total as Commander (Hrs)
ME piston (land)	925:20	614:05
SE piston (land)	552:30	
Helicopter	49:55	
All types:	*1527:45*	

b)

	Total (Hrs)	Total as Commander (Hrs)
Cessna 404 TITAN	93:20	87:00

1.5.1.4 Route and aerodrome competence qualification.

The Commander had previously flown to Narsarsuaq (BGBW) and Kulusuk (BGKK). But it was the first time that the Commander was scheduled to fly to BGGH. The Commander stated that, in accordance with the Operator's procedures, he had received route and aerodrome competence qualification training.

1.5.2 The First Officer.

1.5.2.1 The First Officer, male, 28 years, was in possession of a valid Icelandic CPL (Commercial Pilot License) and had a valid Medical Certificate.

1.5.2.2 The First Officer was licensed to the following classes and ratings:

Rating	Date of Check	Valid until
Flight Instructor (FI)	16.05.2001	06.05.2004
ME piston (land)	24.01.2002	24.01.2003
SE piston (land)	31.07.2002	31.07.2004
Instrument Rating (IR(A))	24.01.2002	24.01.2003

1.5.2.3 Operator's Proficiency Check (OPC).

The First Officer completed a JAR-OPS 1 OPC on May 16, 2002.

1.5.2.4 Flying experience.

a)

Aircraft Classes/Rating	Total (Hrs)	Total as Commander (Hrs)
ME piston (land)	219:00	53:00
SE piston (land)	497:00	
All types:	*716:00*	

b)

	Total (Hrs)	Total as Commander (Hrs)
Cessna 404 TITAN	81:00	04:00

1.5.3 Flight duty time.

With reference to the Operator's documentation of flight duty time, the Commander had an off duty period of 13:30 hrs before check in on August 1, 2002. The First Officer had an off duty period of 12:00 hrs before check in on August 1, 2002.

1.6 Aircraft information

1.6.1 General aircraft information.

Manufacturer:	Cessna Aircraft Company
Type:	Cessna 404 TITAN
Year of manufacture:	1977
Serial number:	C404400033
Engines:	2 Continental GTSIO-520-M
Total airframe hours:	14151:34
Certificate of Airworthiness:	Valid
Max. allowable take-off mass:	8400 lbs
Max. zero fuel mass:	8100 lbs
Max. allowable landing mass:	8100 lbs
Aircraft weighing report:	July 16, 2001
CG aft limit (gear extended):	179.08 inches aft of reference datum (30.00 % MAC) 8400 lbs or less
CG forward limit (gear extended):	170.31 inches aft of reference datum (16.32% MAC) at 8400 lbs or less and 165.62 inches aft of reference datum (9.00% MAC) at 6100 lbs or less with straight line variation between these points.
Ice protection equipment:	Heated stall warning vane Heated pitot head Deice system kit (electrical anti-icing pilots windshield, inboard and outboard wing and empennage boots and propeller deice boots) 100-ampere alternators Deice light

1.6.2 Aircraft technical log.

With reference to Operator's documentation, the aircraft's technical log did not contain entries of significance to the incident.

1.6.3 Aircraft inspection.

1.6.3.1 At BGKK, the aircraft was inspected by the Operator and a test flight was performed. All technical systems were tested. The inspection and the test flight did not give rise to remarks.

1.6.3.2 The next inspection of the aircraft (200 hrs) was due at total flight hrs: 14167.

1.6.4 Mass and balance.

1.6.4.1 The mass and balance report made by the flight crew.

The report was computerised.

Item	Arm (cm)	Max	Mass (kg)
Pilots	345.0	-	170
Basic empty mass	429.2	-	2264 *(4991 lbs)*
Row 1	423.0	190	120
Row 2	494.0	190	120
Row 3	565.0	190	120
Row 4	635.0	90	70
Row 5	705.0	190	120
Avionics Bay	81.0	114	0
Nose Baggage	180.0	160	80
Right Locker	536.0	90	0
Left Locker	536.0	90	0
BAY A	765.0	182	0
BAY B	805.0	45	0
Fuel	456.0	927	750
Ramp mass			3814 *(8408 lbs)*
CG			451.7
% MAC			19.2
Landing mass			3286 *(7244 lbs)*
Landing CG			451.1
Landing % MAC			19.0

Note: Values in italics are inserted by the Danish AAIB.

1.6.4.2 Load sheet example.

The load sheet example in the Operator's Operations Manual stated that the max. take off mass of the aircraft was 3946 kg (8699 lbs) and the max. landing mass was 3682 kg (8117 lbs).

1.6.4.3 Aircraft weighing report.

Data from the aircraft weighing report:

Basic mass (lbs):	5453 lbs *(2473 kg)*
CG (inch):	167.14
Basic moment (lbs x inch):	911415.6

Note: Value in italics is inserted by the Danish AAIB.

1.6.4.4 Mass and balance calculation.

The aircraft's mass could not be accurately determined. However, the Danish AAIB using data from the aircraft weighing report, JAR-OPS 1.620 (c) (1) (2), the operational flight plan and the Manufacturer's Airplane Flight Manual (AFM) calculated the range of masses:

Item	Mass (lbs)	Arm (inch)	Moment (lbs x inch)
Basic empty mass	5453.00	167.14	911414.42
Pilots	375.00	137.00	51375.00
Row 1	396,00	168,00	66528.00
Row 2	396,00	196,00	77616.00
Row 3	396,00	224,00	88704.00
Row 4	198,00	252,00	49896.00
Row 5	317,00	280,00	88760.00
Nose Baggage	176,00	71,00	12496.00
Zero fuel mass	7707,00	174,75	1346789.42
Fuel	1653,00	181,45	29936.85
Ramp mass	9360,00	175,93	1646726.27
Estimated mass at 1442 hrs	8721,00	175,53	1530779.72

- *JAR-OPS 1.620 (c)(1)(2 (standard masses): Male 90 kg, female 72 kg and a flight crew member 85 kg.*
- *Passengers on board: 7 males and 2 females.*

1.6.5 Operating speeds.

1.6.5.1 Air minimum control speed (VMCA).

With reference to the AFM section two, the VMCA was 78KIAS/80KCAS.

1.6.5.2 Stall speed.

With reference to the AFM section five (stall speed charts), stall speed was KIAS 86 with throttles at idle, clean configuration, clean airfoils, an aircraft mass of 8400 lbs and a zero degree bank angle. At the time of the incident, stall speed was approximately 88 KIAS with an estimated aircraft mass of 8721 lbs and clean airfoils.

1.6.5.3 Single engine service ceiling.

With reference to the AFM section five and the flight and meteorological data on August 1, 2002, the single engine service ceiling was approximately FL 116 (an aircraft mass of 8400 lbs and an OAT of -17°C).

Note: "The single engine service ceiling is the maximum altitude where the aeroplane has the capability of climbing 50 feet per minute with one engine inoperative and the propeller feathered".

1.6.6 Oxygen requirements (non pressurized aircraft).

1.6.6.1 The Operations Manual Part A chapter 8.8.1 and 8.8.2.

"A commander shall ensure that flight crew members engaged in performing duties to the safe operation of an aeroplane in flight use supplemental oxygen continuously whenever aeroplane's altitude exceeds 10000 ft for a period in excess of 30 minutes and whenever the aeroplane's altitude exceeds 13000 ft . This applies for pilot(s) and passengers.

Special requirements for:

a. *Flight crew – 100% above 10000 feet.*
b. *Cabin crew – not applicable*
c. *Passengers – 10% after 30 min between 10000 feet and 13000 feet and 100% above 13000 feet."*

1.6.6.2 Oxygen system.

The aircraft was equipped with an oxygen system, which could provide individual service for the Commander, the First Officer and each passenger. However, it has not been possible for the Danish AAIB to determine whether the oxygen system on board the aircraft was capable of complying with the requirements in 1.6.6.1.

1.6.7 Fuel log (operational flight plan).

1.6.7.1

Fuel calculation	Time	Fuel (kg)	Reserve	Time	Fuel (kg)
Climb + T/O	0:08	19	Contingency 0%	0:04	9
Cruise (FL 100)	4:27	468	Alternate Fuel	0:00	0
Descent	0:12	19	Holding/Final Reserve	0:45	79
Approach	0:07	11	Additional Fuel	0:00	0
Total Trip Fuel	4:55	518	Min. required fuel	5:45	616
Taxi		10	Extra Fuel	1:17	135
Burn Off	4:55	528	Loaded Block Fuel	7:02	750

1.6.7.2

The fuel log did not comply with the requirements of JAR-OPS 1.255 (cruise, contingency and alternate fuel).

1.6.8 Fuel on board the aircraft.

1.6.8.1 The fuel supplier.

In the morning on August 1, the fuel supplier in BIRK examined the quality of the fuel in the supply tank. Due to the incident involving TF-JVG, the fuel supplier examined the quality of the fuel in the supply tank once again in the afternoon. Both inspections did not give rise to remarks.

1.6.9 Radio equipment.

1.6.9.1 AIP Greenland (GEN 1.5-1):

"3.1 Radio and navigation equipment

a. All aircraft shall be provided with radio communication equipment capable of conducting two-way communication at any time during the flight with at least one aeronautical station and with such other aeronautical stations and on such frequencies as may be prescribed in this AIP.

b. The equipment shall consist of at least one VHF and one HF transceiver.

Note 1: The mentioned requirements (items a. and b.) are considered fulfilled if the ability to conduct two-way communication is established during radio propagation conditions, which are normal for the route.

Note 2. for transiting flights the HF equipment is not required if full VHF coverage is available for the leg(s) flown."

1.6.9.2 The aircraft.

The aircraft was not equipped with HF radio communication equipment.

1.6.10 VHF radio communication coverage.

On the route BGKK-BGGH at FL 100 – FL 130, two-way VHF communication could not be established continuously.

1.6.11 Flight into icing conditions.

1.6.11.1 Statement from the Manufacturer.

" According to the aircraft information manual, it states that the aircraft is approved for flight into icing conditions as defined by the FAA, if the following equipment is installed and operational:

- *Heated stall warning vane or optional AOA lift sensor vane.*
- *Heated pitot head (one minimum required).*
- *De-ice system kit*
- *Electrical windshield anti-ice system.*
- *Inboard and outboard wing and empennage deice boots*
- *Propeller deice boots*
- *100-ampere alternators.*

According to Cessna, during the flight test certification, the aircraft was flown in icing conditions most probably in some degree of light icing, which have satisfied the FAA"

1.6.11.2 Cessna pilot safety and warning supplements.

"Icing conditions.

Moderate – The rate of accumulation is such that even short encounters become potentially hazardous and use of de-icing/anti-icing equipment and flight diversion is necessary."

1.7 Meteorological information

1.7.1 General meteorological situation near BGKK on August 1, 2002, at 1440 hrs:

Synoptic situation:	A low pressure area east of Cape Farwell moved slowly towards the north. An occlusion trended through the Strait of Denmark (sea) up to Jan Mayen
Clouds:	Layered with stratocumulus, altocumulus and altostratus. Cloud base between 2000 and 6000 feet. Top of clouds between FL 140 and FL 200.
Icing:	In clouds risk of icing, especially at FL 130 and below. Moderate icing forecasted for the planned route BIRK-BGGH from freezing level up to approximately FL 140.
Min. safe FL across the ice cap:	FL 120
OAT at FL 130:	-17°C (TEMP: Ammassalik on August 1, 2002 at 1100 hrs).
OAT at 3000 feet AGL:	+1°C (TEMP: Ammassalik on August 1, 2002 at 1100 hrs).

1.7.2 Weather forecasts (TAF) for Keflavik (BIRK), Nuuk (BGGH), Kangerlussuaq (BGSF), Maniitsoq (BGMQ) and Kulusuk (BGKK).

birk 010918 15007kt 9999 few020 sct040=
birk 011221 16008kt 9999 few025 bkn030=
birk 011524 16008kt 9999 bkn030=
bggh 011019 04010kt 0500 bcgf bkn004 becmg 1012 9999 nsw few 005=
bggh 011320 04010kt 9999 few030 tempo 1315 2000 vcfg
bggh 011620 05008kt 9999 few200=
bgsf 010606 07010kt 9999 sct035 tempo 1220 25010kt=
bgsf 011212 06010kt 9999 sct030 tempo 1220=
bgsf 011818 vrb08kt 9999 few030 tempo 1218 sct030=
bgmq 011120 vrb08kt 9999 sct060=
bgmq 011322 vrb08kt 9999 few060=
bgmq 011623 30010kt 9999 few035=
bgkk 011019 09008kt 9999 few020 bkn070 tempo1219 –ra bkn018=
bgkk 011319 06008kt 9999 few020 bkn070 tempo 1319 –ra bkn020=

1.7.3 Actual weather reports (METAR) for Keflavik (BIRK) and Kulusuk (BGKK).

birk 011000z 1605kt 9999 few026 bkn034 13/09 q1027=
birk 011200z 19005kt 9999 bkn030 14/09 q1026=
birk 011300z 21007kt 9999 sct030 15/10 q1026=
bgkk 011350z 32002kt 9999 dz few002 sct022 bkn043 07/05 q1022=
bgkk 011450z 24005kt 9999 –dz few003 sct020 bkn036 07/05 q1022=
bgkk 011550z 26005kt 9999 –dz few004 sct023 bkn037 06/05 q1022=

1.8 Aids to navigation

1.8.1 All the appropriate aids to navigation at BGKK were serviceable. Navigation was not a factor in this incident.

1.8.2 Global positioning system (GPS).
1.8.2.1 On board the aircraft, there was a handheld GPS. The GPS was turned on.

1.8.2.2 The Icelandic AAIB assisted the Danish AAIB in downloading data from the GPS. See enclosure 1.

1.9 Communication

Tape recordings of relevant RTF communications between TF-JVG and Air Traffic Services contacted in Greenland were obtained.

1.10 Aerodrome information

1.10.1 General.
1.10.1.1 BGKK has two runways (RWY 11/29). Runway 11, which was used by TF-JVG, is 1205 metres long and 30 metres wide; the landing distance available is also 1205 metres. The airport elevation is 114 feet msl.

1.10.1.2 BGSF has two runways (RWY 10/28) . The runways are 2810 metres long and 60 metres wide; the landings distances available are 2810 metres. The airport elevation is 165 feet msl.

1.10.1.3 BGMQ has two runways (RWY16/34). The runways are 799 metres long and 30 metres wide; The landings distances available are 799 metres. The airport elevation is 91 feet msl.

In case of a diversion to BGMQ and with reference to the operational flight plan data, the estimated landing mass at BGMQ would approximately be 7147 lbs. The landing distance at BGMQ would be 1960 feet (597 metres).

1.10.2 Radar coverage.
Near the place of incident, neither en route nor terminal radar data were available, since no radar system was established in the area.

1.11 Flight recorders

Existing regulations (JAR-OPS 1) did not require the aircraft to be fitted with flight recorders and none were fitted.

1.12 Place of incident

See enclosure 2.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

None.

1.15 Survival aspects
Not applicable.

1.16 Test and research
No specific test or research was conducted.

1.17 Organisational and management information
1.17.1 The operator.

1.17.1.1 On July 5, 2002, the Icelandic CAA issued a JAR-OPS 1 Air Operator Certificate (AOC) to the Operator. At the time of the incident the Operator was approved to perform scheduled flights and non-scheduled charter flights with five aircraft (one PN-68B, one Cessna 404 Titan, one Cessna 402C and two PA-28). According to the AOC, the Operator was approved to operate in Iceland and Greenland.

1.17.1.2 By mistake, the manufacturer's standard empty mass of the aircraft was entered in the Operator's mass and balance computer database.

1.17.2 The operations manual part A.

1.17.2.1 Crew composition.

"4.1

It shall be ensured that:

c. On flights outside Iceland the minimum crew is two pilots.

e. A pilot shall have at least 20 sectors and 20 hours on the class with the company before he is sign on as Commander."

"4.1.2 Route and aerodrome competence qualification.

a. The Operator (The company name is replaced by the Danish AAIB) shall ensure that, prior to being assigned as pilot-in-command, the pilot has obtained adequate knowledge of the route to be flown and of the aerodromes(including alternates), facilities and procedures to be used.

b. The period of validity of the route and aerodrome competence qualification shall be 12 calendar months in addition to the remainder of:

i. The month of qualification or,

ii. The month of the latest operation on the route or to the aerodrome

c. Route and aerodrome competence qualification shall be revalidated by operating on the route or to the aerodrome within the period of validity prescribed in sub-paragraph(b) above.

d. If revalidated within the final 3 calendar months of validity of previous route and aerodrome competence qualification, the period of validity shall extend from the date of revalidation until 12 calendar months from the expire date of that previous route and aerodrome competence qualification."

1.17.2.2 Performance.

"8.1.0.1.7 Landing – dry runway.

An operator shall ensure that the landing mass of the aeroplane for the estimated time of landing allows a full stop landing from 50 feet above the threshold within 70% of the landing distance available at the destination aerodrome and at any alternate aerodrome."

1.17.2.3 Mass values for passengers and baggage.
"8.1.8.5.1 It is allowed to use the actual mass of passengers. The two methods of doing so are:

- *By asking the passenger to step on scale, as close to the aeroplane as possible, and as close to the departure time as possible or;*
- *By asking the passenger to give up there own weight and add to that weight, the weight of their clothes. The standard weight of clothes are as follows:*
  - *Adults 4 kg*
  - *Children 4 kg*
  - *Infants 4 kg*
- *The amount of 6 kg shall be added for hand baggage."*

"8.1.8.8 Last minute change.
If any last minute change occurs after the completion of the mass and balance documentation, this must be brought to the attention of the Commander, and the last minute change must be entered on the mass and balance documentation. The maximum LMC is 50 kg. If the LMC is greater than that, a new weight and balance report must be done."

1.17.2.4 Operational flight plan.
1.17.2.4.1 "8.1.10.1 The Commander is responsible for ensuring that the Operational Flight Plan is correct in all manner and he is fully aware of all the details."

1.17.2.4.2 With reference to item 8.1.10.2, the used computerised operational flight plan did not contain information of destination alternate(s) and NOTAM.

1.17.3 The operations manual part B.
1.17.3.1 Checklist.
"Section 3 emergency procedures.
Air inlet or filter icing emergency procedures.
1. Alternates Air Control – PULL OUT
2. Propeller(s)- INCREASE RPM (Avoid continuous operation in the yellow arc).
3. Mixture(s) – LEAN as required.

With reference to the Aircraft Flight Manual (AFM), the above-mentioned checklist consisted of immediate-action items and should be committed to memory.

1.17.3.2 Alternate induction air.
"Section 4.
The induction air system on these engines is considered to be non-icing. However, manually operated alternate induction air is provided to assure satisfactory operation should the induction air filter become obstructed with ice. Should a decrease in manifold pressure be experienced when flying in icing conditions, the alternate air doors should be manually opened. This will provide satisfactory operation."

1.17.3.3 Fuel additive (extract).

"Section 8.

Isopropyl alcohol, ethylene glycol monomethyl ether (EGME) or diethylene glycol monomethyl ether (DIEGME) may be added to the fuel supply in quantities not to exceed 1% (alcohol) or .15% by volume (EGME/DIEGME), of the total.

Strict adherence to recommended pre-flight draining instructions as called for in section 4 will eliminate any free water accumulations from the tank sumps. While small amounts of water may still remain in solution in the gasoline, it will normally be consumed and go unnoticed in the operation of the engine. One exception to this can be encountered when operating under the combined effect of:

1. *Use of certain fuels, with*
2. *high humidity conditions on the ground*
3. *followed by flight at high altitude and low temperature (flight levels of 20000 feet or above and temperatures –28.9° C (-20° F) or below.*

under these unusual conditions small amounts of water in solution can precipitate from the fuel system and freeze in sufficient quantities to induce partial icing of the engine fuel injection system.

While these conditions are quite rare and will not normally pose a problem to owners and operators, they do exist in certain areas of the world and consequently must be dealt with when encountered.

Therefore, to alleviate the possibility of fuel icing occurring under these unusual conditions it is permissible to add isopropyl alcohol, ethylene glycol monomethyl ether (EGME) or diethylene glycol monomethyl ether (DIEGME) compound to the fuel supply.

Alcohol, if used, is to be blended with the fuel in a concentration of 1 % by volume. Concentrations greater than 1% are not recommended since they can be detrimental to the fuel tank materials.

Any high quality isopropyl alcohol may be used."

1.17.4 The operations manual part D.

1.17.4.1 Paragraph 2.1.4.

" ROUTE COMPETENCE TRAINING (JAR-OPS 1.975)

1. Prior to being assigned as pilot-in-command the pilot shall undergo training to ensure that he has obtained adequate knowledge of the route to be flown and of the aerodromes (including alternates), facilities and procedures to be used. The validity period is 12 calendar months.

2. Route competence training will include knowledge of:

a. terrain and minimum safe altitudes,

b. seasonal meteorological conditions,

c. meteorological, communication and air traffic facilities, services and procedures;

d. for aerodrome competence qualification the operator shall:

**For Category A aerodromes; The captain is responsible for acquiring the knowledge of that aerodrome*

**For Category B aerodromes; The captain should be briefed, or self-briefed by means of programmed instruction, on the Category B aerodrome(s) concerned and should certify that he has carried out these instructions.*
**For Category C aerodromes; The captain should be briefed and visit the aerodrome as an observer and/or undertake instruction in a flight simulator approved by the Authority for that purpose. This instruction should be certified by the operator.*

e. search and rescue

f. navigational facilities associated with the route along which the flight is to take place."

1.17.4.2 In Appendix 8.9, the Operator states:
"Appendix 8.9 is an Airport classification sheet:

Classification on following Greenland airports can be found:

BGGK (Kulusuk)	*BC*	
BGBW (Narsarsuaq)	*C*	*Remarks: Navigation procedure*
BGMQ (Manitsoq)	*B*	
BGGH (Nuuk)	*BC*	*Remarks: Navigation procedure*
BGTL (Thule)	*B*	*Remarks: Navigation procedure*
BGCO (Co-Pynt)	*BC*	*Remarks: Navigation procedure*
BGSF (Sondre Stroemfjord)	*B*	*Remarks: Navigation procedure*

1.17.5 JAR-OPS 1.
1.17.5.1 AMC OPS 1.975.
"*All aerodromes to which an operator operates should be categorised in one of these three categories. The operator's categorisation should be acceptable to the Authority".*

It has not been possible for the Danish AAIB to determine the reason for the operator's dual categorisation of certain aerodromes and to determine how the Authority accepted this dual categorisation.

1.17.5.2 JAR-OPS 1.346 (b)
Ice and other contaminants – flight procedures.
A Commander shall not commence a flight nor intentionally fly into expected or actual icing conditions unless the aeroplane is certificated and equipped to cope with such conditions."

1.17.6 The Icelandic CAA.
The Icelandic CAA recommended the use of two destination alternates for long flights.

1.18 Additional information
1.18.1 UK accident report.
1.18.1.1 In 1999, the UK AAIB investigating an accident with a Cessna 404 examined the handling characteristics and performance penalties with one engine inoperative. Some of the conclusions were:

- *"The simulation of an unexpected engine failure resulted in a yaw of about 20° and a loss in airspeed of 10 knots. A pedal force of between 60 and 70 lb. (estimated) was required to stop the yaw and a control wheel rotation of about 30° was necessary to contain the tendency to roll towards the failed engine."*

- *A yaw to the left will occur after an unexpected power reduction on the left engine. Simulation of an unexpected, rapid and complete loss within the left engine was performed during the AAIB flight tests. During that simulation the aircraft yawed to the left through 20° in the one to two seconds taken by the pilot to react and apply right rudder. Moreover, although the aircraft's tendency to roll to the left was strong, it was easily contained with far less than full roll control whereas almost full right rudder pedal was required to stabilize the heading with one engine wind milling and the other at full power."*

1.18.1.2 Furthermore, the UK AAIB in the abovementioned report recommended that the UK CAA should re-examine the criteria for the carriage of flight recorders by multi engine aircraft, which have in force a certificate of airworthiness in the Transport Category (passenger) and are certified to carry more than nine passengers, with a view to requiring all aircraft, whether piston or turbine powered to carry at least a Cockpit Voice Recorder.

1.19 Useful or effective investigation techniques
No new special effective investigation techniques were used.

2. Analysis
2.1 The investigation in general.
2.1.1 The paucity of firm data, particularly the absence of any flight data or cockpit voice recording frustrated efforts to reconstruct precisely the sequence of events which led up to the incident. The aircraft was below the weight category for which flight recorders are required to be fitted. The investigation was thus hampered by the lack of any record of the flight crew's conversation including routine and emergency checklist action. It is most likely that any such record would have added greatly to the understanding of this incident.

2.1.2 There was no radar data available with which to reconstruct the sequence of events. However, the obtained GPS data were supportive to the investigation and to the analysis in this report.

2.2 Technical status.

It is the opinion of the Danish AAIB that the technical status of the aircraft and the quality of the fuel on board did not contribute to the sequence of events.

The following supports this:

- The pre-flight inspection was performed without remarks.
- The fuel supplier in BIRK examined twice the quality of the fuel in the supply tank. The inspections did not give rise to remarks.
- Though operating under normal flight conditions (ref. AFM section 8), the addition of 2 litres of isopropyl alcohol to 959 litres of aviation gasoline would not contribute to a negative engine performance.
- At BGKK, the Commander drained the fuel tanks twice. The fuel samples did not show any sign of water or contamination.
- The flight crew did not report any technical malfunctions.
- At BGKK, the Commander made a thorough inspection of the aircraft, which did not give rise to remarks.
- At BGKK, a test flight was performed and all technical systems were tested without remarks.

2.3 Preplanning of the flight.

2.3.1 The flight crew were properly licensed and it is the opinion of the Danish AAIB that the flight crew's flight duty time did not have any influence on the sequence of events.

2.3.2 Concerning route and aerodrome competence qualification, the Operator categorised BGGH as a BC aerodrome. A dual categorisation of an aerodrome seems to be inconsistent with the intentions of AMC OPS 1.975. If the requirements to aerodrome competence qualification training (both B and C) were to be fulfilled, the Operator should not have scheduled the Commander as Commander, since it was his first flight to BGGH.

2.3.3 Before the flight, the flight crew were in possession of weather information, which forecasted risk of moderate icing for the planned route BIRK-BGGH, especially at levels from freezing level up to approximately FL 140. In the light of the FAA certification of the aircraft, the requirements in JAR-OPS 1 and the aircraft's general flight operation envelope, the Danish AAIB finds it inexpedient to plan and perform a flight into areas of forecasted moderate icing.

2.3.4 In accordance with the recommendation from the Icelandic CAA, an ATC flight plan with two destination alternates was filed. The choice of BGMQ as a destination alternate was inappropriate, since BGMQ under the actual conditions did not fulfil the requirement to landing distance in the Operations Manual (full stop landing within 70% of the landing distance available). Based on the data in the

operational flight plan and in the computerised mass and balance report, the landing distance at BGMQ would approximately be 1960 feet (597 metres), which represents 74.7% of the landing distance available. The choice of BGSF as a destination alternate was appropriate.

2.3.5 In the ATC flight plan and in the operational flight plan, FL 100 was filed as the final cruising level for the whole flight, though at the time of the incident the minimum safe FL across the ice cap was FL 120. It is the opinion of the Danish AAIB that the pre-flight planning of the flight across the ice cap at a flight level below the minimum safe FL was inappropriate and a latent hazard of flight safety.

2.3.6 In the operational flight plan, some information was missing and some figures were wrong (choice of destination alternates, required fuel to the destination alternate, NOTAM and the amount of contingency fuel). In general, the fuel log in the operational flight plan did not fulfil the requirements of JAR-OPS 1 and the procedures laid down in the Operations Manual. However, it is the opinion of the Danish AAIB that the on board amount of fuel was sufficient to cover the planned route from BIRK to BGGH with BGSF as the destination alternate.

2.3.7 The Operator's mass and balance documentation was inconsistent and incorrect. The flight crew made a computerised mass and balance report. The computerised input data were incorrect. The actual basic empty mass of the aircraft was 462 lbs (9.2%) above the presented figure in the computerised report. Furthermore, the presented maximum take off mass in the Operations Manual was 299 lbs (3.5%) above the maximum allowable take off mass. Before the flight, the passengers were neither asked to step on a scale nor did the passengers inform the flight crew of their own mass. For that reason and in accordance with the Operations Manual, the flight crew should have used standard masses instead of estimating the masses of the passengers. By using standard masses, the actual take off mass was 960 lbs (11.4%) above the maximum allowable take off mass.

2.3.8 The flight crew made LMC corrections of 80 kg to the mass and balance report. This was inconsistent with the procedure in the Operations Manual, which stated a maximum LMC of 50 kg.

2.3.9 At the time of the incident, the estimated mass was approximately 621 lbs (7.7%) above the maximum allowable landing mass, which in the opinion of the Danish AAIB resulted in an overweight landing at BGKK. However, in the actual situation and for safety reasons an overweight landing was preferable.

2.3.10 By using the computerised flight documentation, the flight crew were indirectly caught into believing the presented data. The input mass data in the mass and balance computer programme were incorrect. The Danish AAIB finds it possible that the lack of appropriate quality assurance led to the incorrect and inconsistent data. Furthermore, the Operator's JAR-OPS 1 approval was rather new (July 5, 2002), which might have led to lack of familiarity with and adjustment to the JAR-OPS 1 requirements.

2.3.11 The radio communication system onboard the aircraft did not fulfil the requirements in the Greenlandic AIP. The aircraft should have carried a HF transceiver. However, this finding did not have any influence on the sequence of events.

2.4 The flight inbound BGGH.

2.4.1 Cruising at FL 130 under IMC, the left and right engine respectively started to run rough. Risk of moderate icing in clouds, especially at FL 130 and below was forecasted. It is the opinion of the Danish AAIB that the partial loss of power on both engines was caused by ice formed in the induction systems, which blocked the source of air to the engines. As the ice continued to grow, the passage of air was reduced and the fuel air mixture to the engines became too rich, which finally precluded normal engine operation and the engines partly quitted.

2.4.2 The flight crew did not perform the emergency checklist for air inlet icing. Though, the flight crew were probably not aware of the reason to the difficulties in controlling the aircraft, the use of alternate air by pulling out the alternate air controls would have provided warm filtered air from inside the cowling to the engines. The Danish AAIB finds it possible that in a short time, the warm alternate air would have provided continued satisfactory engine operation and that this incident would not have occurred.

2.4.3 When the left engine started to run rough, the aircraft was not able to maintain altitude, which was probably caused by the aircraft at that time operating above the single engine service ceiling of approximately FL 116 (mass of 8400 lbs and an OAT of-17°C). Even though, the flight crew most likely were not aware of the mass data inconsistencies, the Danish AAIB finds it a latent hazard of flight safety that the single engine service ceiling that day very likely was below the minimum safe FL across the ice cap.

2.4.4 The sudden and unpredictable changes in engine operations required the Commander to compensate by applying almost full right and left rudder respectively. A rather large pedal force and control wheel rotation were required to stop the yaw and the tendency to roll. The indicated airspeed very likely approached the actual stall speed. Furthermore, it cannot be excluded that the aircraft while climbing to and cruising at FL 130 was exposed to structural icing which might have changed the aerodynamic characteristics significantly, hereunder increased the risk for changed stall behaviour. The Danish AAIB has good reason to believe that a combination of the above-mentioned led to either an asymmetric stall (one wing stalled while the other is not) or a pilot induced Dutch roll (when the lateral (roll) stability is excessive with respect to its directional (yaw) stability) resulting in a uncontrollable diving descent.

2.4.5 At 3000 feet msl, the flight crew were able to regain control of the aircraft. With reference to the TEMP at Ammassalik, it can be assumed that a positive temperature was present at approximately 3000 feet msl leading to removal of the ice in the induction system of the engines.

2.4.6 The Danish AAIB considers this incident as a serious one because it was a mere coincidence that an accident did not occur. The incident occurred near the ice cap and the descent was uncontrollable.

3. Conclusion

3.1 Findings.

1. The flight crew were properly licensed.
2. The flight crew's flight duty time did not have any influence on the sequence of events.
3. The aircraft was not equipped with any flight recorders.
4. The obtained GPS data were supportive to the investigation.
5. Risk of moderate icing was forecasted and probably present for the planned flight.
6. The choice of BGMQ as destination alternate was inappropriate.
7. The planned and filed FL was below the minimum safe FL across the ice cap.
8. The operational flight plan did not fulfil the requirements of JAR-OPS 1.
9. The quality of the fuel in the supply tank was examined without remarks.
10. Fuel samples from the aircraft did not show any sign of water or contamination.
11. The onboard amount of fuel was sufficient to cover the planned flight.
12. The mass and balance documentation was inconsistent and incorrect.
13. The passenger mass data in the mass and balance report was not in accordance with JAR-OPS 1 and the Operations Manual.
14. With reference to standard masses, the actual take off mass was 960 lbs above the maximum allowable take off mass.
15. A LMC correction of 80 kg was inconsistent with the procedure in the Operations Manual.
16. Mass data in the mass and balance computer programme were incorrect.
17. The flight documentation was most likely not properly quality assured by the Operator.
18. The aircraft was not equipped with HF radio communication equipment as required in the Greenlandic AIP.
19. During climb to and cruise at FL 130, the aircraft was most likely exposed to icing conditions.
20. The single engine service ceiling was most probably below the minimum safe FL across the ice cap.
21. Partial loss of power on both engines was probably caused by ice in the induction systems of the engines.
22. The flight crew did not perform the emergency checklist for air inlet icing.
23. The aircraft was not able to maintain altitude.
24. The IAS very likely approached the actual stall speed.
25. The partial loss of power on both engines probably resulted in either an asymmetric stall or a pilot induced Dutch roll.
26. At 3000 feet msl with a positive OAT, the flight crew regained control of the aircraft.
27. The flight crew very likely made an overweight landing at BGKK.
28. The pre- and post-flight inspection of the aircraft did not give rise to remarks.

3.2 Causal factors.

1. During climb to and cruise at FL 130, the aircraft was most likely exposed to icing conditions.
2. Partial loss of power on both engines was probably caused by ice in the induction systems.
3. The flight crew did not perform the emergency checklist for air inlet icing.

3.3 Summary.

The flight crew planned and performed a flight into an arctic area with forecasted risk of moderate icing conditions.

The icing conditions led to a sudden and unpredictable partial power loss on both engines. The unpredictable partial loss of engine power and the lack of appropriate emergency checklist actions resulted in an uncontrollable descent. Consequently, this incident is considered to be a temporary loss of control in flight, which resulted in a significant loss of altitude.

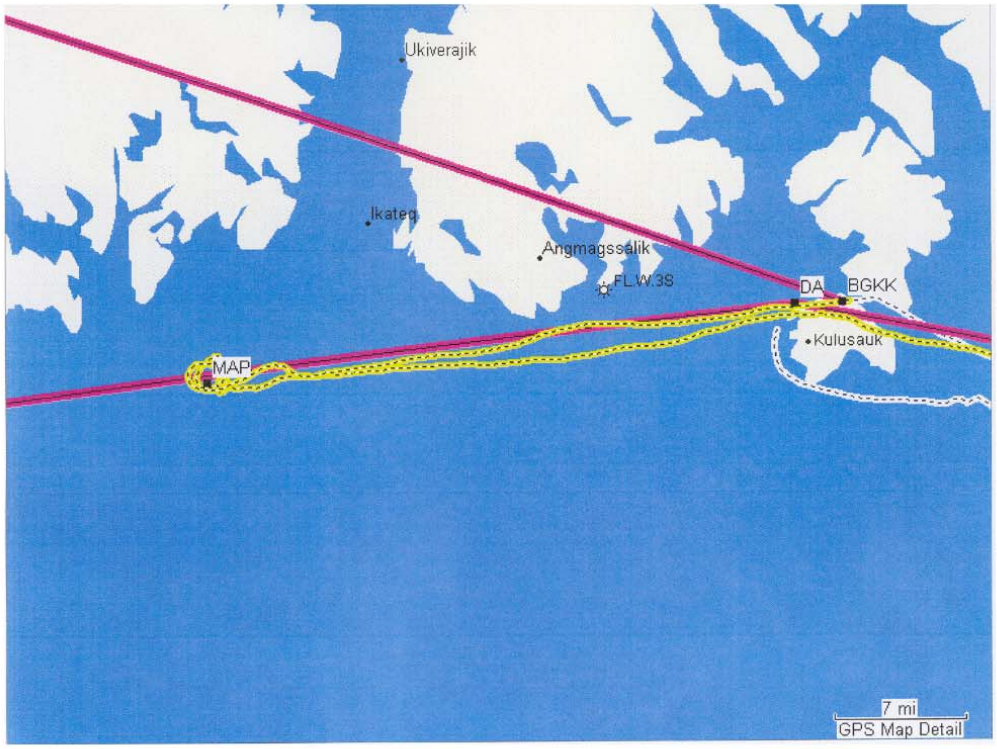
4. Recommendations

No safety recommendations were made during the course of this investigation.

5. Enclosures

1. GPS read out.
2. The place of incident.

Enclosure 1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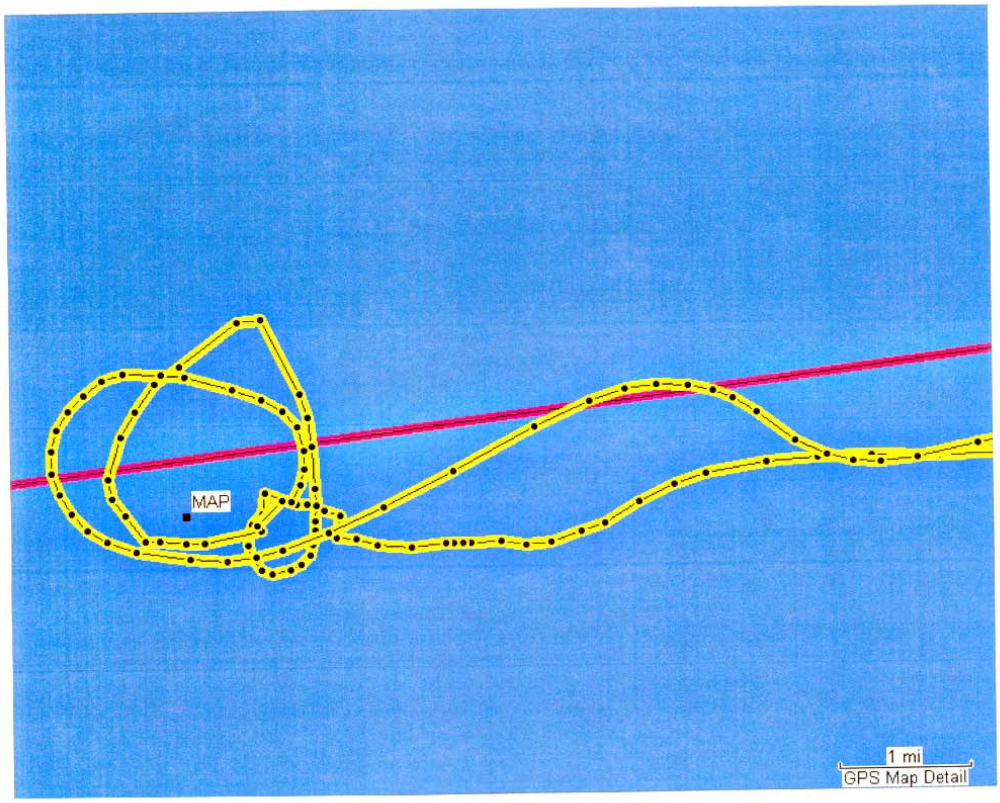
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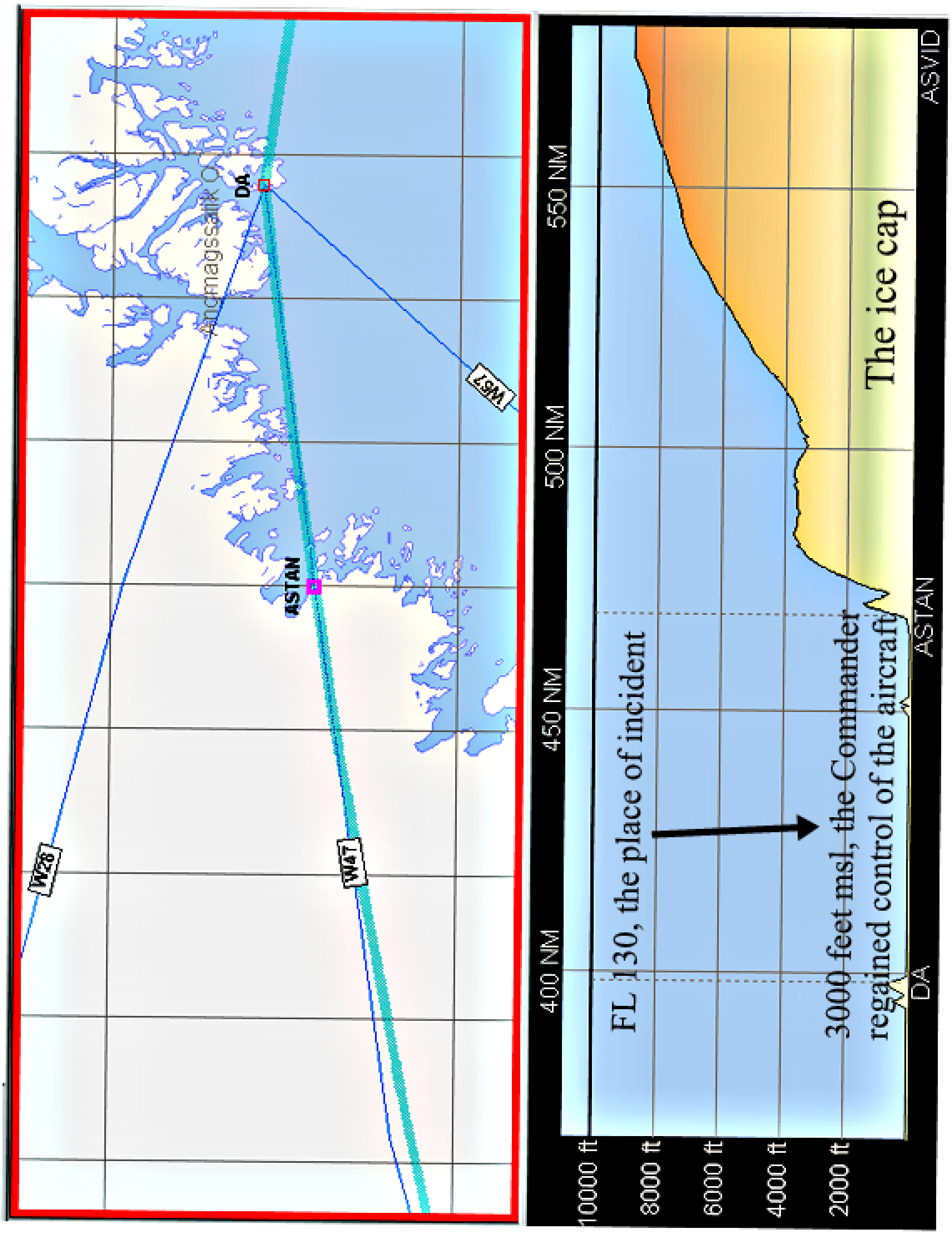
GPS Map Detail

Enclosure 2



DA
ASTAN
W28
W47
W57
Angmagssalik
FL 130, the place of incident
3000 feet msl, the Commander regained control of the aircraft
The ice cap
400 NM
450 NM
500 NM
550 NM
ASVID
10000 ft
8000 ft
6000 ft
4000 ft
2000 ft