FINAL REPORT

HCL 49/01	**Accident**		
Aircraft Type:	Dassault Falcon 20	Aircraft Registration:	D-CBNA
Engine(s):	2 CF 700-2D2	Type of Flight:	Charter, IFR
Crew:	2- fatal injuries	Passengers:	1- fatal injuries
Place:	4.5 nm SW of Narsarsuaq (BGBW)	Date and Time:	05.08.2001 0443 UTC

Synopsis

All times in this report are UTC.

Air Traffic Management at Copenhagen Airport Kastrup (EKCH) notified the Danish Aircraft Accident Investigation Board (AAIB) on August 5, 2001, at 05:27 hrs. Two aircraft accident inspectors from the Danish AAIB arrived at the accident site at Narsarsuaq on August 6, 2001.

The German Bundesstelle für Flugunfalluntersuchung (BFU), the French Bureau Enquètes-Accidents (BEA), the Icelandic AAIB and the International Civil Aviation Organisation (ICAO) were notified on August 5, 2001. As a manufacturer of the engines, the US National Transportation Safety Board (NTSB) requested participation on August 9, 2001, and designated an accredited representative to the investigation.

On the final approach to runway 07 at Narsarsuaq (BGBW), the aircraft impacted mountainous terrain 4.5 nm SW of the aerodrome.

The flight crew and the passenger were fatally injured. The aircraft was destroyed.

The accident occurred in dark night and under visual meteorological conditions (VMC).

Summary.

Several of the most common factors found in Controlled Flight Into Terrain (CFIT) accidents were present in this accident. The flight crew did not follow Standard Operating Procedures (SOPs) (adherence to the approach procedure, altitude calls, checklist reading). Furthermore, the Ground Proximity Warning System (GPWS) was inoperative and the flight crew were exposed to peak fatigue. The absence of CRM and non-adherence to SOPs removed important defences in preventing CFIT.

In this accident, the aircraft was capable of being controlled and was under control of the flight crew until impact. Nothing indicated that the flight crew were aware of their proximity to the mountainous terrain. Consequently, this is considered to be a CFIT accident.

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

1. Factual information

1.1 History of the flight

The flight, during which the accident occurred, was part of a non-scheduled international cargo flight from Gdansk (EPGD) to Louisville (KSDF). The flight crew had previously on August 4, 2001, on another charter flight, flown the aircraft from Hanover (EDDV) to Palma de Mallorca (LEPA) and then to EPGD in order to bring the aircraft in position for the cargo flight.

The flight was chartered by a cargo courier to depart EPGD at 2000 hrs on August 4, 2001, and arrive at KSDF at 0900 hrs on August 5, 2001.

Technical landings (fuel uplift) were planned at EKCH in Denmark, at Keflavik (BIKF) in Iceland, at BGBW in Greenland and at Sept-Iles (CYZV) in Canada.

The aircraft had a two hour delay at LEPA due to a slot time. For that reason, the aircraft did not arrive at EPGD until 2106 hrs. The aircraft was refuelled and the flight crew loaded the cargo themselves. The aircraft departed EPGD at 2218 hrs and arrived at EKCH at 2238 hrs. Then the aircraft departed EKCH at 2313 hrs and arrived at BIKF at 0202 hrs.

At BIKF, the aircraft was refuelled with 1034 USG of JET A1. The commander filed an ATC flight plan for BGBW with Kangerlussuaq (BGSF) in Greenland as destination alternate. At BIKF no weather reports for BGBW were valid for the flight crew's flight planning. The handling agent directed the Commander's attention to the lack of updated weather reports for BGBW, but the Commander seemed not to be concerned. It was the general opinion of the handling agent that the Commander seemed stressed.

At 0246 hrs, the flight crew requested start up and shortly after they got an ATC clearance to BGBW via EMBLA, 63N 30W, 62N 40W and NA at FL 240 with cruise Mach at 0.76.

The aircraft departed BIKF at 0300 hrs and the flight crew got an ATC clearance with FL 260 as the final cruising level inbound BGBW. The First Officer was the pilot flying and the Commander was the pilot non-flying.

At 0423:24 hrs, the Commander contacted Narsarsuaq Flight Information Service (FIS) on frequency 121.300 MHz. The Commander reported that they expected to be overhead NA (358 KHz) at 0438 hrs. At this time, the aircraft was cruising at FL 260 and was inbound NA on a magnetic track of 280° approximately 50 nm east of the aerodrome. Through link to Gander ATC, Narsarsuaq FIS cleared the aircraft to descend out of controlled airspace on QNH 1004 and to report FL 195 descending. The Commander was now the pilot flying and the First Officer was the pilot non-flying. The Commander had experience of flying to BGBW.

The aircraft left FL 260, and at 0434:27 hrs, the First Officer reported that the aircraft was passing FL 195. Narsarsuaq FIS requested the flight crew to report 10 nm from the aerodrome. While descending, the flight crew made a briefing on the NDB/DME approach procedure to runway 07.

At 0437:00 hrs, the First Officer reported that the aircraft was 10 NM from NA. Narsarsuaq FIS requested the flight crew to contact Narsarsuaq AFIS on frequency 119.100 MHz.

At 0437:17 hrs, the flight crew was in contact with Narsarsuaq AFIS and the First Officer reported passing FL 130. The AFIS Operator reported that there was no reported traffic in the TIZ and that the flight crew could make an approach by their own discretion. The weather was reported to be a wind direction and speed of 080° at 24 knots, visibility 10 kilometres with broken clouds at 6000 feet and overcast at 9000 feet, light rain, temperature +14°C, dew point +3°C and the QNH 1004 hPa.

At 0440:26 hrs and at 0440:52 hrs, one of the flight crewmembers made cockpit call outs of passing 6 nm and 8 nm respectively outbound from NA. At 0441:45 hrs, one of the flight crewmembers made a cockpit call out of the aircraft being on base. The Commander ordered the extension of the landing gear.

With reference to the CVR read out, there were no audible flight crew call outs concerning the use of checklists, altitude checks and Standard Operating Procedures (SOP) during the descent, the initial and the final approach phase.

At 0442:29 hrs, the First Officer reported that the aircraft was on final to runway 07. The AFIS operator reported the threshold wind for runway 07 to be 070° at 22 knots gusting to 29 knots and the runway to be free. The AFIS operator made a visual scan of the approach sector, but he did not see the aircraft, as he normally would have, when an aircraft was established on final in dark night and under similar weather conditions.

At approximately 0443:07 hrs, the aircraft impacted in landing configuration mountainous terrain at approximately 700 feet msl. The accident occurred 4.5 nm southwest of the aerodrome. On the CVR read out, there were no audible flight crew call outs immediately before the impact.

Several times from 0452 hrs until 0459 hrs, Narsarsuaq AFIS tried to get in radio contact with the aircraft, but there was no reply.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	2	1	-
Serious	-	-	-
Minor/None	-	-	-

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

There was no other damage.

1.5 Personnel information

1.5.1 The Commander.

1.5.1.1 The Commander, male, 56 years, was in possession of a valid German ATPL (Airline Transport Pilot License) and had a valid Medical Certificate.

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

- Single piston-engine land up to 2000 kg max. mass
- Instrument rating
- Falcon 20

1.5.1.3 It has not been possible for the Danish AAIB to obtain documentation of the commander's flying experience, JAR-OPS 1 and JAR-FCL 1 training from the Operator.

1.5.2 The First Officer.

1.5.2.1 The First Officer, male, 40 years, was in possession of a valid German ATPL and had a valid Medical Certificate.

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

- Single piston-engine land up to 2000 kg max. mass
- Instrument rating
- Falcon 20 as co-pilot

1.5.2.3 It has not been possible for the Danish AAIB to obtain documentation of the First Officer's flying experience, JAR-OPS 1 and JAR-FCL 1 training from the Operator.

1.5.3 The passenger.

1.5.3.1 The passenger, male, 36 years, was in possession of a valid German ATPL and had a valid Medical Certificate.

1.5.3.2 The passenger was licensed to the following classes and ratings:

- Single piston-engine land up to 2000 kg max. mass
- Instrument rating
- Falcon 20 as co-pilot.

1.5.4 Flight duty time.

1.5.4.1 Routing and flight times.

Route sector	ATD/ATA	ETE
EDDV/LEPA	12:17/unknown	02:05
LEPA/EPGD	18:40/21:06	02:35
EPGD/EKCH	22:18/22:38	00:30

EKCH/BIKF	23:13/02:02	02:35
BIKF/BGBW	03:00/ Crashed at 04:43 hrs	01:40
BGBW/CYZV (planned)		02:15
CYZV/KSDF (planned)		02:30

1.5.4.2 Regulations regarding flight duty time.
A German regulation established flight duty time limitation and rest requirements for the flight crew: *"Luftverkehr – B5b – Flug-, Flugdienst- und Ruhezeiten von Besatzungmitgliedern (2.DV LuftBO)"*.

1.5.4.3 Documentation of flight duty time.
It has not been possible for the Danish AAIB to obtain documentation of the planned flight duty time valid for the flights on August 4 and 5, 2001, from the Operator.

1.5.4.4 Circadian physiology (Flight Safety Digest February 1997).
"On a 24-hours basis, body temperature, hormone secretion, digestion, physical and mental performance, mood etc. fluctuate in a regular pattern with a high level at one time of day and a low level at another time. The circadian (circa=around, dies=day) pattern of wakefulness is programmed for wakefulness during the day and sleep at night. The circadian clock repeats this pattern on a daily basis. Certain hours of the 24-hour cycle, that is 0200 to 0600 (home base), are identified as a time when the body is programmed to sleep and during which performance is degraded."

1.6 Aircraft Information

1.6.1 General aircraft information.

Manufacturer:	Dassault Aviation
Type:	Dassault Falcon 20
Year of Manufacture:	1966
Serial Number:	063
Certificate of Airworthiness:	Issued 9 May 1988. Valid until October 2001
Engines:	2 General Electric CF 700-2D2
Recommended Fuel Type(s):	JET A, JET A1, JET B, JP4, JP5, JP8, AVTUR, AVTUR/FSii, AVTAG, AVTAG/Fsii, AVCAT, AVCAT/Fsii.
Fuel Type Used:	JET A1
Max. Zero Fuel Mass:	22000 lb
Max. Allowable Take-off Mass:	27337 lb
Max Landing Mass:	26036 lb
CG percent M.A.C. Take-off:	Forward limit 20.0 / Aft limit 28.5
CG percent M.A.C. Landing:	Forward limit 17.5 / Aft limit 28.5
Aircraft Weighing Report:	January 15, 2001
Aircraft Approach Category:	C

1.6.2 Aircraft maintenance.
1.6.2.1 The aircraft was due for an A-inspection on July 15, 2001. This inspection was scheduled on August 6, 2001, which was within authorized tolerances.

1.6.2.2 The Danish AAIB went through the aircraft maintenance documentation received from an approved JAR 145 maintenance facility. The received maintenance documentation did not give rise to remarks.

1.6.2.3 It has not been possible for the Danish AAIB to obtain the JAR-OPS 1 documentation of the maintenance status from the operator.

1.6.3 Fuel.

Two fuel samples were taken in BIKF on August 5, 2001. The results of the analysis complied with the requirements of specification for JET A1 AFQRJOS.

1.6.4 Mass and balance.

1.6.4.1 Aircraft loading.

In EPGD, the aircraft was loaded with 209 boxes (47x27x27 cm) of automotive parts. The total mass of the boxes was 1566.60 lb. The flight crew loaded the cargo themselves. The passenger seats were not installed on board the aircraft.

1.6.4.2 The Operator's Operations Manual Part A.

"8.1.8.6 One copy is to be carried on the aeroplane, whilst another, as accepted by the commander, must remain available on the ground for at least 1 day".

The flight crew did not leave a copy of mass and balance documentation at the departure airports on August 4 and 5, 2001.

1.6.4.3 The Operator's Operations Manual Part B.

The Operations Manual Part B did not contain an example of a cargo version load sheet.

1.6.4.4 Mass and balance calculation.

The following mass and balance calculation valid for the flight from BIKF to BGBW is based on data from the Manufacturer's Airplane Flight Manual (AFM), fuel uplifts, cargo manifests and cockpit instrument indications.

Item	Mass lb	Arm inch	MAC%
Empty mass without seats	15510.0	30.52	27.23
Two pilots 2 X 187 lb	374.0	-189.83	-169.37
One observer 1 X 187 lb	187.0	169.49	-151.23
Subtotal	16071.0	23.06	20.58
Cargo arm –126 to arm +75 inches	1566.6	-25.50	-22.75
Zero fuel mass	17637.6	18.75	16.73

Fuel at engine start	7588.7	15.02	13.40
Ramp mass	25226.3	17.63	15.73
Fuel onboard at the time of accident	3360.0	33.67	30.04
Mass at the time of accident	20997.6	21.13	18.86

1.6.5 Ground Proximity Warning System (GPWS).

1.6.5.1 The aircraft was equipped with a Sundstrand Mark VI GPWS. The GPWS was tested without remarks on January 15, 2001.

1.6.5.2 Product Specification SDC Part No. 965-0686-001, revision C:

"The GPWS uses a downward looking radio altimeter and does not sense forward terrain. Warning times for flight into precipitous terrain with little or no preamble terrain, can be very short or nonexistent".

"When the aircraft is in landing configuration, with a stable descent rate, no Glideslope signal, and when Altitude Callouts are not used, then warning times for flight into water, or terrain, can be very short or nonexistent."

1.6.5.3 GPWS modes.

Mode 1:	Excessive Descent Rate
Mode 2:	Excessive Closure Rate To Terrain
Mode 3:	Descent After Takeoff
Mode 4:	Insufficient Terrain Clearance
Mode 5:	Descent Below Glideslope
Mode 6:	Altitude Callouts
	Optional features:
	- *Descent below DH*
	- *Excessive Bank Angle*
	- *"500" and "200"*
	- *Automatic Volume Control.*

The following optional features were installed: Descent below DH, Excessive Bank Angle and Altitude Call Outs ("500 and 200").

1.6.5.3.1 The advisories and alerts that remained active in the landing configuration, were those for excessive descent rate (sink rate), excessive terrain closure rate, excessive glideslope deviation and the mentioned installed optional features.

1.6.5.4 Minimum Equipment List (MEL).

The Operator's Operations Manual Part B did not contain a MEL. The Master MEL stated that the GPWS may be inoperative.

1.6.5.5 Aural alerts.
No GPWS aural alerts were presented to the pilots during the final approach.

1.6.6 Global Positioning System (GPS).
1.6.6.1 The aircraft was equipped with a Trimble TNL 2000 Approach GPS. The GPS was approved for B-RNAV operations.

1.6.6.2 The GPS was tested without remarks on January 15, 2001.

1.6.6.3 A Trimble TNL 2000 Approach GPS does not save track history.

1.6.6.4 The BFU assisted the Danish AAIB in downloading data from the GPS. The GPS was heavily damaged due to the exposure of fire. However, the internal print cards were almost intact.

1.6.6.5 Findings.
- The data base card was not expired.
- The internal clock operated correctly.
- Neither an active flight plan nor any other flight plan was stored.
- The CDI scale was 5 NM.
- "Direct" "Fly Track 280°". The waypoint was BGBW.
- "Present Position" (i.e. last position) was 61°07.200N 45°33.552W.
- "Navigation" "Fly ←001° →1.19 NM.
- "Waypoint" BGBW. Bearing 089°. Distance 4,58 NM.
- Navigation" "Fly < 5.3> DME".

1.7 Meteorological information

1.7.1 General meteorological situation at BGBW on August 5, 2001, at 0445 hrs:

Synoptic situation:	A decreasing low pressure situated South-Southeast of Cape Farwell moving towards the east. An easterly air stream in the area.
Weather:	Light rain.
Visibility:	App. 30 km.
Clouds:	Overcast by altostratus, ceiling at 6000 ft.
Freezing level:	11000 ft (msl).
Icing:	None.
Turbulence:	Light to moderate mechanical turbulence. Neither wind shear nor microburst.
Surface wind:	East 20-25 knots.
Altitude wind (ref. TN):	The information of altitude winds were based on measured data from a weather balloon launched from Narsarsuaq on August 4, 2001, at 2300 hrs. 500 ft: 070 degrees 20-25 knots

1000 ft: 070 degrees, 20-25 knots.
2000 ft: 090 degrees, 20-25 knots.
3000 ft: 090 degrees, 20-25 knots.
4000 ft: 110 degrees, 20-25 knots.
5000 ft: 110 degrees, 20-25 knots.

Sunset on August 4, 2001: At 2332 hrs.
Sunrise on August 5, 2001: At 0644 hrs.

1.7.2 Weather forecasts (TAF) for Narsarsuaq (BGBW), Kangerlussuaq (BGSF) and Keflavik (BIKF) Airports.

Note: BGKK (Kulusuk) and BGGH (Nuuk) airports were not operational on August 4, 2001. For that reason neither TAF nor METAR were available.

BGBW did not make weather observations from August 4, 2001, at 1850 hrs until August 5, 2001, at 0250 hrs.

BGBW 050415z 050408 08020kt 9999 –ra few010 sct025 ovc 060=
BGBW 050725z 050714 08020kt 9999 –ra few050 ovc080 tempo 0714 bkn050=
BGSF 042315z 050024 06010kt 9999 few 060 sct100 bkn180 tempo 0012 11022kt becmg 0204 sct060 bkn100=
BGSF 050504z 050606 06010kt 9999 few060 sct100 bkn180 tempo 0612 11022kt=
BGSF 050504z 050606 06010kt 9999 few060 sct100 bkn180 tempo0612 11022kt=
BIKF 050130z 05012 vrb03kt 9999 few040=
BIKF 050430z 050615 vrb05kt 9999 few050 becmg 1114 bkn045 prob40 tempo 1415 9000 shra bkn020cb=

1.7.3 Actual weather reports (METAR) for Narsarsuaq (BGBW), Kangerlussuaq (BGSF) and Keflavik (BIKF) Airports.

BGBW 050250z 08024kt 8000 –ra ovc060 14/03 q1003=
BGBW 050350z 08022kt 9999 –ra ovc060 14/03 q1003=
BGBW 050450z 08023kt 9999 –ra ovc060 13/03 q1004=
BGBW 050550z 08025kt 9999 –ra ovc070 14/02 q1005=
BGBW 050650z 08023kt 9999 –ra ovc080 14/02 q1005=
BGSF 050350z 07011kt 9999 few100 bkn180 10/03 q1005=
BGSF 050450z 07011kt 9999 few100 sct180 10/03 q1005=
BGSF 050550z 08012kt 9999 sct100 bkn180 09/03 q1005=
BGSF 050650z 07009kt 9999 sct100 bkn150 10/04 q1006=
BIKF 050230z 18001kt cavok 08/07 q1011=
BIKF 050300z 18002kt 9999 08/07 q1011=
BIKF 050330z 19003kt 9999 07/06 q1012=
BIKF 050400z 19002kt 9999 mifg vcfg few060 07/06 q1012=

1.8 Aids to navigation

1.8.1 There was one instrument approach for BGBW, the non-directional beacon (NDB) NA (357 KHz). The NDB approach to runway 07 can be combined with DME NQ (111.850 MHz). See enclosure 1.

1.8.2 The approach procedure is to the southwest of the airport and, for the most part, over mountainous terrain. A note on the approach plate stresses the following: *"Adhere strictly to prescribed procedure due to high surrounding terrain."*

1.8.3 At the time of the accident the aids to navigation were functioning properly.

1.8.4 AIP Greenland AD2-BGBW-4.

19. Radio navigation and landing Aids.

FAC ILS CAT VAR	ID	FREQ CH	HR	PSN	DME ELEV	Remarks
NDB	NA	359 KHz	H24	61 10 12N 045 24 36W		Coverage 25 NM. Caution: Track displacement up to APRX 6° northwards may occur on final APCH to RWY 07 on NDB NA.
DME 07	NQ	111.850 MHz CH 55y	H24	61 09 33N 045 24 21W		Coverage 30 NM ACFT on the RWY may experience false DME indications, as there is no "line of sight" to the facility. DME for use only in connection with published procedures
MKR		75 KHz	H24	61 10 09N 045 24 43W		Orientated perpendicular to course 070° GEO.

1.9 Communications

Tape recordings of RTF communications between D-CBNA and Air Traffic Services contacted on the flight from BIKF to BGBW, were obtained from the relevant Aviation Authorities. Communications between D-CBNA and Air Traffic Services were normal throughout the flight.

1.10 Aerodrome information

1.10.1 General.

Narsarsuaq Airport:	BGBW
Position (ARP):	61 09 34N 045 25 26W
Elevation:	112 FT
MAG VAR:	29.8° W (SEP 1999)
Designation:	NARSARSUAQ TIZ
Lateral limits:	A circle 12 NM radius centred at 61 09 34N 045 24 26W (ARP)
Airspace classification:	G
ATS unit call sign:	NARSARSUAQ AFIS
RWY:	07 and 25
Dimensions RWY 07:	1830 x 45 M
Direction RWY 07:	041.0° GEO and 070.8° MAG
Aerodrome lighting:	Identification beacon
Lighting RWY 07:	High Intensity Runway Edge Lights, Runway End Identifier Lights, PAPI* (angle 3.5°) *Only to be used within 2 NM from THR 07 (within D 3.0 from NQ DME)

1.10.2 Rescue and fire fighting service.

- AD category for fire fighting: CAT 7
- Rescue equipment: Boats
- Capability for removal of disabled aircraft: -
- Remarks: NIL

1.10.3 Lighting.

At the time of the accident, the lighting to runway 07 and the identification beacon were turned on and were operational.

1.10.4 NOTAM.

No NOTAM were valid on August 5, 2001.

1.10.5 Radar coverage.

Neither final en route nor terminal radar data were available, since no radar coverage was established in the area.

1.11 Flight recorders

1.11.1 Flight Data Recorder (FDR).

1.11.1.1 Manufacturer: Sundstrand

Model: F-542M (metal foil recorder)

1.11.1.2 The BFU and the NTSB assisted the Danish AAIB in the examination of the FDR. The FDR was not significantly damaged. The foil medium was extracted from the cartridge and examined. Based on information known about the accident flight, such as flight time and the elevation of the crash, the last recorded data on the accident foil did not match expected values. The data ended at a cruise altitude, and the styli had imprinted an abnormal upwards scribe. In examining the last several recorded flights, the flight times, headings and altitudes were not consistent with the flight plans, the aircraft was known to have followed. Also, there was some damage noted to the sprocket holes and the bottom edge of the foil. It could not be determined when this damage occurred or why. Based on the available information, it was concluded that the accident flight data were not recorded on the FDR.

1.11.2 The Cockpit Voice Recorder (CVR).
1.11.2.1 Manufacturer: Sundstrand
Model: V-557

1.11.2.2 The BFU and the BEA assisted the Danish AAIB in making a transcript of the flight crew communication.
The CVR was not significantly damaged and it had recorded up to the time of impact. Approximately 31 minutes of poor quality audio data were obtained. The poor quality was partly caused by a lot of background noise on the recording from the area microphone. For that reason, it was only possible to make a transcript based on fragments of the flight crew communication.

1.12 Wreckage and impact information
1.12.1 General wreckage description.
1.12.1.1 Examination of the ground scars and the debris pattern revealed that the aircraft impacted mountainous terrain at 61 07 194N 045 33 595W and at an elevation of about 700 msl in a wings-level attitude. The wreckage trail track had a direction of approximately 110 degrees magnetic. The wreckage pattern observed was consistent with a controlled shallow descent. The wreckage trail was approximately 165 metres long by 30 metres wide.

1.12.1.2 The initial point of impact was evidenced by ground impact marks, consistent with the left and right wing tip, the left and right wing and the left and right main landing gear. These marks were followed by marks from the aft bottom empennage and the nose landing gear. Throughout the wreckage trail, fuel coloured the vegetation.

1.12.1.3 The aircraft started to break up from the beginning of the wreckage trail. During the break up, the cargo exited the aircraft and was spread over a relatively large area of the last part of the wreckage trail. No cargo tie-down rings or any other sign of use of cargo net were found within the accident area.

1.12.1.4 The aircraft came to a stop in a north-south magnetic direction. The empennage and the cockpit were separated from the fuselage. The empennage was located in an upside down position. The right wing remained attached to the fuselage, whereas parts of the left wing separated from the fuselage at the beginning of the wreckage trail. The landing gear separated from the aircraft at the beginning of the

wreckage trail. When the aircraft came to a stop, the fuselage, the right wing and the cockpit caught fire. The fuselage, the right wing and the cockpit were burned out.

1.12.1.5 The two engines were found separated from their respective mounted positions on the aircraft. The starboard engine was located 40 metres SW of the main wreckage site. The port engine was located within the main wreckage area.

1.12.1.6 The wreckage area.
See enclosure 2.

1.12.2 Engines.

- The indications on both engines were similar.
- The Inlet Guide Vanes (IGV) were positioned at almost the same position. This position was not at one of its extreme positions, but somewhere in between.
- IGV, 1st compressor blades and 1st stage stator vanes had indication of being in contact with each other. All bent tips and bent trailing edges were similar and showed that the engine was turning at some rpm at impact.
- The buckled exhaust on each engine indicated that the engines had been hot at impact. There were no cracks on the exhausts, even though the buckling contained very sharp edges.
- The starboard engine had traces of aluminium in its exhaust pipe. The engine had been rolling down through the wreckage site. When it rolled through the wreckage site, some melted aluminium got into the exhaust pipe. The aluminium had been spread around in the pipe when the engine was rolling. The traces of aluminium in the pipe also showed that the engine was lying still when the aluminium started to solidify again.

1.12.3 Flaps setting.
A number of flap screw jacks were examined in order to determine the flaps setting at impact. The examination identified that the flaps were set to landing configuration before impact.

1.12.4 Cockpit indications

General:

- Power levers near flight idle position
- Landing gear in down position
- Speed brakes in
- Emergency landing gear lever not activated
- Engine fire extinguishers not activated
- Radio altimeter 20 feet
- Overhead panel burned out
- Radio equipment compartment burned out
- Centre consol burned out

Instrument indications:

The Commander

- Altimeter 750 feet (QNH 1002)

The First Officer

- Altimeter 640 feet

- Compass 090 degrees	- Compass 097 degrees
-	- VSI 850 fpm, VSI standby 200 fpm
- Heading selector bug 155 degrees	-
- RMI I 080 degrees RMI II 060 degrees	- RMI I 095 degrees RMI II 065 degrees

1.12.5 Wreckage examination.
An examination of the wreckage conducted by the AAIB did not reveal technical failures that would have caused or contributed to the accident.

1.13 Medical and pathological information
There was no indication that incapacitation or physiological factors affected the performance of the flight crew.

1.14 Fire
A fire erupted during the final impact sequence and was sustained by the fuel on board the aircraft. The last report of a remaining fire was at 0807 hrs. The investigation revealed no evidence of an in-flight fire.

1.15 Survival aspects
1.15.1 General.
1.15.1.1 The accident was not survivable due to the impact forces and the fire.

1.15.1.2 The flight crew seats were equipped with a four-point restraint system. The observer's seat was equipped with a hip restraint system.

1.15.1.3 The Commander had been thrown from the aircraft. The autopsy report of the Commander revealed that he did not use his shoulder harness at impact. The First Officer was found in the right hand flight crew seat in the cockpit. Both hip and shoulder harness were fastened. The passenger was found in the left hand side of the cockpit. The damages to the observer's hip belt identified that the passenger used his hip belt at impact.

1.15.2 Search and rescue.
1.15.2.1 After losing radio contact with the aircraft, the AFIS Operator contacted Flight Information Centre (FIC) in Iceland and Canada in order to obtain information whether the aircraft for some unknown reason had diverted to another aerodrome. The initiative was unsuccessful and the AFIS Operator contacted the Rescue Co-ordination Centre (RCC) in Soendre Stroemfjord.

1.15.2.2 The local police in Narsarsuaq was notified at 0645 hrs. At 0656 hrs, a helicopter search was initiated in the direction of the approach path. The wreckage site was located at 0807 hrs.

1.15.2.3 It has not been possible for the AAIB to establish whether the Emergency Locator Transmitter (ELT) was operative. However, even if the ELT had activated no equipment, capable of receiving the signal on 121.500 MHz or homing in on the signal, was available at BGBW.

1.16 Test and Research

No specific test or research was conducted.

1.17 Organisational and management information

1.17.1 The Management of the Operator.

1.17.1.1 The Operator was a one-man owned company. The Commander was the owner of the company. In the JAR-OPS 1 organisation, the Commander acted as the Accountable Manager and as the nominated post holder of Flight Operations. The First Officer acted as the nominated post holder of the Maintenance System, the Crew Training and the Ground Operations. The passenger was employed as First Officer.

1.17.1.2 At the time of the accident, the Operator had a total number of 7 employees, of which two were employed as freelance pilots, one as Quality Manager and one as Administrator.

1.17.2 Operational approvals and type of operations.

1.17.2.1 On April 24, 2001, the Operator was approved according to JAR-OPS 1. At the time of the accident, the Operator was approved to perform passenger, cargo flights and medical service flights with a Fan Jet Falcon.

1.17.2.2 According to the Air Operator Certificate (AOC), the Operator was approved to operate in the European and Mediterranean ICAO region (EUR/MID).

1.17.3 The Operator's Operations Manual Part A.

1.17.3.1 *"1.4.2 The general responsibility of the Commander.*

The Commander is responsible for the safe operation of the aeroplane and safety of its occupants during flight time. He has:

- *To be sure that all operational procedures and check lists are complied with in accordance with the OM."*

1.17.3.2 *"8.1 Flight preparation instructions.*

The Commander shall not commence a flight unless he is satisfied that:

- *The load is properly distributed and safely secured.*

1.17.3.3 "*8.1.5.3 Destination alternate (JAR-OPS 1.295).*

The Commander must select two destination alternates when the appropriate weather reports of forecasts for the destination or any combination thereof indicate that:

- *During a period commencing 1 hour before and ending 1 hour after the estimated time of arrival the weather conditions will be below the applicable planning minima; or*
- *When no meteorological information is available.*

1.17.3.4 *"8.1.7.2 Alternate fuel.*

f) If two alternates are required due to weather, alternate fuel should be sufficient to proceed to the alternate which requires the greater amount of fuel."

1.17.3.5*"8.3.11 Use of safety belts for crew and passengers.*
Crew members at their station have to secure by all safety belts and harnesses during:
- *During takeoff and landing*
- *Whenever deemed necessary by the Commander in the interest of safety.*

1.17.3.6 The Operations Manual Part A did not contain a stabilized approach concept.

1.17.4 The Operator's Operations Manual Part B.
1.17.4.1 "*2.4 Call out procedures.*
"The principal of bilateral supervision, information and support is also the basis for so called "Call out procedures". The PNF supports the PF with laid down callout procedures upon fix points and altitudes. The PF answers these calls and thereby confirms the crosscheck procedures. Deviations from mandatory are also named and are demands for correction."

1.17.5 Standard Operating Procedures (SOPs).
1.17.5.1 JAR-OPS 1 states that SOPs are to be established and maintained for each aircraft that will be flown in a commercial operation. The Operator used the Manufacturer's prescribed procedures. These procedures used the challenge-and-response method to ensure that important cockpit checks were conducted.

1.17.5.2 Normal two-engine VOR/ADF Approach.
See enclosure 3.

1.18 Additional information
1.18.1 Crew resource Management (CRM).
CRM training is a requirement for JAR-OPS 1 operations. The application of CRM concepts can improve crew performance through enhanced communication, problem solving, decision-making, and workload management.

1.18.2 Controlled Flight into Terrain (CFIT).
CFIT accidents are accidents in which an aircraft, capable of being controlled and under control of the flight crew, is flown into the ground, water, or obstacles with no prior awareness on the part of the flight crew of the impending collision. Although CFIT accidents occur in all phases of flight, most occur during the approach and landing phase. A study by the Flight Safety Foundation Approach-and-Landing Accident Reduction (ALAR) Task Force identified causes and contributing factors to CFIT accidents in approach and landing occurrences*.
*Flight Safety Digest, November-December 1998 and January-February 1999.

The most common causes and contributing factors are the following:

- *"Poor professional judgement: Not executing a missed approach in the absence of visual cues,*
- *Omission of action/inappropriate action: Omission of approach briefing or altitude call outs; failure to check the radio altimeter, failure to call out "runway in sight/no contact" at MDA; and omission of checklist items,*
- *Failure in CRM: Continuing an approach in adverse conditions; descent below MDA/DH prior to acquiring visual cues in whiteout conditions; absence of standard call outs and briefings; and failure to recognize deviations from standard/approved procedures. Failures in CRM may be associated with complacency and overconfidence, high workload, cultural influences, and a lack of risk assessment; and*
- *Lack of positional awareness: Lack of vertical position awareness resulting in CFIT.*

It should also be noted that 75 percent of aircraft involved in the ALAR study were not equipped with a GPWS."

1.18.3 Spatial disorientation – visual illusions.
Aviation Medicine by J. Ernsting.

"Darkness degrades or eliminates many of the external visual cues employed in the day-time approach and the pilot must rely on the angular subtend (retinal image size) of the pattern of runway and approach lights. The perceptual task is made even more difficult if the approach is over water or lightless terrain, a condition known to most pilots as the 'black hole' approach. Under these circumstances, pilots may think that they are flying higher than their true altitude, and hence make a low approach. Distance from runway threshold may also be misjudged; bright runway and good visibility leads to an underestimation of distance."

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 investigation was rendered difficult due to the lack of FDR and radar data.

2.1.2 The CVR audio data were of poor quality due to lot of background noise. However, the obtained data were supportive to the final conclusion.

2.2 The flight inbounds BGBW.
2.2.1 With reference to the AOC, the Operator was not approved by the German Aviation Authorities to operate in the North Atlantic (NAT; BIKF and BGBW) and the North American (NAM; CYZV and KSDF) ICAO regions. The AAIB is of the opinion that this finding did not have major impact on the sequence of events, but it is possible that the flight crew's lack of a thorough familiarity with operation in the abovementioned ICAO areas, might have been a minor stress factor.

2.2.2 The flight crew loaded the cargo themselves at EPGD. At the wreckage site, there were no sign of use of cargo restraints. Improper restrained cargo can be hazardous since cargo movement can alter the aircraft's centre of gravity. However, it is the opinion of the AAIB that the volume of the cargo within the cabin area made it almost impossible for the cargo to move significantly in flight and thereby contribute to the accident.

2.2.3 A copy of the mass and balance documentation was not left at BIKF, nor was the documentation found at the accident site. The lack of available documentation and the apparent lack of appreciation displayed by the flight crew regarding the importance of safely securing cargo indicate that the Operator's load control procedures were not being followed. Based on the mass and balance calculations made by the AAIB, the AAIB believes that the aircraft's centre of gravity was within limitations before impact. For that reason the aircraft's actual centre of gravity at impact is not considered to be a contributing factor to the accident.

2.2.4 The flight crew planned the flight inbound BGBW with one destination alternate (BGSF). The pre-flight planning was not in accordance with the requirements of JAR-OPS 1 and the Operator's procedures. The flight should have been planned with two destination alternates, since no weather reports at BIKF at that time were available for BGBW. From a planning point of view, the AAIB believes that regarding fuel and aircraft loading, a pre-flight planning with two destination alternates would have made the flight inbound BGBW impossible. However, it is the opinion of the AAIB that the described discrepancy was not a contributing factor to the accident.

2.2.5 During the descent the Commander took over the control of the aircraft (pilot flying), which probably was due to the fact that he was familiar with the aerodrome and the approach procedures.

2.2.6 With reference to the flight crew's reporting and their call outs, the AAIB assumes that the aircraft had a initial sink rate of approximately 2300 feet per minute (Fl 195 – FL 130) and an average initial ground speed of approximately 280 knots (pilot reporting: "10 nm out of NA" – flight crew call out: "6 nm"). Based on these assumptions, the aircraft passed NA at approximately 0439 hrs at an altitude of approximately 8700 feet. At station passage, the aircraft was still above the reported broken cloud layer, and the AAIB believes that the flight crew initiated the NDB/DME approach procedure. On the outbound leg, the aircraft came below the reported broken cloud layer. The aircraft seems to have had a high airspeed on the outbound leg (flight crew call outs: "6 nm and 8 nm" which versus time is equal to a relative ground speed of approximately 277 knots"). This indicates that the initial approach procedure was not flown in accordance with the Operator's SOP for a two-engine VOR/ADF approach.

2.2.7 It is the opinion of the AAIB that the flight crew in the inbound turn got visual contact with the aerodrome, and in order to save time they decided to continue the flight with visual reference to the aerodrome, and they set an almost direct course to the aerodrome in order to be established on a short final (compass heading of approximately 090° - 097°). This is consistent with the wreckage trail, the cockpit indications and the observation (did not see the aircraft in the approach sector) made by the AFIS operator. See enclosure 4. The flight crew hereby made a procedural decision error, since the approach procedure

clearly stated a strict adherence to the procedure due to the high surrounding terrain. The Commander was familiar with the area, and it is possible that his overconfidence might have influenced the flight crew's decision making.

2.2.8 Furthermore, the AAIB believes that the flight crew continued descending relying only on the angular subtends of the runway and the aerodrome lights and not crosschecking the aircraft flight instruments. The flight crew were preoccupied with maintaining visual reference during the descent and did not adequately monitor the aircraft flight instruments, and they were hereby exposed to the "black hole" phenomenon resulting in a lack of vertical position awareness. Consequently, they misjudged the aircraft's true altitude and were not aware of their proximity to the terrain. It is the opinion of the AAIB that the First Officer's reporting of the aircraft being on final, when the aircraft was presumably established on a wide left base, was also caused by the "black hole" phenomenon. The true distance from the runway was misjudged. A bright runway/aerodrome and a good visibility lead to an underestimation of the distance.

2.2.9 It is the opinion of the AAIB that a combination of non-adherence to the approach procedure and the lack of vertical position awareness was the causal factor to this CFIT accident.

2.2.10 On the initial and final approach, the flight crew did not comply with the Operator's SOPs, thus increasing their exposure to risk during the flight. Non-adherence to SOPs and lack of a stabilized approach concept are recognized as a frequent causal factor in approach and landing accidents. In this flight, SOPs and a stabilized concept, especially altitude calls, would have heightened the flight crew's awareness about their proximity to terrain.

2.2.11 Effective CRM enhances decision-making and improves situational awareness. It has not been possible for the AAIB to obtain documentation of the flight crew's JAR-FCL and JAR-OPS training from the Operator in order to determine the status of the flight crew's latest CRM training. However, CRM techniques were not evident in their performance on the accident flight.

2.3 Flight Duty Time.

2.3.1 With reference to the routing and the flight times on August 4 and 5, 2001, and in accordance with the German regulations, the planned flight duty time for the flight crew was limited to maximum 14 hours. For the flight crew, this means that the flight duty time started at 1147 hrs and had to end at 0147 hrs at the latest. Therefore the last flight of the day had to end at 0132 hrs. At the time of the accident, the flight crew had been on duty for 16:56 hrs. Thereby, the flight duty time was exceeded by 2:56 hrs.

2.3.2 Taking into consideration the flight times on August 4 and 5, 2001, the rest period for the flight crew should have begun at BIKF. Under no circumstances, the planned flight could be a non-rest flight to KSDF. Even though the passenger was type rated as co-pilot on the aircraft, he could not be considered as a relief pilot since there were no approved rest-facilities on board the aircraft.

2.3.3 The accident occurred at 0443 hrs, where the body with reference to circadian physiology is programmed to sleep (peak fatigue). On the assumption that the flight crew got up at 0700 hrs on August

4, 2001, the flight crew had been awake for approximately 22 hours at the time of the accident. It is in the opinion of the Danish AAIB that the exceeding of the flight duty time in combination with the abovementioned physiological elements, resulted in fatigue and thereby degraded the performance and the alertness of the flight crew. It is possible that an underestimation by the flight crew of their fatigue contributed to improper decision making, lack of situational awareness and thereby to their failure to properly execute the approach.

2.3.4 In combination with fatigue, another contributing element to the accident might have been stress, since the flight was chartered to deliver the cargo in KSDF at 0900 hrs on August 5, 2001. When leaving EPGD, the flight was more than two hours late. The handling agent in BIKF stated that the Commander seemed stressed.

2.4 Technical status.

2.4.1 General.

It is the opinion of the AAIB that the aircraft was capable of being controlled until impact.

The following supports this:

- The examination of the wreckage conducted by the AAIB did not reveal technical failures, which would have caused or contributed to the accident.
- The examination of the engines concluded that the engines were running at impact.
- At the wreckage examination, the power levers were found in a position near flight idle.
- During the final approach neither aural aircraft systems warnings were presented to the flight crew, nor were any flight crew call outs made on that subject.
- The aircraft was in landing configuration.

The exact power setting at impact was not determined. However, the power levers position near flight idle and the lack of flight crew call outs right before impact indicate that the flight crew were not aware of their proximity to terrain. The aircraft did not suffer technical failures, which influenced the flight crew's way of handling the aircraft and performing the final approach. The flight crew handled the aircraft as in a normal operation.

2.4.2 Technical documentation.

It has not been possible for the AAIB to go through the aircraft's JAR-OPS 1 technical documentation. However, the AAIB believes that access to the documentation would not have changed the outcome of this investigation.

2.4.3 GPWS.

It is the opinion of the AAIB that the GPWS was inoperative, since no aural GPWS altitude calls ("500" and "200") were presented to the pilots during the final approach. Though, the Master MEL stated that the GPWS may be inoperative, the AAIB finds it hazardous to operate in mountainous terrain without an operable GPWS. An operable GPWS would have assisted in restoring the flight crew's situational awareness by providing them with appropriate advisories and cues about their proximity to terrain and would have reduced the likelihood of this accident occurring.

3. Conclusion

3.1 Findings

1. The flight crew were properly licensed.
2. Radar data were not available due to the lack of radar coverage.
3. The FDR was inoperative.
4. The CVR data were of poor quality.
5. The Operator was not approved to operate in the NAT ICAO region.
6. The cargo was not restrained.
7. The Operator's Operations Manual Part B did not contain an example of a cargo version load sheet.
8. A copy of the mass and balance documentation was not left at BIKF.
9. The Operator's load control procedures were not being followed.
10. The aircraft's centre of gravity was within limitations before impact.
11. At BIKF no valid weather reports were available for BGBW.
12. The pre-flight planning did not fulfil the requirements of JAR-OPS 1 and the Operator's procedures.
13. A pre-flight planning with two destination alternates would from a planning point of view have made the flight inbound BGBW impossible.
14. The Commander was the pilot flying.
15. The Commander was not properly fastened.
16. The Commander was familiar with the aerodrome and the approach procedures.
17. At the time of the accident, the aids to navigation were functioning properly.
18. No NOTAM (BGBW) was valid on August 5 2001.
19. The NDB/DME approach procedure was not flown in accordance with the Operator's SOP for a two-engine VOR/ADF approach.
20. The Operator's Operations Manual did not contain a stabilized approach concept.
21. The flight crew made a procedural decision error by planning a visual approach.
22. The flight crew made a visual approach.
23. The flight crew continued descending relying only on the angular subtend of the runway and the aerodrome lights.
24. The flight crew were exposed to the "black hole" phenomenon.
25. No aural aircraft system warnings were presented to the flight crew.
26. No aural GPWS warnings were presented to the flight crew.
27. The flight crew were not aware of their proximity to terrain.
28. A combination of non-adherence to the approach procedure and the lack of vertical position awareness was the causal factor to this CFIT accident.
29. During the final approach, the flight crew did not comply with the Operator's SOPs.
30. It has not been possible for the AAIB to obtain documentation of the flight crew's JAR-FCL and JAR-OPS training from the Operator.
31. CRM techniques were not evident in the flight crew's performance.
32. It has not been possible for the AAIB to obtain documentation of the planned flight duty time for the flights on August 4 and 5, 2001.

33. The planned flight duty time for the flight crew was limited to 14 hours.
34. At the time of the accident the flight crew had been on duty for 16:56 hrs.
35. The flight duty time was exceeded by 2:56 hrs.
36. The rest period for the flight crew should have begun at BIKF.
37. Regards flight duty time, the planned flight could not be a non-rest flight to KSDF.
38. At the time of the accident, the flight crew had been awake for approximately 22 hours.
39. The flight crew were exposed to peak fatigue, which degraded the performance and the alertness of the flight crew.
40. Fatigue in combination with stress contributed to improper decision making, lack of situational awareness and thereby to the failure to properly execute the approach.
41. It has not been possible for the AAIB to obtain the JAR-OPS 1 documentation of the maintenance status from the operator.
42. Technical failures did not cause or contribute to the accident.
43. The engines were running at impact at a power setting near flight idle.
44. The aircraft was in landing configuration.
45. The flight crew handled the aircraft as in a normal operation.
46. The Operator's Operations Manual Part B did not contain a MEL.
47. The GPWS was inoperative.
48. The Master MEL stated that the GPWS may be inoperative.

3.2 Causal factor.

A combination of non-adherence to the approach procedure and the lack of vertical position awareness was the causal factor to this CFIT accident.

3.3 Summary

Several of the most common factors found in CFIT accidents were present in this accident. The flight crew did not follow SOPs (adherence to the approach procedure, altitude calls, checklist reading). Furthermore the GPWS was inoperative and the flight crew were exposed to peak fatigue. The absence of CRM and non-adherence to SOPs removed important defences in preventing CFIT.

In this accident, the aircraft was capable of being controlled and was under control of the flight crew until impact. Nothing indicated that the flight crew were aware of their proximity to the mountainous terrain. Consequently, this is considered to be a CFIT accident.

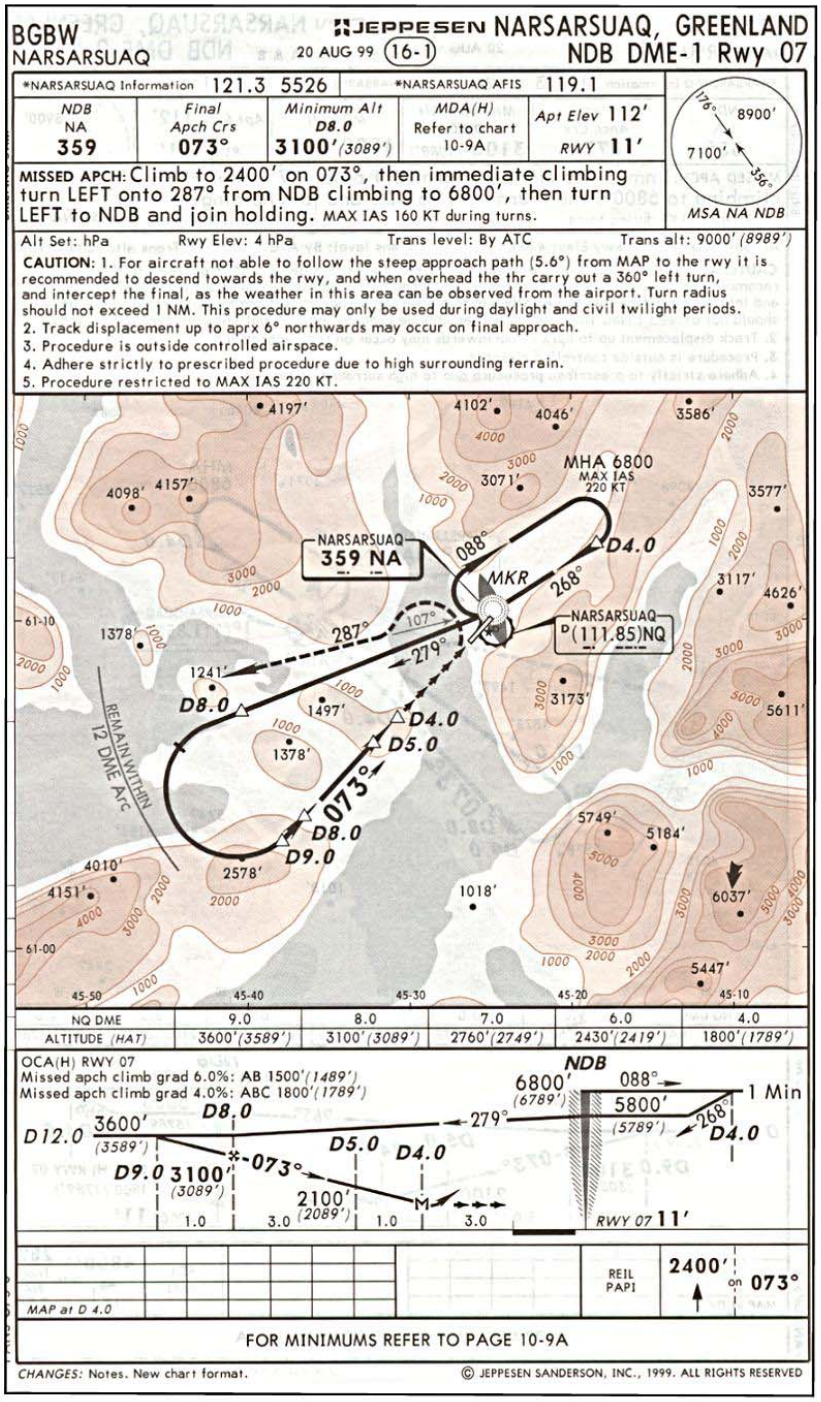
4. Recommendations

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

5. Enclosures

1. The NDB/DME approach procedure to runway 07 at BGBW.
2. The wreckage area.
3. The SOP for a two-engine VOR/ADF approach.
4. The aircraft's assumed final approach track.

Enclosure 1


BGBW
NARSARSUAQ
JEPPESEN NARSARSUAQ, GREENLAND
20 AUG 99 (16-1)
NDB DME-1 Rwy 07
*NARSARSUAQ Information 121.3 5526
*NARSARSUAQ AFIS 119.1
NDB NA 359
Final Apch Crs 073°
Minimum Alt D8.0 3100′(3089′)
MDA(H) Refer to chart 10-9A
Apt Elev 112′
RWY 11′
MISSED APCH: Climb to 2400′ on 073°, then immediate climbing turn LEFT onto 287° from NDB climbing to 6800′, then turn LEFT to NDB and join holding. MAX IAS 160 KT during turns.
MSA NA NDB
Alt Set: hPa
Rwy Elev: 4 hPa
Trans level: By ATC
Trans alt: 9000′(8989′)
CAUTION: 1. For aircraft not able to follow the steep approach path (5.6°) from MAP to the rwy it is recommended to descend towards the rwy, and when overhead the thr carry out a 360° left turn, and intercept the final, as the weather in this area can be observed from the airport. Turn radius should not exceed 1 NM. This procedure may only be used during daylight and civil twilight periods.
2. Track displacement up to aprx 6° northwards may occur on final approach.
3. Procedure is outside controlled airspace.
4. Adhere strictly to prescribed procedure due to high surrounding terrain.
5. Procedure restricted to MAX IAS 220 KT.
MHA 6800 MAX IAS 220 KT
NARSARSUAQ 359 NA
MKR
NARSARSUAQ D(111.85)NQ
088°
268°
287°
279°
073°
107°
D4.0
D5.0
D8.0
D9.0
REMAIN WITHIN 12 DME ARC
NQ DME 9.0 8.0 7.0 6.0 4.0
ALTITUDE (HAT) 3600′(3589′) 3100′(3089′) 2760′(2749′) 2430′(2419′) 1800′(1789′)
OCA(H) RWY 07
Missed apch climb grad 6.0%: AB 1500′(1489′)
Missed apch climb grad 4.0%: ABC 1800′(1789′)
NDB
6800′ (6789′)
5800′ (5789′)
1 Min
D12.0
3600′ (3589′)
3100′ (3089′)
2100′ (2089′)
1.0
3.0
1.0
3.0
RWY 07 11′
MAP at D 4.0
REIL
PAPI
2400′ on 073°
FOR MINIMUMS REFER TO PAGE 10-9A
CHANGES: Notes. New chart format.
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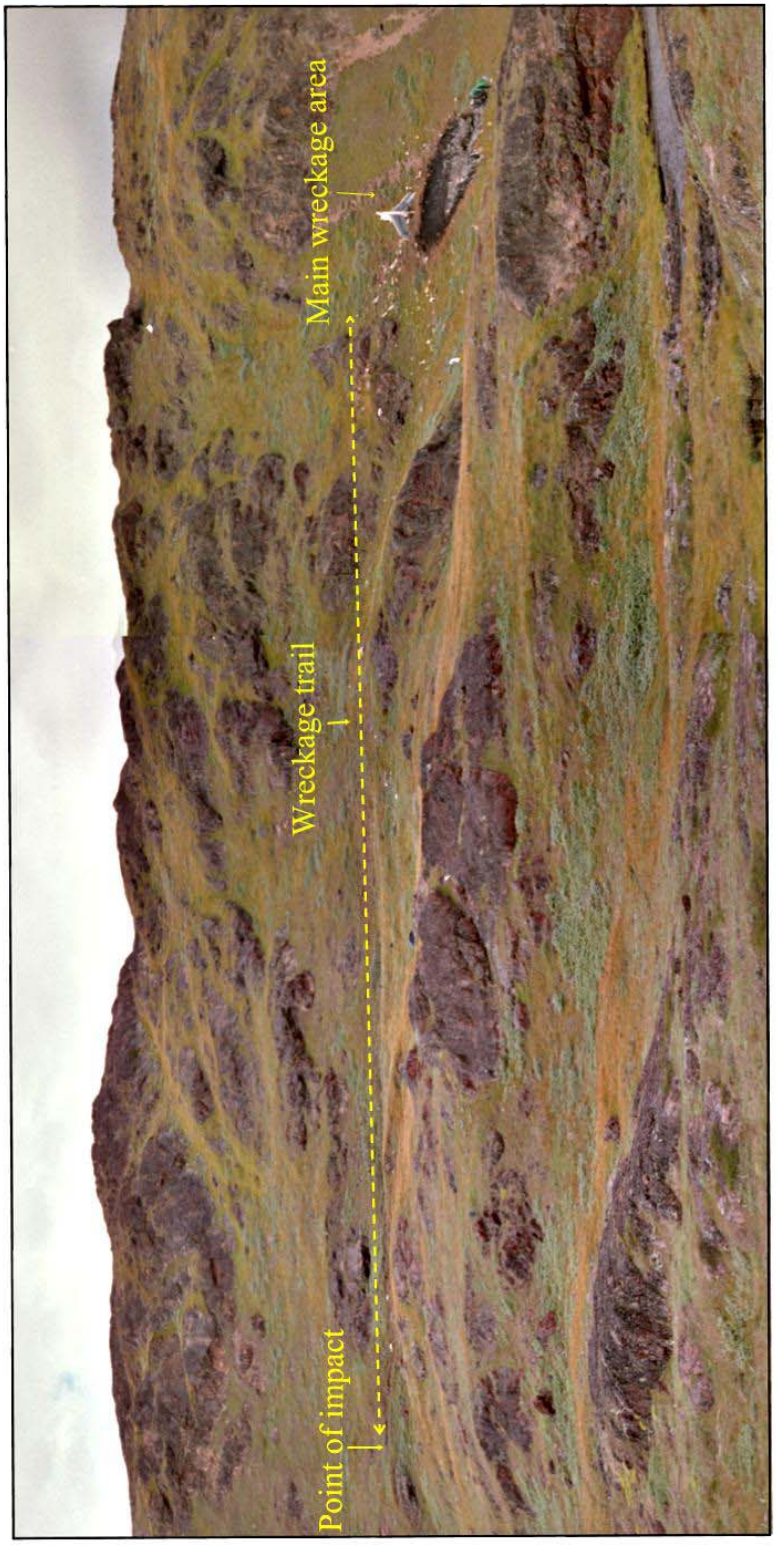
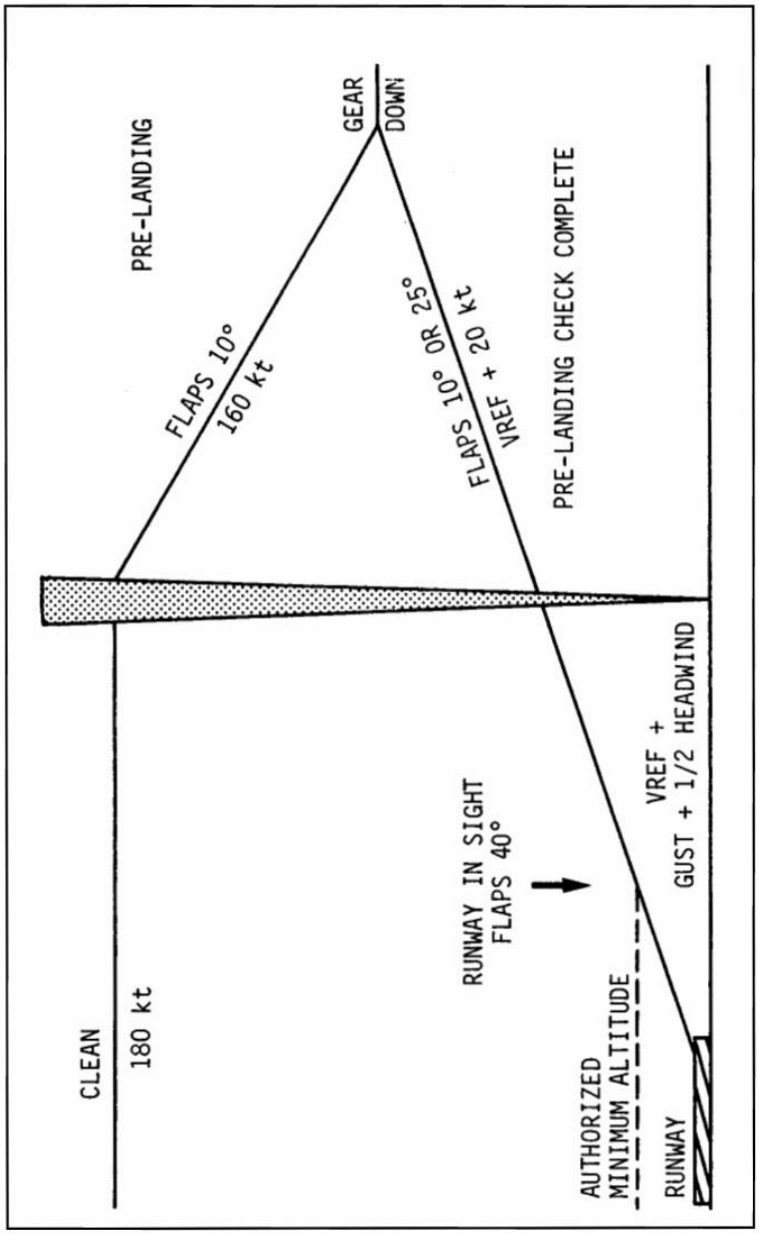
Enclosure 2



Enclosure 3


CLEAN
180 kt
PRE-LANDING
FLAPS 10°
160 kt
GEAR
DOWN
FLAPS 10° OR 25°
VREF + 20 kt
PRE-LANDING CHECK COMPLETE
RUNWAY IN SIGHT
FLAPS 40°
AUTHORIZED
MINIMUM ALTITUDE
VREF +
GUST + 1/2 HEADWIND
RUNWAY

Enclosure 4

The drawing is non-measurable

– – – – – NDB/DME approach procedure

• • • • • • • • • • The aircraft's assumed final approach track

The accident site