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Aircraft Accident Investigation Bureau AAIB

Final Report No. 1984 by the Aircraft Accident Investigation Bureau

concerning the accident

to the Bell 206 B helicopter, registration HB-XXN

on 14 April 2005

Valletta di San Gottardo, Airolo/TI

24 NM north-north-west of Locarno

Bundeshaus Nord, CH-3003 Berne

Ursachen

Der Unfall ist darauf zurück zu führen, dass der Helikopter mit dem Gelände kollidierte, weil der Flug fortgesetzt wurde, obwohl keine ausreichenden Sichtreferenzen mehr vorhanden waren.

Folgende Faktoren haben die Entstehung des Unfalls möglicherweise begünstigt:

- geringe Erfahrung des Piloten bezüglich Flügen im Gebirge bei anspruchsvollen Wetterbedingungen
- zu optimistische Wettervorhersage für die betreffende Sichtflugroute

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All times in this report, unless otherwise indicated, are indicated in the standard time applicable to the area of Switzerland (local time – LT), corresponding at the time of the accident to Central European Summer Time (CEST). The relationship between LT, CEST and coordinated universal time (UTC) is: LT = CEST = UTC + 2 h.

For reasons of protection of privacy, the masculine form is used in this report for all natural persons, regardless of their gender.

Contents

Final Report

Owner	BB Heli AG, 8172 Niederglatt, Switzerland
Operator	BB Heli AG, 8172 Niederglatt, Switzerland
Aircraft type	Helicopter Bell 206 B Jet Ranger
Country of registration	Switzerland
Registration	HB-XXN
Location	Valletta di San Gottardo, Airolo/TI Elevation: 2440 m AMSL 8005 ft AMSL
Date and time	14 April 2005, towards midday (precise time of accident unknown)

Summary

Synopsis

On 14 April 2005 the Bell 206 B helicopter, registration HB-XXN, took off at 10:36 LT from Zurich airport on a flight to Bergamo-Orio al Serio (I). Shortly after 11:00 LT it was observed flying from the Gotthard Pass in the direction of Hospental. When the helicopter had still not arrived in Bergamo-Orio al Serio (I) some time after its scheduled arrival time, a search was launched. At 18:05 LT the wreck of HB-XXN was located on the north face of a rock ridge of the Pizzo della Valletta. It was evident that the aircraft had collided with the terrain and exploded. Both occupants were fatally injured in the accident.

Investigation

The Swiss Air Rescue Service (REGA) notified the Aircraft Accident Investigation Bureau (AAIB) at approximately 14:00 LT on 14 April 2005 about the search and rescue operation which had been launched. When the helicopter had been located, the investigation was opened in cooperation with the Ticino cantonal police.

According to Annexe 13 of the Convention on International Civil Aviation (ICAO Annex 13), the states of manufacture of the aircraft and of components have the option of designating authorised representatives who may assist in the investigation. Canada, as the state of manufacture of the helicopter, availed itself of this right. The companies which manufactured the helicopter and engines assisted in the investigation.

The accident is attributable to the fact that the helicopter collided with the terrain because the flight was continued even though adequate visual references were no longer available.

The following factors may have contributed to the origin of the accident:

- the pilot's limited experience of mountain flying under demanding weather conditions
- a too optimistic weather forecast for the visual flight route concerned

1 Factual Information

1.1 Pre-flight history and history of the flight

1.1.1 General

The recordings of radio communications, radar data, forensic findings and the statements of eye witnesses and informants were used for the presentation of the facts.

1.1.2 Pre-flight history

1.1.2.1 Helicopter

Helicopter HB-XXN was not in use from 1 February 2005 to 31 March 2005. After it was brought back into service, it was flown on 2 April 2005 by two different pilots for a total of 2 hours 10 minutes and then no longer used until the day of the accident. The last pilot to fly HB-XXN on 2 April 2005 was the pilot who made the flight involved in the accident on 14 April 2005. After the flight on 2 April 2005, the pilot entered the fuel reserves as 18 American gallons[1] (USG) on the flight report.

1.1.2.2 Pilot

The pilot was employed by the air transport company BB Heli AG as director of operations and in addition occasionally made flights for the company. On 14 April 2005 at about 07:30 LT, a customer ordered from the managing director of BB Heli AG a return flight from Zurich via Bergamo-Orio al Serio (I) to Modena (I) with the return leg scheduled for Friday 15 April 2005. The managing director subsequently asked two pilots who flew regularly for his company whether they would be able to fulfil this order. Both were unavailable for this flight. The managing director was also not available to make this flight and therefore approached to the director of operations, who was working that morning in the offices of BB Heli AG. According to the managing director's statement, the director of operations stated enthusiastically that he was prepared to make the flight.

According to the managing director's statements, there remained about two hours to prepare the flight. The company flight plan was drawn up by hand by the pilot using the ICAO[2] chart of Switzerland. The managing director and another pilot prepared the ATC[3] flight plan and organised a slot[4] for the departure from Zurich. The passenger arrived at the airport at 10:00 LT. According to the fuel receipt, HB-XXN was refuelled at 10:00 LT with 345 l of Jet A-1 kerosene. The managing director, the pilot of HB-XXN, the pilot assisting with flight preparation and the passenger drove to the helicopter and prepared it for the flight.

[1] 18 USG corresponds to approximately 68 l.

[2] ICAO – International Civil Aviation Organisation

[3] ATC – air traffic control

[4] Slot: ATC unit's time window for departure, approach or flying a section of a route

1.1.3 History of the flight

At 10:15:14 LT, the pilot made contact with Zurich aerodrome control (ADC) and reported that helicopter HB-XXN was ready for departure. Since at this time several long-haul aircraft were taking off from runway 16 in Zurich and since during such a phase no departures under visual flight rules are possible via the departure route in the direction of Lake Zurich, take-off was delayed by about 20 minutes. Aerodrome control gave departure clearance at 10:35:48 LT: *"Helicopter X-ray November, follow route number one*[5]*, depart own discretion from heliport west, the wind three two zero degrees, four knots, QNH one zero zero niner."* The pilot confirmed the essential elements of this radio conversation, took off and left the airport in a south-westerly direction.

Both the transcript of the radio conversations and the radar recordings prove that HB-XXN flew out over the Gasometer and City reporting points. The final primary radar echo was recorded at 10:42:52 LT over the northern end of Lake Zurich, shortly after the pilot had left the aerodrome control frequency.

Neither the civil nor the military primary and secondary radar systems subsequently recorded flight data which could clearly be attributed to HB-XXN. There are no indications that the pilot, after leaving the Zurich aerodrome frequency, made contact with other air traffic control or information services.

A snow blower driver, who was clearing snow from the road over the Gotthard Pass, observed a helicopter from the boundary between the cantons of Uri and Ticino between 11:00 LT and 11:30 LT; it was later able to be clearly identified as
HB-XXN. The helicopter was flying low from the Gotthard Pass towards Hospental. From the witness's position, the Gotthard appeared to be covered in cloud and it was snowing.

When the aircraft did not arrive at its destination as planned and was more than 30 minutes overdue, the search and rescue services' uncertainty phase (INCERFA), and then the alert phase (ALERFA) were declared.

After the maximum flying time which would have been available to HB-XXN according to its fuel reserves had elapsed, at 14:56 LT the distress phase (DETRESFA) was declared and the search for the helicopter was launched both in Italy and in Switzerland.

At 18:05 LT, a Swiss Air Force search helicopter was able to locate the wreckage of HB-XXN. It turned out that both the pilot and the passenger had been fatally injured in the accident. The helicopter was destroyed.

[5] Departure route "number one" was renamed "Sierra" for S – South – a few months after the accident.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	1	1	2	0
Serious	0	0	0	0
Minor	0	0	0	---
None	0	0	0	---
Total	1	1	2	0

1.3 Damage to aircraft

The helicopter was destroyed.

1.4 Other damage

There was minor crop damage.

1.5 Personnel information

1.5.1 Pilot

Person	(deceased) Swiss citizen, born 1967
Licence	Professional helicopter pilot's licence, issued by the Federal Office for Civil Aviation (FOCA) on 27.11.2003, valid till 8.8.2005
Ratings	Type rating B 206/206 L Type rating EC 120 B International radiotelephony for visual flight RTI (VFR) Night flying NIT Mountain landings (MOU)
Medical fitness certificate	Class 1, without restrictions
Last medical examination	13.07.2004
Commencement of pilot training	20.09.2000
Flying experience before the flight involved in the accident	255:00 hours total
on the accident type	229:00 hours
during the last 90 days	7:40 hours
of which on the accident type	1:14 hours

1.5.2 Passenger

Person	(deceased) Iranian citizen, born 1965
Licence	No pilots' licences or ratings

1.6 Aircraft information

1.6.1 Helicopter HB-XXN

Aircraft type	Helicopter Bell 206 B
Characteristics	Lightweight single-engined multi-purpose helicopter with five seats which can be flown by one pilot. It is equipped with a semi-rigid main rotor and a tail rotor for torque balance.
Length	11.96 m
Height	3.55 m
Main rotor diameter	10.17 m
Max. permitted take-off mass	1452 kg
Manufacturer	Bell Helicopter Textron Inc., Canada
Registration	HB-XXN
Serial number	4123
Year of construction	1990
Owner	BB Heli AG, CH-8172 Niederglatt/ZH,
Operator	BB Heli AG, CH-8172 Niederglatt/ZH,
Engine	Freewheel shaft drive, Allison 250-C20R/4 with available maximum output of 450 SHP[6] corresponding to 335 kW. Because of the main transmission's operating limits, the engine output is restricted to 317 SHP, corresponding to 236 kW (flat rated).
Engine manufacturer	Allison Engine Company/Rolls-Royce Corporation, Indianapolis, Indiana, USA
Operating hours, airframe	3654 hours
Operating hours, engine	3654 hours
Maintenance	The last scheduled maintenance took place on 24 September 2004 at 3600:52 hours of operation. This corresponded to a 1200 operating hours check.
Last inspection	22.09.2004 by an inspector on behalf of the FOCA
Fuel grade	Jet A-1 kerosene
Fuel tank	The helicopter was equipped with a tank designed as a rubber bladder, with a useable capacity of 344.4 l.

[6] SHP – shaft horse power – Anglo-Saxon unit of measurement of shaft power, corresponding to 0.746 kW per SHP

Fuel reserves	Before take-off in Zurich, the helicopter was refuelled with 345 l. Assuming a flight time before the accident of approximately one hour, at that time the accident a fuel reserve equivalent to at least 2:30 hours flying time was still available.
Mass and centre of gravity	The helicopter's mass at the time of the accident was approximately 1270 kg and was therefore below the maximum permitted take-off mass. The centre of gravity was also within the permitted limits both laterally and longitudinally.
Registration certificate	Dated 24.09.1990, issued by the FOCA, valid till removal from the aircraft register
Airworthiness certificate	Dated 22.05.1995, issued by the FOCA, valid till revoked Category: Standard Sub-category: Normal
Certification	In commercial use: VFR by day In non-commercial use: VFR by day / VFR by night

1.6.2 Power specifications

According to the rotorcraft flight manual (RFM), it is possible, with a mass of approximately 1270 kg, under the prevailing environmental conditions and in the applicable configuration of the helicopter, to hover out of ground effect at an altitude equivalent to the elevation of the accident location.

If the helicopter's anti-ice system is used in addition, at an altitude equivalent to the elevation of the accident location, hovering out of ground effect is possible only at a mass of approximately 1200 kg. Hovering within the ground effect is, however, also possible at this altitude with the anti-ice system switched on.

At an altitude equivalent to the elevation of the Gotthard Pass (6915 ft AMSL, corresponding to 2109 m AMSL), the Bell 206 B is also able to hover out of ground effect if the anti-ice system is used and at a mass of approximately 1270 kg.

1.7 Meteorological information

1.7.1 Information available at the time of flight preparation

1.7.1.1 Aviation weather forecast[7]

Aviation weather forecast for Switzerland
for Thursday 14 April 2005, valid from 06:00 to 12:00 UTC
Issued by MeteoSwiss

[7] This meteorological information was provided by MeteoSwiss and is translated from German

General situation:

A low-pressure area lay over the British Isles. A corresponding cold front has reached France. For the time being, it is moving eastward only slowly. In front of it, the winds are veering from the south-west to south. Today, they are initially bringing only moderately humid air to the area of the Alps. During the second half of the day, this air mass becomes increasingly unstable.

Cloud (amount, base, ceiling), visibility, weather:

North side of the Alps, Valais, north and central Grisons:
Initially, fog banks in the central and eastern Midlands, otherwise from the south-west intermittently 2-5/8, base 7000-9000 ft AMSL. On the central and eastern crest of the Alps from the south 1-3/8, base 8000-10 000 ft AMSL. Towards mid-day over the Jura and western pre-Alps 1-3/8 Cu base 4000 to 6000 ft AMSL. Visibility in the Midlands initially 4-7 km, with fog below 1 km. Otherwise over 8 km.

South side of the Alps and the Engadine:

In central and southern Ticino 1-3/8, along the Alps 3-6/8, base 7000-9000 ft AMSL, some local precipitation not entirely excluded on the southern slopes of the Alps. Visibility mostly over 8 km.

Wind and temperature, north side of the Alps:

ALTITUDE	*DEGR./KT*	*TEMP*
GROUND	*SW/1-4*	
05000FT	*230/005-010*	*PS03*
10000FT	*200/010-015*	*MS05*
18000FT	*220/010-015*	*MS23*
30000FT	*240/20*	*MS48*
39000FT	*240/20*	*MS59*
45000FT	*240/25*	*MS56*
-------FT	*---/---*	*MAXIMUM WIND*
36100FT	*TROPOPAUSE*	*MS62*
06500FT	*ZERO DEGREE ISOTHERM*	

Hazards

Reduced visibility due to fog banks in the Midlands.

Evolution of the weather up to midnight

In the north, formation of cumulus, especially over the Jura and the pre-Alps, isolated rain showers possible. Increasingly cloudy on the southern slope of the Alps, but probably initially only little rain.

1.7.1.2 Route weather forecast[7]

The forecast (GAFOR – general aviation forecast) provides information on the expected visibility and expected main cloud base (ceiling) on the main visual flight routes in Switzerland. For the route 72 applicable to the flight involved in the accident, from Goldau to Biasca, with a reference altitude of 7200 ft AMSL the forecast issued on 14 April 2005 at 05:00 UTC, with a validity from 06:00 to 12:00 UTC was: marginal, difficult, difficult (MDD)

In clear text this means that between 06:00 UTC and 08:00 UTC visibility of more than 2 km and a main cloud base not below 8200 ft could be expected on the route. For the period between 08:00 UTC and 12:00 UTC visibility values in excess of 5 km and a main cloud base of at least 8700 ft AMSL were to be expected.

1.7.1.3 Webcams

According to the managing director's statements, the images from webcams at the following locations were used in the preparation of the flight: Gütsch above Andermatt, Andermatt towards Hospental and Ambri.

1.7.2 Reconstructed weather situation

1.7.2.1 General weather situation[7]

Switzerland was at the front of a low-pressure area centred over England. The pressure differences in Switzerland were minor. A southerly air flow was slowly progressing at altitude.

1.7.2.2 Weather conditions in the area of the accident[7]

The following information on the weather at the time and in the area of the accident is based on a spatial and chronological interpolation of the observations of various weather stations. This interpolation was carried out by MeteoSwiss.

Cloud	*7 – 8/8 base at approximately 7000 – 8000 ft AMSL, with shreds of stratus beneath*
Weather	*Light snowfall cannot be excluded*
Meteorological visibility	*Hazy visibility conditions*
Wind	*Southerly wind approximately 12 kt, gusting to 20 kt*
Air temperature	*-2 °C*
Dew point	*-3 °C*
Atmospheric pressure	*QNH LSZH 1009 hPa* *QNH LSZA 1009 hPa*
Hazards	*Partially limited visibility* *Gotthard Pass in cloud from the south*

1.7.2.3 Satellite image[7]

On the route from Zurich airport to the area of Lake Lucerne, no cloud can be seen on the satellite image. To the south, the cloud cover is very compact and extends over the ridge of the Alps as far as the Lugano region.

1.7.2.4 Webcams

Since webcam images are generally archived only for a short time, after the accident it was only possible to obtain an image of an area to the south of the region of the accident, showing the weather conditions in the upper Leventina shortly before the presumed time of the accident (see Figure 1).

Figure 1 – webcam image: Image from Catto, looking towards Piotta and Airolo on 14 April 2005 at 11:01 LT. Ambri aerodrome can be seen in the foreground.

1.7.2.5 Eye witness observations

A snow blower driver who was clearing the snow from the road over the Gotthard Pass, located at the boundary between the cantons of Uri and Ticino, observed a helicopter between 11:00 LT and 11:30 LT; it could subsequently be clearly identified as HB-XXN. This eye witness provided the following information about the weather conditions [translated from German]: *"Visibility in the direction of the Gotthard was poor and sleet was falling. A strong wind was blowing from the south. (…) The Gotthard seemed obscured from our position. From my viewpoint down towards Hospental the mountainsides were visible at least up to the height of the high-voltage power line."*

1.7.3 Natural light conditions

1.7.3.1 Position of the sun

Azimuth	*131°*
Elevation	*43°*

1.7.4 Information regarding the compilation of a route weather forecast

1.7.4.1 General

MeteoSwiss provided the following information [translated from German] concerning the compilation of a forecast for the main visual routes in Switzerland (GAFOR – general aviation forecast):

The production process for the GAFOR product for Switzerland can be split into three stages:

1. Concept relating to the general evolution of the weather

The evolution of the weather situation prevailing at the time of production in the area of Switzerland is assessed for the forecast period on the basis of the synoptic and results of various numeric weather forecasts (concept).

2. Short-term evolution for the GAFOR routes

a) Current situation

Various sensors (visual observations, various automatic weather station parameters, remote sensing systems such as camera images, satellite data and precipitation radar) are used to record the current situation along the route.

b) Evolution

For each GAFOR section and each validity period (3 x 2hours), the evolution of the weather is assessed on the basis of the concept, above all in relation to changes in the ceiling and visibility conditions. The assessment incorporates knowledge of the micro-scale evolution of the weather as a function of the meso-scale evolution and interpretation of numeric results in the micro-scale range. Critical sections of the route in particular are assessed.

c) Classification and coding

Classification into O, D, M and X is undertaken on the basis of the expected evolution.

3. Weather monitoring

As part of the weather monitoring activity, the GAFOR forecast is compared with the current evolution of the weather and amended if necessary. In addition, consistency in relation to other products for aviation is constantly checked.

1.7.4.2 Weather categories

The period of validity for GAFOR Switzerland is sub-divided into three periods of time, each of two hours. The weather conditions to be expected during these periods on the main visual flight routes are classified into weather categories according to the following diagram and encoded with the letter X, M, D and O. A reference altitude to which the ceiling altitude refers is specified for each main visual flight route.

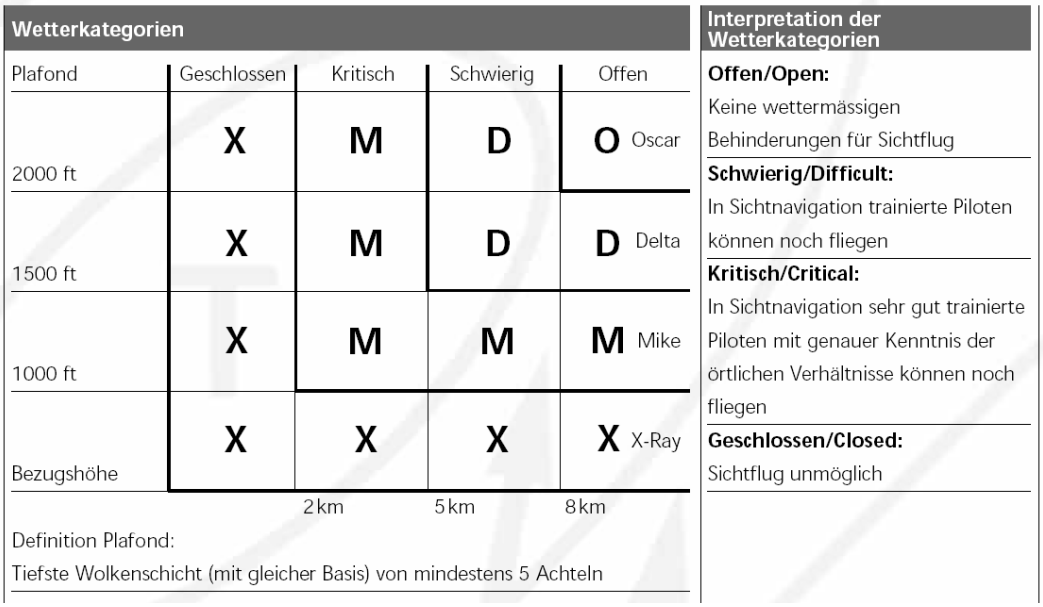
In the diagram below the text in column *Interpretation der Wetterkategorien* translates as follows:

Open: no impediments to visual flight regarding the weather

Difficult: pilots trained in visual navigation can still fly

Critical: pilots very well trained in visual navigation and with precise knowledge of local conditions can still fly

Closed: visual flight impossible



Wetterkategorien

Plafond	Geschlossen	Kritisch	Schwierig	Offen
2000 ft	X	M	D	O Oscar
1500 ft	X	M	D	D Delta
1000 ft	X	M	M	M Mike
Bezugshöhe	X	X	X	X X-Ray
		2 km	5 km	8 km

Definition Plafond:
Tiefste Wolkenschicht (mit gleicher Basis) von mindestens 5 Achteln

Interpretation der Wetterkategorien

Offen/Open:
Keine wettermässigen Behinderungen für Sichtflug

Schwierig/Difficult:
In Sichtnavigation trainierte Piloten können noch fliegen

Kritisch/Critical:
In Sichtnavigation sehr gut trainierte Piloten mit genauer Kenntnis der örtlichen Verhältnisse können noch fliegen

Geschlossen/Closed:
Sichtflug unmöglich

Figure 2 – GAFOR Switzerland weather categories and their interpretation: Extract from the publication *"Flugwetterinformationen in der Schweiz"* [Aviation weather information], published by MeteoSwiss.

1.8 Aids to navigation

According to information from the flight operations manager of BB Heli AG, an ICAO chart for Switzerland, scale 1:500 000, was exclusively used for planning and executing the flight. It was possible to locate the chart used after the accident. A set of charts of Switzerland, scale 1:100 000 was located after the accident. These were in the helicopter's baggage compartment.

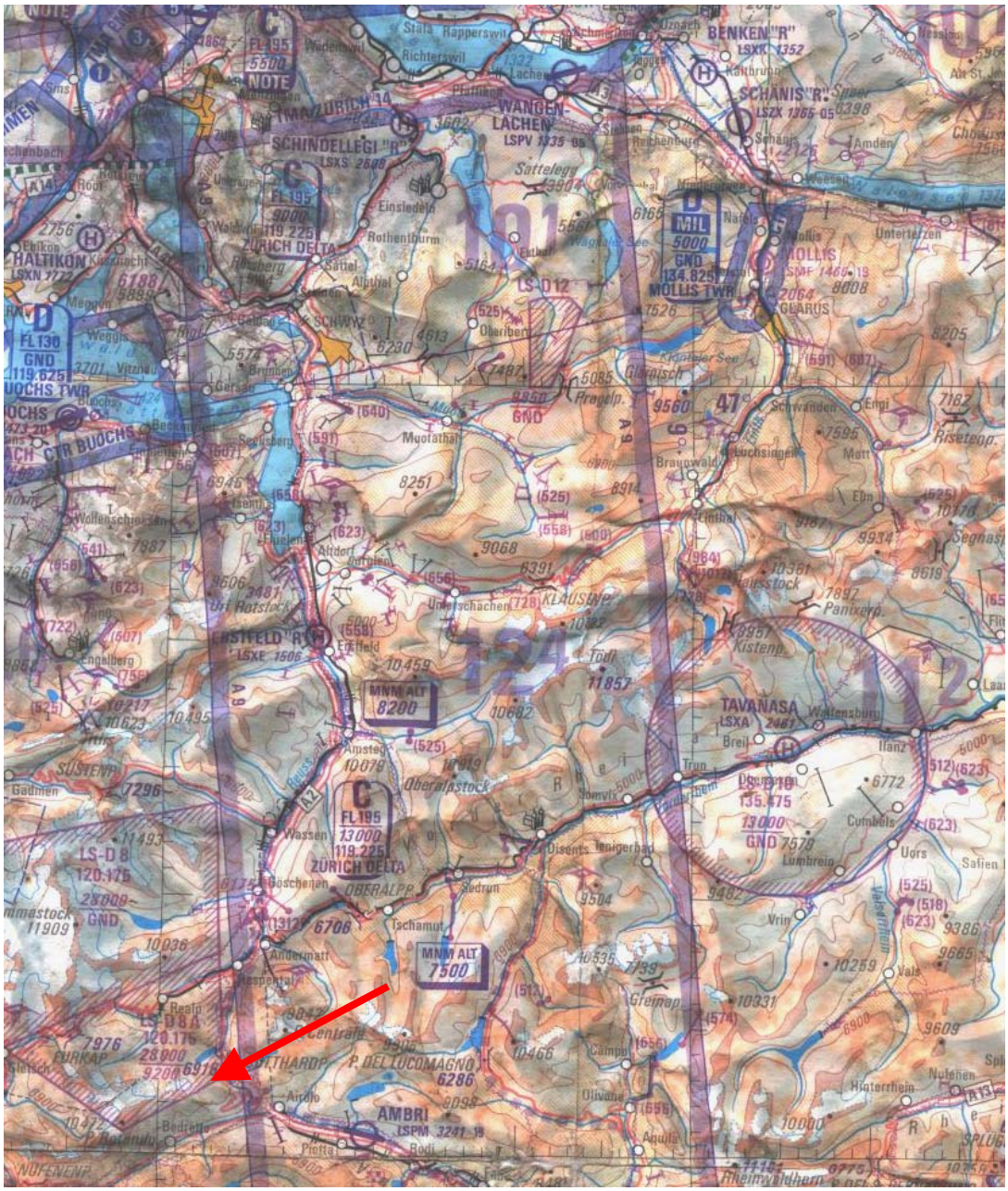


Figure 3 - Section of the ICAO chart: This chart, scale 1:500 000 was being carried on the flight involved in the accident. The section shows the area of the Gotthard Pass. The red arrow indicates the site of the accident.

1.9 Communications

Radio communication between the pilot and the Zurich aerodrome control unit took place normally and without any difficulties. There are no indications that the pilot, after leaving the Zurich tower frequency, made contact with other aircraft or other air traffic control and information services.

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

No equipment which was able to record flight parameters or flight path data was installed in the aircraft involved in the accident. The GPS[8] navigation unit carried by the pilot was so badly damaged after the accident that it could no longer be analysed.

1.12 Wreckage and impact information

1.12.1 Impact and site of the accident

The helicopter collided with the Pizzo della Valletta ridge, which falls away towards the north-east, at an elevation of 2440 m AMSL, corresponding to 8005 ft AMSL. After the initial collision with the terrain, the aircraft, while breaking apart, crashed on a slightly inclined slope some 100 m lower down. At this point a fire, caused by the impact, broke out.

Accident location	Valletta di S. Gottardo
Swiss coordinates	684 978/156 726
Geographical latitude	N 46° 33' 27"
Geographical longitude	E 008° 32' 51''
Elevation	2440 m AMSL
	8005 ft AMSL
Location	24 NM north-north-west of Locarno
National map of Switzerland	Sheet No. 1251 Val Bedretto, scale 1:25 000

1.12.2 Wreckage

The individual items of debris were subjected to thorough investigation. The manufacturers of the airframe and engine cooperated in this investigation. The following findings are significant with regard to the accident:

- All the fracture surfaces of the flight controls, lift-generating components and propulsion systems exhibited the characteristics of forced fractures.
- The cyclic pitch control, i.e. the stick and the lever for collective pitch control were fitted only on the right side of the cockpit, i.e. on the pilot's side.
- Seat belts were being worn by both occupants at the time of collision with the terrain.
- A heading of approximately 235 degrees was indicated on the directional gyro at the time of collision with the terrain. The moving dial indicator (MDI) of the automatic direction finder (ADF) coupled to this instrument indicated a course of approximately 240 degrees.
- No warning or caution lights on the warning and control panel were illuminated at the time of the accident.
- The engine oil pressure gauge indicated a pressure of 40 psi or more at the time of the accident.

[8] GPS – global positioning system: a satellite-based system which can be used worldwide, with appropriate receivers, for highly accurate positioning, navigation and time measurement.

- When it was located at the site of the accident, the pointer on the indicator for the gas producer rotary speed was at approximately 93% of the nominal speed.
- When the gas producer rotary speed indicator was examined, it was found that the instrument cannot have indicated less than 80% of the nominal speed when impact occurred.
- According to the traces on the torque meter, at the time of impact approximately 18% of the nominal torque was being transferred from the turbine to the rotor transmission.
- The on-board mechanical clock indicated a time of 11:30 LT when it was located at the site of the accident. There were no pointer impact traces on the dial and it was possible to restart the clock by shaking it.

1.13 Medical and pathological information

The pilot's body was subjected to a post-mortem examination which included chemical/toxicological analysis. These clarifications produced no indications of ill health which might have affected the accident. It was also possible to exclude the effects of alcohol, drugs and xenobiotic compounds.

1.14 Fire

A crash fire broke out after the helicopter collided with the rock face. The traces on the debris and on the ground indicate that this fire was only of brief duration.

1.15 Survival aspects

1.15.1 Search and rescue measures

According to the ATC flight plan, helicopter HB-XXN would have needed an estimated flight time of 1:40 hours for the route from Zurich to Bergamo-Orio al Serio (I). Since the aircraft took off from Zurich at 10:36 LT, according to the flight plan it should have arrived in Bergamo-Orio al Serio (I) at about 12:15 LT.

When HB-XXN was more than 30 minutes overdue at its destination, the aerodrome authorities informed the Milan area control centre (ACC) and the latter undertook investigations as to the whereabouts of the aircraft[9]. Both the planned alternate aerodromes and landing sites which were on the envisaged flight path were unable, when asked, to provide any information about the position of HB-XXN. Various air traffic control units and information units tried repeatedly to make radio contact with the missing helicopter. When all these efforts proved unsuccessful, at 14:04 LT Milan ACC declared the alert phase (ALERFA) and among others informed the Zurich and Geneva area control centres of this fact, whereupon the Swiss search and rescue service began its work. Helicopters were immediately made ready in both Italy and Switzerland for a possible search and rescue operation.

When the maximum time specified in the ATC flight plan during which HB-XXN could have remained in the air had expired, the Swiss search and rescue service declared the distress phase (DETRESFA) at 14:56 LT. At 15:50 LT the first search

[9] Among other things, clarifications as part of the so-called uncertainty phase (INCERFA) are initiated when an aircraft is more than 30 minutes overdue without any news.

helicopter took off from Linate (I) and shortly afterwards the first air force helicopters also launched the search for HB-XXN in Switzerland.

Throughout the entire time, the COSPAS[10]/SARSAT[11] satellite tracking system had not received any signals from an emergency transmitter. However, it was established that the pilot's mobile telephone was still working. It was then possible to radio locate this device from an antenna. This enabled the search area to be narrowed and the air force search helicopters were immediately ordered to the area in question, south of Andermatt.

At 18:05 LT the crew of a search helicopter saw the crashed aircraft and shortly afterwards rescue personnel were set down at the site of the accident; however, these were able only to confirm the death of the occupants of HB-XXN.

1.15.2 Causes of injuries

The helicopter crashed at considerable speed into a rock face. Such a collision configuration generates forces which are not survivable.

1.15.3 Emergency transmitter

Helicopter HB-XXN was equipped with an emergency location beacon aircraft (ELBA), type Kannad 406 AF. As was evident after the wreckage was found, the emergency beacon had been triggered during the accident and had subsequently transmitted signals. The antenna was torn off during the crash, as a result of which the signals could only have been received in the immediate vicinity of the transmitter, precluding radiolocation by the COSPAS/SARSAT tracking system.

1.16 Tests and research

1.16.1 Examination of the engine

The Allison 250-C20R/4 twin-shaft engine was badly damaged in the crash and the subsequent fire. However, it was possible to test the operation of the individual components and the units coupled to the engine such as oil and fuel pumps. In particular, the gas producer, the combustion chambers and the power turbine were disassembled and in part subjected to metallographic analysis. From the traces on the compressor blades and the two turbines and from the deformation of the guide vanes and the grooves on the inside of the engine casing it was possible to conclude that the rotating parts of the engine were turning at high speed when the helicopter collided with the terrain.

1.16.2 Examination of the transponder

A transponder was fitted to helicopter HB-XXN. Such a device is able to receive a secondary radar interrogation and respond automatically. Such a response typically consists of a code which has been assigned by an air traffic control unit and which allows the aircraft to be identified. There is also the possibility that such a code has to be set independently by the pilot, characteristically for a specific airspace or as a function of the flying altitude. Furthermore, depending on the unit's setting, the altitude of the aircraft with reference to the standard pressure of 1013 hPa can be transmitted.

[10] COSPAS – *cosmicheskaya sistyema poiska avariynich sudov*: space-based search system for aircraft and vessels in an emergency situation.

[11] SARSAT – search and rescue satellite aided tracking system.

Despite considerable damage, it was possible to check the settings on the transponder on HB-XXN. It was evident that the mode switch of the unit at the time of collision with the terrain was set to "STBY" – standby – corresponding to the warm-up mode. When in this setting, the unit does not respond to secondary radar interrogation.

1.17 Organisational and management information

1.17.1 BB-Heli AG air transport company

The BB-Heli AG air ransport company was founded in 1991 and was engaged in charter traffic and training with several Bell Jet Ranger and Eurocopter EC 120 helicopters. The founder and managing director was also the operations manager, chief pilot and technical manager of the company. Together with other flying instructors, who worked part-time for the company, he trained private and professional pilots, retrained pilots on the helicopter types in use and provided training courses for the acquisition of ratings such as night-time flying or mountain landings.

At the time of the accident, the pilot of HB-XXN was the only permanent employee of the company, apart from the managing director. He primarily worked as director of operations and was occasionally able to make flights for the company if no other pilots were available.

1.17.2 Use of the transponder

With regard to the use of the transponder, at the time of the accident the following principles applied to aircraft flying under visual flight rules (VFR):

*"**VFR transponder mandatory instructions**[12]*

*In **Class E airspace above 7000 ft AMSL** switching of the transponder to **Code 7000, Mode A/C** (with altitude reporting) is **mandatory** for **VFR flights**. (...)"* [bold in the original].

The restriction of using the transponder only at altitudes above 7000 ft AMSL was the result of the insufficient capacity of certain components of Skyguide's secondary radar system. Constant use of the transponder even by aircraft which were flying under visual flight rules could have led to saturation of the radar screens or to the loss of radar echoes. In the course of 2005, these technical limitations were eliminated and subsequently the rules for transponder use by VFR traffic were amended as follows:

*"**VFR transponder mandatory instructions**[13]*

*In **Class E airspace above 7000 ft AMSL** switching of the transponder to **Code 7000, Mode A/C** (with altitude reporting) **or mode S is mandatory for VFR flights and is recommended for lower altitudes and in Class G airspace*** [bold in the original].

1.18 Additional information

None.

1.19 Useful or effective investigation techniques

None.

[12] Cf. VFR Guide RAC 1-4, 2005 edition [translated from German]
[13] Cf. VFR Guide RAC 1-4, 2006 edition [translated from German]

2 Analysis

2.1 Technical aspects

Analysis of the engine instruments and examination of the engine permit the conclusion that the propulsion systems of helicopter HB-XXN were functioning normally at the time of the accident. It was possible to establish that the gas producer rotor was operating at a speed between 80 and 93% of its nominal speed when the collision with the terrain occurred. The rather low torque which was being transferred at this time from the power turbine to the rotor gearbox probably indicates that the helicopter was flying forward with a low power requirement and was not hovering. This conclusion is consistent with the traces on the wreckage and at the site of the accident, which indicate a substantial forward speed of the helicopter at the time of the accident.

There are no indications that there were any technical defects or limitations of the helicopter which might have influenced the accident.

2.2 Operational and human aspects

2.2.1 Pre-flight history

The pilot was employed by the air transport company mainly as the director of operations and was only occasionally deployed as a pilot. The managing director initially tried to find two other pilots also for the flight from Zurich via Bergamo-Orio al Serio (I) to Modena (I) and back on 14 April 2005, because he himself was not available. When he was unable to find other pilots, he finally entrusted this flight to his director of operations. It can be assumed that the pilot, who still had little experience, was motivated by this challenging mission and was pleased to take it on.

Between the time the flight was assigned and the arrival of the passenger, two hours were available, which should have allowed thorough flight preparation, especially as the work to be done was split between the pilot, the operations manager and another company employee. The available weather information permitted the conclusion that the helicopter flight was possible in principle, even though cloud and some reduced visibility could be expected in the area of the Alps. According to the GAFOR route weather forecast, condition D, corresponding to “difficult”, was to be expected for a flight over the Gotthard Pass. In relation to this route, this would have meant a visibility of between 5 and 8 km or a main cloud base above 8700 ft AMSL. For an experienced helicopter pilot such weather conditions do not represent any substantial limitation and they can also be contended with in a fixed-wing aircraft, given knowledge of the terrain.

According to the AFM, helicopter HB-XXN had a tank with a usable capacity of 344.4 l. The fact that according to the refuelling receipt the helicopter was filled with 345 l of kerosene indicates that the tank was empty at this time. This contradicts the information from the pilot on the last flight report before the accident, according to which a residual quantity of 18 USG (68 l) was present. This contradiction cannot be conclusively explained.

2.2.2 History of the flight

Even though only fragmentary information is available for the course of the flight between the base of Lake Zurich and the site of the accident, it can be assumed on the basis of the general weather conditions that the flight progressed without any problems as far as the Andermatt region.

As the observation by the snow blower driver on the north side of the Gotthard Pass proves, between 11:00 LT and 11:30 LT the aircraft was flying at low altitude from the Gotthard Pass in the direction of Hospental. At this time, this eye witness was still able to make out the high-voltage power line on the western side of the slope, indicating that the cloud base was at approximately 2000 m AMSL. From the eye witness's position, the Gotthard Pass appeared to be covered in cloud. The flight of HB-XXN down the valley towards Hospental can only be explained by the fact that the pilot had tried to cross the Gotthard Pass but had had to abort this attempt because of unfavourable weather conditions.

No more is known about the further progress of the flight. The pilot may possibly have reached the area directly north of the Gotthard Pass again via a pass further to the east or he was flying a little later from Hospental in the direction of the pass once again. The decision to make a second attempt to fly over the Gotthard Pass and not return to Zurich is probably attributable to the fact that the pilot wanted to complete the important mission and get the passenger to Italy.

On a heading of approximately 240°, HB-XXN finally collided with a rock face, running from north to south, of the Pizzo della Valletta. The impact angle of approximately 60° indicates that the aircraft was not flying parallel to the rock face when the collision did occur. The technical investigations indicate that the forward speed at the moment of the collision was considerable. These facts indicate that the collision with the rock face took place suddenly and not at the conclusion of a braking manoeuvre or while the helicopter was hovering. From this it can be concluded that the pilot did not see the obstacle or saw it too late, making loss of visual references probable.

The final direction of flight of HB-XXN, more or less across the valley, indicates that the pilot had lost orientation. In this context it is worthy of note that an ICAO chart of Switzerland using a scale of 1:500 000 was used to make the flight. In view of the low degree of detail, this chart is of limited suitability only for navigation in the mountains. Larger-scale charts, however, do provide the necessary degree of detail for mountain flying. Onboard the helicopter there was a full set of charts of Switzerland, scale 1:100 000, which, however, was not used.

Though the emergency beacon (ELBA) was transmitting, the fact that the antenna was broken made tracking from a satellite or an aircraft impossible. As the transponder was not switched on at an altitude of over 7000 ft AMSL, as it should have been, the flight path in the mountains was not targeted. As was established during the recovery flights by helicopter, an aircraft in the Gotthard Pass region can be tracked reliably if the transponder is switched on. Thus the only remaining possibility for search and rescue was to determine the position of a mobile telephone, which by chance was still functional.

2.3 Meteorological aspects

The weather information from the aviation weather forecast available to the pilot revealed that in the area of the Alps moderate south-westerly winds and, at least on the southern slopes of the Alps, 3-6/8 cloud and a main cloud base of 7000 to 9000 ft AMSL were to be expected. Moreover, increasing cloud was forecast on the southern slopes of the Alps. The GAFOR route weather forecast indicated a visibility of more than 5 km and a main cloud base over 8700 ft AMSL, i.e. some 1700 ft above the Gotthard Pass. According to this, flying over the pass in a helicopter appeared to be possible.

Eye witness reports and webcam images permit the conclusion that on the day of the accident, at least after 09:00 UTC, cloud was lying on the Gotthard Pass and that flying over it under visual flight rules was therefore not possible.

This discrepancy between GAFOR and the actual weather conditions can be explained at least partially by the fact that the cloud cover information in the route weather forecast relates to the expected main cloud base. The latter is defined as the lower limit of the lowest layer of cloud which covers more than half the sky and lies below an altitude of 6000 m. Consequently, cloud of less than 5/8 is not recorded in the GAFOR. In the mountains in particular, such clouds, e.g. in the form of valley cloud, may additionally hamper an aircraft operating under visual flight rules.

The production process for the route forecast applied by MeteoSwiss (cf. section 1.7.4.1) provides for the GAFOR forecast to be compared with current weather developments and amended if necessary. In addition, consistency with other aviation forecasts should be compared. According to the available documentation, neither a comparison with the aviation weather forecast nor an adaptation of the GAFOR to the actual conditions took place. Consequently, the too optimistic forecast for the visual flight route over the Gotthard Pass remained in place. It is conceivable that it induced the pilot to make several attempts to cross the pass, because he expected better conditions or at least hoped that the relatively good weather conditions, as forecast, would prevail.

In summary, it must be stated that for the visual flight route in question there was a forecast which was too optimistic compared with the actual weather situation. From the other weather information the pilot was evidently not able to foresee the possibility of deteriorating weather.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The Bell 206 B helicopter, registration HB-XXN, exhibited no technical defects or restrictions which had an effect on the origin of the accident.
- The helicopter's mass and centre of gravity were within the permitted limits.
- The usable tank capacity of helicopter HB-XXN was 344.4 l according to the AFM.
- The cyclic pitch control, i.e. the stick and the lever for collective pitch control, were fitted only on the right side of the cockpit, i.e. on the pilot's side.
- The transponder of HB-XXN was, with a high degree of probability, being operated in standby mode throughout the flight and did not therefore respond to the secondary radar interrogation.
- The emergency beacon of HB-XXN was triggered by the accident, but could not be located because the antenna had broken off from the device as a result of the impact.

3.1.2 Crew

- The pilot was in possession of the necessary licences.
- There is no indication that the state of health or capabilities of the pilot were in any way impaired during the flight involved in the accident.

3.1.3 Pre-flight history and history of the flight

- The last flight by helicopter HB-XXN before the flight involved in the accident was made on 2 April 2005 by the pilot involved in the accident.
- After the last flight, the pilot entered a remaining fuel quantity of 18 USG on the flight report.
- According to the fuel receipt, HB-XXN was refuelled with 345 l of Jet A-1 kerosene before the flight involved in the accident.
- For preparing and making the flight, the pilot used a 1:500 000 scale ICAO chart of Switzerland.
- Take-off from Zurich airport took place at 10:36 LT.
- The last primary radar echo of HB-XXN was recorded at 10:42:52 LT over the northern end of Lake Zurich.
- There are no indications that the pilot, after leaving the Zurich aerodrome frequency, made contact with other air traffic control or information services.
- Between 11:00 LT and 11:30 LT, the helicopter was observed from the pass road on the Gotthard as it was flying at low altitude from the Gotthard Pass towards Hospental.

- When the aircraft was more than 30 minutes overdue, the search and rescue services' uncertainty phase (INCERFA), and then the alert phase (ALERFA) were declared.
- At 14:56 LT the distress phase (DETRESFA) was declared and the search for the helicopter began both in Italy and in Switzerland.
- At 18:05 LT, a Swiss Air Force search helicopter located the wreckage of HB-XXN.

3.1.4 General conditions

- The pilot primarily worked as director of operations for the company and flew if no other pilots were available.
- At the time of the accident, hazy visibility conditions prevailed at the accident site and the Gotthard Pass was in cloud from the south.
- The GAFOR route weather forecast for route 72 from Goldau over the Gotthard Pass to Biasca for the period from 06:00 to 12:00 UTC on 14 April 2005 was as follows: marginal, difficult, difficult (MDD).

3.2 Causes

The accident is attributable to the fact that the helicopter collided with the terrain because the flight was continued even though adequate visual references were no longer available.

The following factors may have contributed to the origin of the accident:

- the pilot's limited experience of mountain flying under demanding weather conditions
- a too optimistic weather forecast for the visual flight route concerned

Berne, 22 April 2008 Aircraft Accident Investigation Bureau