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Swiss Transportation Safety Investigation Board STSB

Aviation Division

Final Report No. 2233 by the Swiss Transportation Safety Investigation Board (STSB)

concerning the serious incident (near collision)

between the Eurocopter EC 120B helicopter, registration HB-ZBB, operated by BB Heli AG, and

the AgustaWestland AW109SP helicopter, registration HB-ZRY, operated by Schweizerische Luft-Ambulanz AG

on 21 June 2013

3 NM south-west of Mollis Aerodrome (LSMF)/GL

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General information on this report

This report contains the Swiss Transportation Safety Investigation Board's (STSB) conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with Article 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the 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/incident prevention, due consideration shall be given to this circumstance.

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

All information, unless otherwise indicated, relates to the time of the serious incident.

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the serious incident, Central European Summer Time (CEST) applied as local time (LT) in Switzerland. The relation between LT, CEST and UTC is:
LT = CEST = UTC + 2 hours.

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Final Report

Synopsis

Aircraft 1

Owner	BB Heli AG, Gotthelfstrasse 41, 8172 Niederglatt, Switzerland
Operator	BB Heli AG, Gotthelfstrasse 41, 8172 Niederglatt, Switzerland
Manufacturer	Eurocopter, Marignane, France
Aircraft type	EC 120B helicopter
Country of registration	Switzerland
Registration	HB-ZBB
Radio call sign	Hotel bravo zulu bravo bravo
Flight rules	Visual flight rules (VFR)
Type of operation	Training
Departure point	Zurich Airport (LSZH)
Destination point	Vorauen on the western shore of the Klöntalersee lake

Aircraft 2

Owner	Schweizerische Luft-Ambulanz AG, Postfach 1414, 8058 Zurich, Switzerland
Operator	Schweizerische Luft-Ambulanz AG, Postfach 1414, 8058 Zurich, Switzerland
Manufacturer	AgustaWestland, Cascina Costa di Samarate, Italy
Aircraft type	AW109SP helicopter
Country of registration	Switzerland
Registration	HB-ZRY
Radio call sign	Rega romeo yankee
Flight rules	VFR
Type of operation	Training flight (long-line evacuation on cargo hook)
Departure point	Hinter Saggberg
Destination point	Hinter Saggberg

Location	Between Hinter Saggberg and Vorder Saggberg alpine meadows, east of the Klöntalersee lake / GL, Swiss sovereign territory
Date and time	21 June 2013, 08:12 UTC
Airspace	Class G
Closest point of approach between the two aircraft	Approximately 20 m laterally and 10 m vertically
AIRPROX category	ICAO category A (high risk of collision)

Investigation

The serious incident occurred on 21 June 2013 at 08:12 UTC. The notification was received on 26 June 2013 at 09:38 UTC by the former Swiss Accident Investigation Board. After preliminary clarifications, which are typical with this type of serious incidents, the investigation was opened on 27 June 2013.

The present final report is published by the Swiss Transportation Safety Investigation Board (STSB).

Summary

On the morning of 21 June 2013 the crew of the Eurocopter EC 120B helicopter, registration HB-ZBB, which consisted of a pilot and a flight instructor, conducted a training flight. During this training flight, the crew decided to perform a landing in Vorauen, on the western shore of the Klöntalersee lake.

At the same time, the crew of the AgustaWestland AW109SP helicopter, registration HB-ZRY, which consisted of a pilot and a helicopter emergency medical services crew member (HCM), was conducting a training flight with a long-line in the area east of the Klöntalersee lake.

Shortly after the crew of HB-ZRY had taken off from Hinter Saggberg with a sandbag on a long-line of 160 m and crossed the Klöntal valley in a northerly direction in slow forward flight, the FLOICE collision warning device issued a message. The HCM then noticed a helicopter at approximately the same altitude and at approximately the three o’clock position and informed the pilot. The pilot could not see the helicopter and began to slowly reduce forward speed to zero. When the HCM realised that the other helicopter was flying directly towards them, he informed the pilot that the helicopter was on a collision course. The pilot then also noticed the helicopter flying directly towards them from the one or two o’clock position at the same altitude and at an estimated distance of approximately a few hundred metres.

At this time the crew of HB-ZBB was busy with the preparations for landing in Vorauen. The pilot was completing the check for approach when the FLARM collision warning device alert sounded. The crew then noticed another helicopter a short distance away and slightly higher at approximately the eleven o’clock position. Intuitively, the crew initiated an abrupt avoidance manoeuvre to the right while descending slightly at the same time.

The crews estimated that at the time of the crossing the lateral separation was 10 to 30 m and the altitude difference was 5 to 20 m.

Both helicopters then continued their flights, the remainder of which were uneventful.

Causes

The serious incident is attributable to the dangerous convergence of a helicopter A and a helicopter B, which was carrying a suspended load on a long-line; it was able to occur because of a combination of the following factors:

- Late visual detection of helicopter B by the crew of helicopter A.
- Inadequate reception range of the FLARM collision warning device on board helicopter A.

The following factors contributed to the serious incident:

- The choice of a training location that made it necessary for helicopter B to repeatedly cross the valley.
- Limited capacity for airspace monitoring by the pilot of helicopter B due to flying with a suspended load.
- Difficult mutual visual recognition due to a constant bearing.
- Temporary reduced airspace monitoring by the crew of helicopter A due to approach preparations.

The following factor may have facilitated the occurrence of the serious incident:

- Lack of blind transmissions by the crew of helicopter A on the frequency of the nearby Mollis Aerodrome.

The following factors were established as neither causal nor directly contributory but were recognised as risky (factors to risk):

- Lack of warning by the traffic advisory system in helicopter B.
- Choice of a take-off and landing site with restricted visibility for the training flight of helicopter B.

1 Factual information

1.1 Pre-flight history and history of the serious incident

1.1.1 General

The recordings of the radar data, the FLOICE collision warning device on board HB-ZRY, a tablet computer on board HB-ZBB, as well as the statements of crew members and others involved in the HB-ZRY training flight were used for the following description of the pre-flight history and history of the serious incident.

Both flights were conducted according to visual flight rules (VFR).

The serious incident occurred in Class G airspace, in which crews are responsible for maintaining sufficient distance from other aircraft according to the “see and avoid" principle.

1.1.2 Pre-flight history

Flight HB-ZBB was a training flight with a pilot and a flight instructor, with take-off from Zurich Airport. The purpose of the flight was on the one hand to serve as preparation for the check flight to revalidate the type rating (proficiency check) on the EC 120B, and on the other hand to familiarise the pilot, who was working as a part-time professional pilot for the company operating the HB-ZBB helicopter, with one of the aviation operator's sightseeing flights.

The pilot prepared for the flight using an internet-based application. This application allowed him to obtain and print out the usual documents, such as weather reports and weather forecasts, as well as NOTAM[1] and DABS[2]. He studied various webcams together with the flight instructor, with particular emphasis on the Säntis area, which was one of the flight destinations.

The pilot took a tablet computer on board the flight with him. This device could display and record information such as the current GPS position on a map. The pilot was sitting in the front right seat and the flight instructor in the front left seat.

HB-ZBB was equipped with a FLARM collision warning device (cf. Section 1.11.2), which was activated during the flight involved in the incident[3].

Flight HB-ZRY was a training flight by Swiss Air-Rescue (Rega) and took place in the context of a training day to practice the long-line rescue technique. This technique involves suspending a rope of up to 220 m (depending on the location) on the helicopter's cargo hook. This can then be used to transport specially trained mountain rescue personnel directly to steep cliffs in order to provide first aid there. The rescue personnel and rescued person are then evacuated from the cliff in the same manner. The crew on board the helicopter for this rescue technique comprises a pilot sitting in the right-hand pilot seat, and a HCM, who sits in a seat behind the pilot and orientated at 90° to the flight direction and primarily monitors the situation below the helicopter through the open right sliding door. There are also the mountain rescue personnel on the long-line and a marshaller, who monitors and marshals the approaching long-line helicopter at the take-off and landing site for the rescue operation.

[1] NOTAM: Notice to airmen, information to alert aircraft pilots of potential hazards that could affect the safety of the flight

[2] DABS: Daily Airspace Bulletin Switzerland, daily publication with graphical representations of hazards, restrictions and changes in Swiss airspace

[3] Subsequently the expression “FLARM” is used for the FLARM device on board HB-ZBB.

This training day involved several crews, each consisting of a pilot and an HCM, as well as several mountain rescue personnel travelling to Hinter Saggberg, a large alpine meadow east of the Klöntalersee lake on the south side of the Klöntal valley at approximately 1050 m AMSL (cf. Figure 1). From there the training flights should be conducted on HB-ZRY which has been brought from Mollis Aerodrome (LSMF) to Hinter Saggberg for this purpose. The drop-off point for the rescue personnel was on a rock face at the Unter Stafel on the north side of the Klöntal valley.

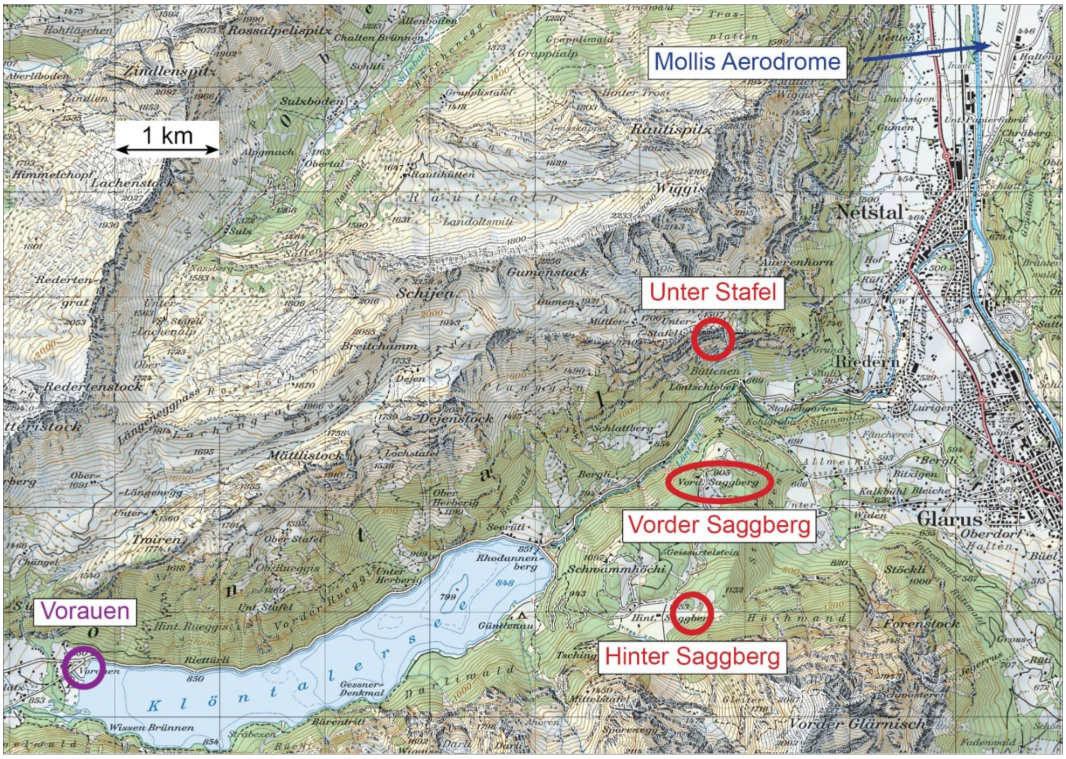

Figure 1: The take-off and landing site for HB-ZRY at Hinter Saggberg as well as the drop-off point on the Unter Stafel are circled in red. The Vorder Saggberg is between these two. The planned landing site for HB-ZBB at Vorauen on the western shore of the Klöntalersee lake is circled in purple. To the east is the Glarner Haupttal valley and Mollis Aerodrome (blue arrow).

In the morning, the pilot of HB-ZRY on the flight involved in the incident had studied the current weather and forecasts, the wind conditions, the NOTAM and the DABS. Before the start of training flights there was a briefing with all those involved.

Before the flight involved in the serious incident, two crews, including the HCM involved in the serious incident, had already completed a full training block. Each training block involved a first flight with a sandbag on the long-line before several flights with personnel on the long-line.

The serious incident occurred on the first flight of the third training block and was also the pilot's first flight on this day. Attached to the long-line (total length 160 m) was a sandbag (cf. Figure 2). There were at this time several personnel at the take-off and landing site at Hinter Saggberg. There were no rescue personnel on the cliff face. All personnel involved were equipped with radios. Communication took place on the R-channel[4] .

[4] R-channel: Internal Rega radio channel

HB-ZRY was equipped with a FLOICE collision warning device, which is based on FLARM technology (cf. Section 1.11.2)[5]. It was also equipped with a traffic advisory system (TAS) (cf. Section 1.11.3). Both systems were activated during the flight involved in the incident.

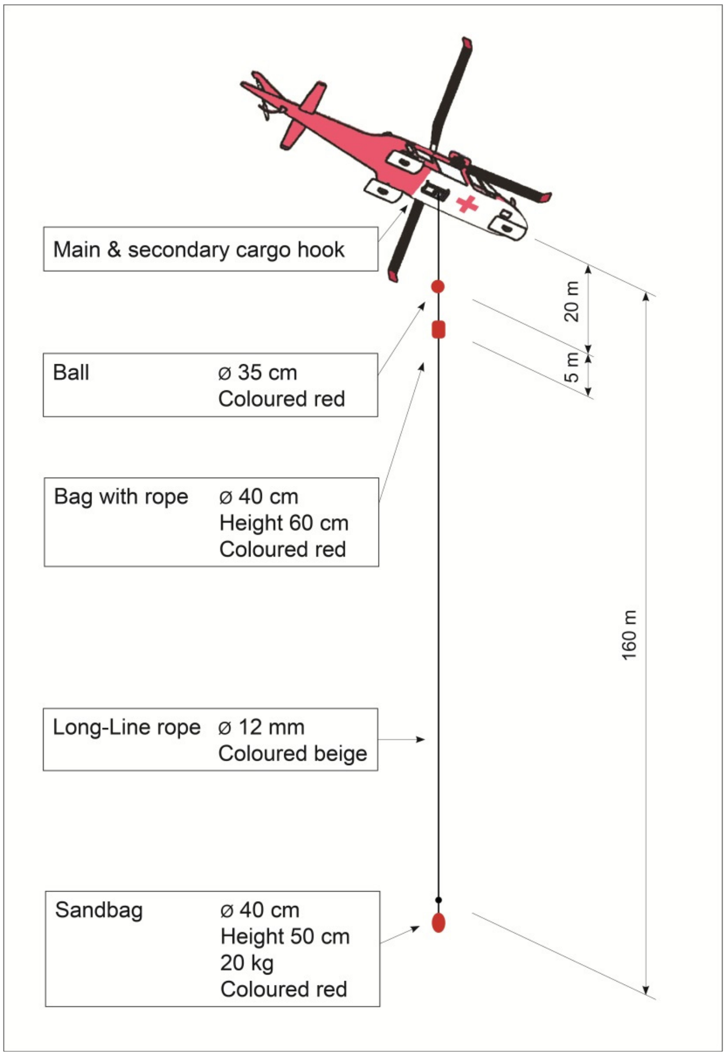

Figure 2: Schematic representation of the long-line suspension gear of HB-ZRY during the flight involved in the incident as specified by Rega.

1.1.3 History of the serious incident

On 21 June 2013 at approximately 07:15 UTC, the crew of the EC 120B helicopter, registration HB-ZBB, took off from Zurich Airport. The flight progressed via the VFR route Echo to the area north of Winterthur, then to the Rheinfall and then to the Säntis area. There, the crew decided to extend the flight somewhat and conduct a landing at Vorauen on the western shore of the Klöntalersee lake (cf. Figure 1). On the one hand, the landing was intended to serve as training for the pilot; on the other hand, the flight instructor wanted to let the pilot take a break and conduct an interim discussion.

HB-ZBB approached Mollis Aerodrome, which it passed to the east at an altitude of approximately 5000 ft QNH (1524 m), via Toggenburg and Amden. At approximately 08:11 UTC the crew turned right onto a heading of 230 - 240 degrees in

[5] Subsequently the expression “FLOICE” is used for the FLOICE device on board HB-ZRY.

order to fly into the Klöntal valley and began a slight descent (cf. Figure 3). The groundspeed during this phase was 120 - 130 kt.

At approximately 08:09 UTC, when HB-ZBB was still approximately 5 km north-north-east of Mollis Aerodrome, slightly south of the Walensee lake, the crew of the AW109SP helicopter, registration HB-ZRY, took off from Hinter Saggberg on the first flight of the planned training block. After a vertical climb to tension the long-line and lift the sandbag off the ground, the helicopter slowly began to increase its forward speed and flew on an approximately northerly heading towards the planned drop-off point (cf. Figure 3). According to the recording of the FLOICE, the vertical climb ended at 08:10:55 UTC at an altitude of approximately 1300 m AMSL. During the subsequent minute, HB-ZRY climbed a further 100 m in slow forward flight (cf. Annex 1).

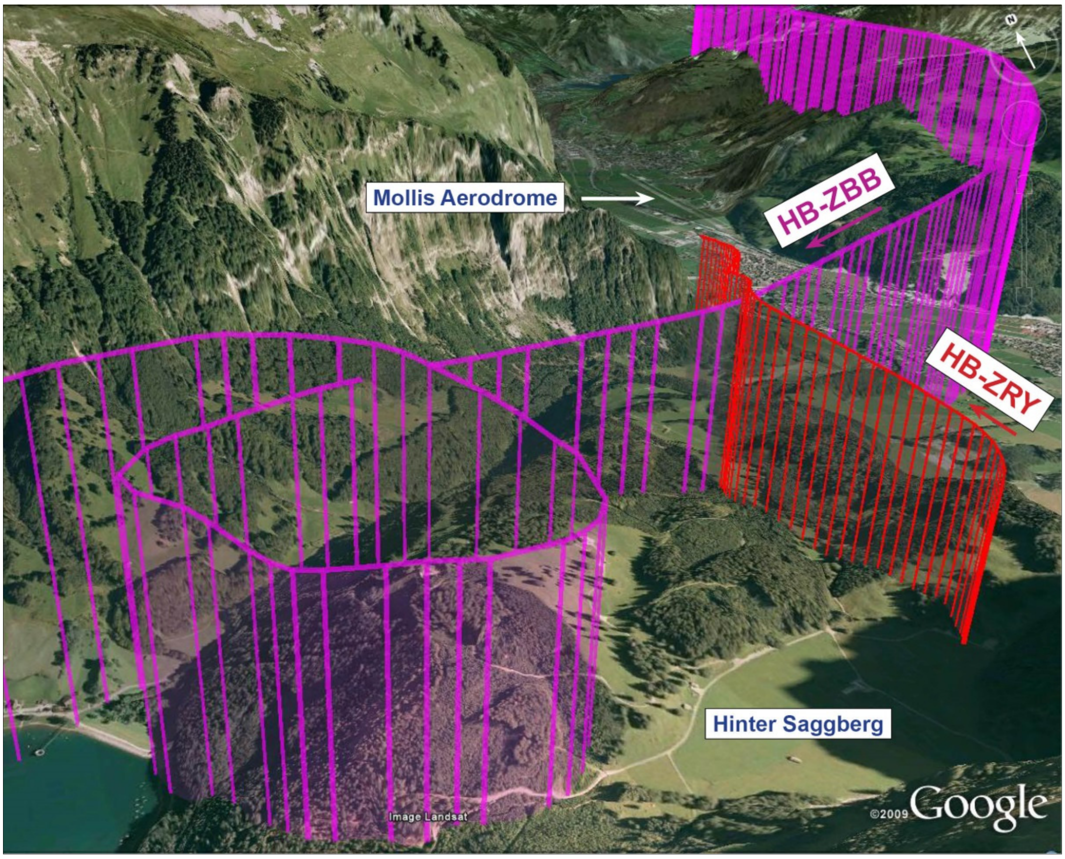

Figure 3: The history of flight HB-ZRY according to the recording of the FLOICE is displayed in red; the history of flight HB-ZBB according to the recording of the tablet computer on board HB-ZBB is displayed in purple (on Google Earth). The altitudes displayed are uncorrected GPS altitudes, i.e. the altitudes are approximately 48 m above the respective altitudes above sea level. Cf. Annex 1 for temporal relations.

Approximately 30 seconds after the vertical climb ended, the FLOICE issued a message. According to the recollection of the pilot, the message was *"Glider, three o'clock, two five"*, although he was no longer certain of the distance *("two five"* (2500 m)). According to the recollection of the HCM, who was able to hear all FLOICE messages via the on-board communication system (intercom), the message was *"Glider, two o'clock, higher"*, although he was no longer certain of the direction specified *("two o'clock")*. He no longer knew the distance.

According to the recording of the FLOICE, at 08:11:23 UTC, HB-ZBB was approximately at the two o'clock position to HB-ZRY at a distance of approximately 2200 m and approximately 50 m higher (cf. Annex 1).

Due to the prevailing weather conditions, the pilot of HB-ZRY considered a *"glider"* to be "*no factor"*. However, the HCM, who was looking approximately towards the three o'clock position through the open right sliding door of HB-ZRY, was able to identify a helicopter at approximately the same altitude and an estimated distance of 1 to 2 km. According to his estimation, the helicopter was at this time flying approximately parallel to HB-ZRY. The HCM reported this observation to the pilot, who replied that according to the FLOICE it was a "*glider"*.

Shortly afterwards the HCM saw the helicopter flying directly towards them. He reported this to the pilot, who then slowly began to reduce forward speed to zero. He also scanned the relevant sector, but could not see the helicopter.

According to the recording of the FLOICE, HB-ZRY attained a maximum groundspeed of 38 kt at 08:11:42 UTC. During the subsequent 15 seconds the speed was reduced to practically zero. At 08:11:47 UTC, the helicopter made a slight right turn from an approximately northerly heading onto a heading of approximately 030 degrees (cf. Annex 1).

The HCM, who had constant visual contact with the helicopter, reported to the pilot that the helicopter was on a collision course, at the same altitude and at approximately their one or two o'clock position. Then the pilot also saw the helicopter flying directly towards them. The distance was estimated at a few hundred metres.

The crew of HB-ZBB was busy with the preparations for the approach to Vorauen. They were discussing the fact that the landing site is often approached by helicopters and were therefore focussing on airspace surveillance on their approach and departure routes, i.e. in the direction of the Klöntalersee lake. The crew did not see any other traffic. The instructor told the pilot that the landing site was not yet visible and invited him to perform the check for approach.

The pilot began the check for approach and commented on this at the same time. According to the statement of the pilot, there was one point at which the flight instructor did not agree with his chosen sequence of the points to be checked and corrected him by showing him the correct sequence on the instrument panel. At this moment, the aural and visual alert of the FLARM was activated. The flight instructor stated that he had looked outside in the direction of the intended flight path while the pilot was working through the check for approach.

The pilot, who was not familiar with the FLARM device and interpretation of the advices, immediately looked outside and saw at approximately the eleven o'clock position a long-line and, a short distance above it, another helicopter from below in side profile. The pilot was not able to make any statement about the exact distances, but the other helicopter was directly in his line of vision.

After the FLARM alert sounded, the flight instructor identified the distance on the FLARM display as 0.1 km. To the left in front of him at approximately the eleven o'clock position and a little higher, he then saw a Rega helicopter from below in side profile. He estimated the lateral separation to be 20 to 30 m and the altitude difference to be 10 to 20 m. It was only then that he saw that the helicopter had a long-line attached. He identified "a little red flag" at approximately the same altitude.

Intuitively, the crew initiated an abrupt avoidance manoeuvre to the right while descending slightly. However, the instructor still thought that there would soon be a collision with the line. According to the estimation of the pilot, the entire sequence from the FLARM alert to the evasive manoeuvre took place within fractions of a second.

The crew of HB-ZRY observed HB-ZBB first approach directly towards them at the same altitude from the one or two o'clock position and then initiate a pronounced avoidance manoeuvre to the right while descending slightly. According to the estimation of the crew, the two aircraft crossed approximately two seconds after the pilot of HB-ZRY had made visual contact with HB-ZBB and at a lateral separation of 10 to 20 m and an altitude difference of approximately 5 m. At this time, HB-ZRY was almost hovering.

According to the recording of the FLOICE, the two helicopters crossed at an altitude of approximately 1400 m AMSL at approximately 08:11:54 UTC (cf. Annex 1). The distance registered at this time was approximately 40 m horizontally and 20 m vertically. The fact that the recording has only discrete time steps and is subject to a certain amount of data inaccuracy mean that the real minimum distances may have been slightly lower or slightly higher.

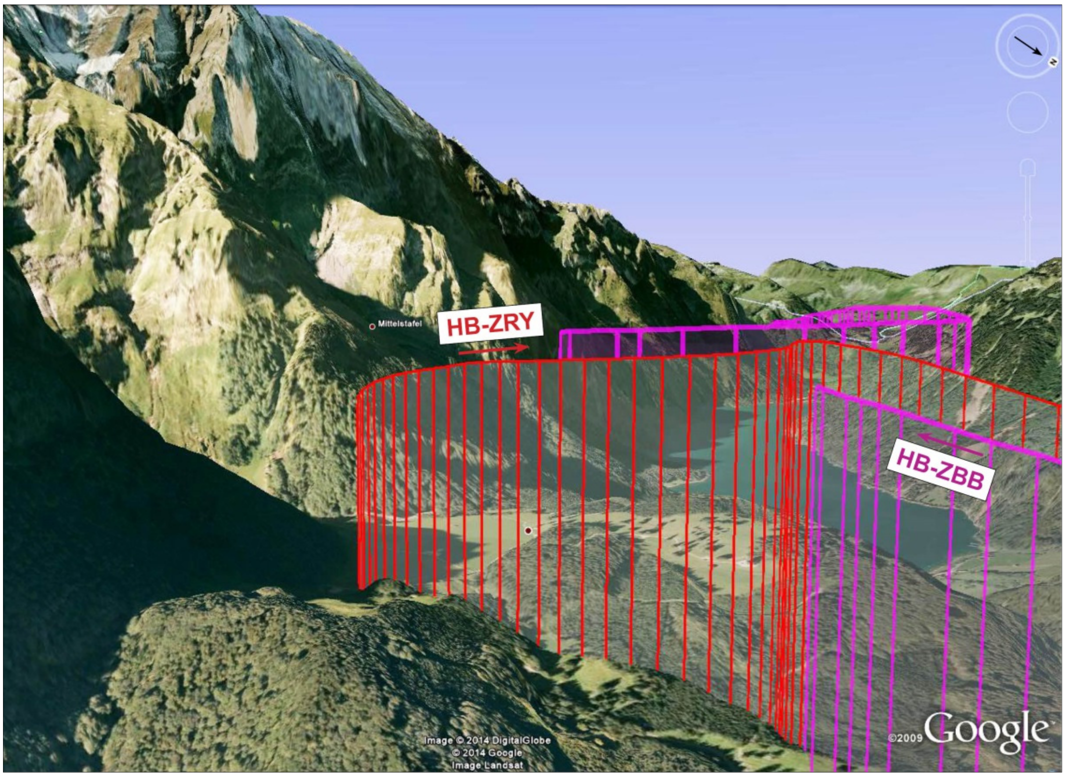

Figure 4: Representation of the crossing on Google Earth (cf. Figure 3, with different perspective).

As the crew of HB-ZBB was not sure if they might have collided with the long-line, they initiated a 360° turn to the left in order to monitor the situation directly after the incident (cf. Figure 3). They were able to see HB-ZRY continuing its flight. HB-ZBB then landed as planned in Vorauen. The instructor then called the Head of Operations of Swiss Air-Rescue.

After the incident, the pilot of HB-ZRY unsuccessfully attempted to contact the crew of HB-ZBB on the FM radio channels[6] Heli 1 and Heli 2, as well as on the Mollis Aerodrome frequency. The flight then continued as planned. A short time later, the Rega Operations Centre provided information via radio that the crew of HB-ZBB had reported and requested a callback. After the flight, the pilot of HB-ZRY called the flight instructor of HB-ZBB and the incident was debriefed.

[6] FM radio: Radio for communication between the crew on board the helicopter and persons on the ground or on the long-line

The same day, the flight instructor of HB-ZBB wrote an occurrence report and submitted it to the Federal Office of Civil Aviation (FOCA). The following day, the pilot of HB-ZRY wrote an internal air safety report (ASR).

1.1.4 Location and time of the serious incident

Position	Between Hinter Saggberg and Vorder Saggberg alpine meadows, east of the Klöntalersee lake / GL
Date and time	21 June 2013, 08:12 UTC
Lighting conditions	Daylight
Altitude	Approx. 1400 m AMSL

1.2 Personnel information

1.2.1 Crew of HB-ZBB

1.2.1.1 Pilot

1.2.1.1.1 General

Person	Swiss citizen, born 1969
Licence	Commercial pilot licence helicopter (CPL(H)) in accordance with the European Aviation Safety Agency standard (EASA)

All available evidence suggests that the pilot started the flight well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.2.1.1.2 Flying experience

Total	440 hours
of which on the type involved in the incident	28 hours
during the last 90 days	11 hours
of which on the type involved in the incident	2 hours

1.2.1.2 Flight instructor

1.2.1.2.1 General

Person	Swiss citizen, born 1943
Licence	CPL(H) according to the EASA standard

All available evidence suggests that the flight instructor started his duty wellrested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.2.1.2.2 Flying experience

Total	13,020 hours
of which on the type involved in the incident	4500 hours
during the last 90 days	98 hours
of which on the type involved in the incident	62 hours

1.2.2 Crew of HB-ZRY

1.2.2.1 Pilot

1.2.2.1.1 General

Person	Swiss citizen, born 1967
Licence	CPL(H) according to the EASA standard

All available evidence suggests that the pilot started his duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.2.2.1.2 Flying experience

Total	5574 hours
of which on the type involved in the incident	955 hours
during the last 90 days	38 hours
of which on the type involved in the incident	30 hours
Number of rotations with the long-line in the context of the operation "long-line evacuation on cargo hook"	32
during the last 90 days	5

1.2.2.2 HCM

1.2.2.2.1 General

Person	Swiss citizen, born 1978

All available evidence suggests that the HCM started his duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.2.2.2.2 Flying experience as HCM

Total	547 hours
of which on the type involved in the incident	547 hours
during the last 90 days	38 hours
of which on the type involved in the incident	38 hours

Number of rotations with the long-line in the context of the operation "long-line evacuation on cargo hook"	70
during the last 90 days	10

1.3 Aircraft information

1.3.1 HB-ZBB

Aircraft type	EC 120B helicopter
Characteristics	Single-engine, five-seater multi-purpose helicopter with encapsulated tail rotor and landing skids
Manufacturer	Eurocopter, Marignane, France
Owner	BB Heli AG, Gotthelfstrasse 41, 8172 Niederglatt, Switzerland
Operator	BB Heli AG, Gotthelfstrasse 41, 8172 Niederglatt, Switzerland
Relevant equipment	2 VHF radios, 1 FM radio Mode S transponder FLARM collision warning device

1.3.2 HB-ZRY

Aircraft type	AW109SP helicopter
Characteristics	Twin-engine rescue helicopter with conventional tail rotor and fixed landing gear in nosewheel configuration
Manufacturer	AgustaWestland, Cascina Costa di Samarate, Italy
Owner	Schweizerische Luft-Ambulanz AG, Postfach 1414, 8058 Zurich, Switzerland
Operator	Schweizerische Luft-Ambulanz AG, Postfach 1414, 8058 Zurich, Switzerland
Special equipment	Main cargo hook and secondary cargo hook with long-line suspension gear (total length 160 m), with a sandbag attached (cf. Figure 2) Electrically adjustable mirror
Relevant equipment	2 VHF radios, 2 FM radios Mode S transponder Traffic advisory system (TAS) FLOICE collision warning device

1.4 Meteorological information

1.4.1 General meteorological situation

Switzerland was at the rear of an undulating cold front that extended from Algeria via the Eastern Alps to the southern Baltic Sea.

1.4.2 Weather at the time of the serious incident

As a result of the inflowing maritime polar air, a ridge of high pressure extended from France to southern Germany. Along the north side of the Alps, humid air remained below 3000 m AMSL.

Cloud	5/8 to 7/8 stratocumulus at approximately 5800 ft AMSL 1/8 to 2/8 cumulus on hillsides from 4100 to 5100 ft AMSL
Visibility	10 km or more
Wind	still
Temperature/dewpoint	13°C / 9°C
Atmospheric pressure QNH	1018 hPa
Hazards	None

1.4.3 Astronomical information

Position of the sun	Azimuth: 106°	Elevation: 46°
Lighting conditions	Daylight	

1.4.4 Weather according to eye witness reports

Both crews described the weather conditions at the time of the serious incident as good. Apart from individual patches of fog along the cliffs at the edge of the valley there was no cloud up to the altitude at which the two aircraft crossed. Above this there was a layer of cloud. Both crews referred to the visibility below this cloud layer as very good.

1.4.5 Webcam image

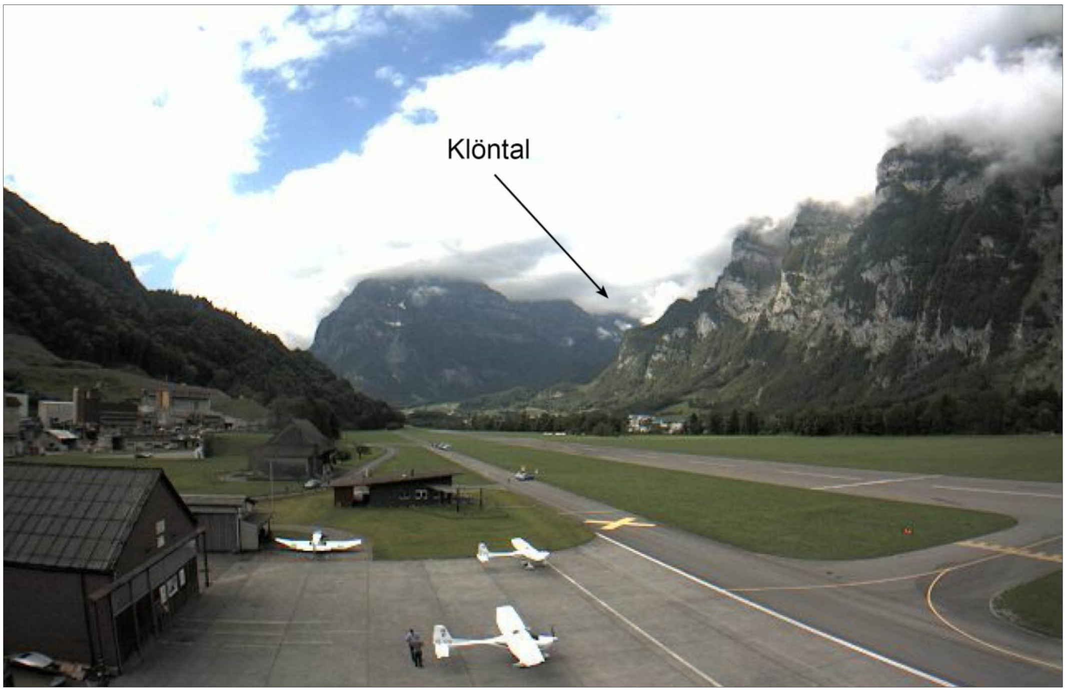

Figure 5: Mollis Aerodrome, 21 June 2013, 08:18 UTC, looking south-west (Klöntal valley).

1.5 Aids to navigation

Not applicable.

1.6 Communications

1.6.1 HB-ZBB

Communication between the pilot and the flight instructor took place via the intercom. Both were wearing headsets.

The crew could no longer reconstruct with certainty the various radio settings selected during the serious incident. The crew was certain that of the two VHF radios only one was selected for listening and speaking on the audio panel[7] and that the FM radio was not turned on.

The frequency selected on the activated and operational VHF radio was probably the mountain frequency (130.35 MHz). The crew was of the opinion that they had not selected the Mollis Aerodrome frequency.

The crew had made no blind transmissions on the radio before the serious incident.

1.6.2 HB-ZRY

Communication between the pilot and the HCM took place via the intercom. Both were wearing helmets with integrated headsets. According to the statement of the crew, communication was unproblematic in spite of the open right sliding door.

Communication between the crew and both the rescue personnel on the long-line and the personnel at Hinter Saggberg and on the rock face was on the R-channel.

The pilot described the various radio settings selected during the serious incident as follows: On VHF radio 1 the Mollis Aerodrome frequency was selected, while on VHF radio 2 it is likely that the Rega company frequency was selected. On FM radio 1 the R-channel was selected, while on FM radio 2 the channel Heli 1 was selected. All devices were selected for listening on the audio panel. The active channel for speaking was the R-channel.

The HCM, who had his own audio panel at his seat, had selected only FM radio 1 with the R-channel. All other devices were not selected.

There was constant mutual communication on the R-channel. The crew made no blind transmissions during the training flights from Hinter Saggberg.

1.7 Airspace information

The serious incident occurred at approximately 1400 m AMSL (approximately 400 m above ground level (AGL)). In the area of the serious incident, the airspace up to a height of 2000 ft (600 m) above ground level is classed as Class G airspace.

Flying in this uncontrolled airspace is permitted without contact with air traffic control. The responsibility lies with the crews to maintain a sufficient distance from other aircraft on the "see and avoid" principle.

[7] Audio panel: Operating unit, on which the radio channels can be selected for listening or speaking

According to Swiss legislation (*Verordnung des UVEK über die Verkehrsregeln für Luftfahrzeuge (VVR)*), the minima for visual meteorological conditions (VMC) for Class G airspace are defined as follows:

- Visibility 5 km**
- Clear of cloud and with the ground or water permanently in sight

** - If at any time airspeeds allow a 180˚ turn within visibility distance and other aircraft or obstacles can be detected in good time, flight visibility may be up to 1.5 km.
- Helicopters can fly with visibility less than 1.5 km, if they fly at an airspeed that allows them to detect other aircraft or obstacles in time to avoid collisions.

1.8 Flight recorders

1.8.1 HB-ZBB

HB-ZBB was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR). These were not prescribed.

The recording of the flight involved in the incident saved by the FLARM was not available for the investigation (cf. Section 1.11.2.2).

However, the recording of the flight involved in the incident saved by the FLOICE also contained certain information regarding the flight path of HB-ZBB (cf. Section 1.11.2.3).

The pilot of HB-ZBB had a tablet computer on board for the duration of the flight involved in the incident. This computer created a GPS recording of the flight path.

Furthermore, radar data excerpts are available for the flight of HB-ZBB. This data could not be used for the investigation of the actual event since the two helicopters were outside radar coverage at that time (cf. Section 1.11.1).

All available data regarding the flight path of HB-ZBB indicate good agreement in the areas where they overlap.

1.8.2 HB-ZRY

HB-ZRY was not equipped with a FDR or a CVR. These were not prescribed.

The built-in electronic flight instrument system (EFIS) on board HB-ZRY records various flight parameters, but at the time it was evaluated, it no longer contained any data regarding the flight involved in the incident. Only the last five flights were stored.

The evaluation of the FLOICE provided a GPS recording of the entire flight path of HB-ZRY as well as excerpts from the flight path of HB-ZBB (cf. Section 1.11.2.3).

1.9 Tests and research

1.9.1 Test flights

1.9.1.1 General

Test flights were conducted with both an AW109SP, which was equipped with the same TAS as HB-ZRY plus a FLOICE, and a second helicopter, which was equipped with a Mode S transponder and a PowerFLARM[8].

[8] PowerFLARM: Collision warning device, which contains a FLARM

The flights took place both in the area of the serious incident, where the approximate flight paths of HB-ZRY and HB-ZBB in particular were recreated, and over level terrain.

The flights primarily served to perform clarifications into the operation and functioning of the TAS. At the same time, the functioning of the FLARM/FLOICE collision avoidance systems were reviewed and findings made with regards to visual recognition.

1.9.1.2 Visual recognition

The AW109SP used for the test flights had similar colours as HB-ZRY, had all the external lights in operation as was the case on HB-ZRY during the flight involved in the incident (cf. Section 1.11.4) and had installed high visibility main rotor blades as was the case on HB-ZRY. Even though the position of the AW109SP was known it was difficult to detect from the helicopter recreating the flight path of HB-ZBB.

1.9.1.3 FLARM/FLOICE

In the context of the tests, both the FLOICE and the PowerFLARM operated correctly and as intended. The direction indicated by the FLOICE on board AW109SP was sometimes erratic, but this was due to the low or non-existent forward speed during the test flights.

1.9.1.4 Traffic advisory system

1.9.1.4.1 Findings

In the context of the test flights the following findings were made with respect to the TAS:

- At heights below 400 ft AGL according to the radio-altimeter, the TAS indicated the other helicopter on the displays but did not generate aural alerts.
- At heights above 400 ft AGL according to the radioaltimeter, the TAS operated as intended in the majority of cases (display and aural alert upon convergence).
- The aural alert occurred only once, i.e. it was not repeated later.
- It was not possible to determine any dependence of the functioning of the TAS on speed, i.e. the device in principle also worked when hovering and at low forward speeds.
- In situations in which the other helicopter approached from the right or from the rear right there were cases in which this helicopter was not displayed and no aural alert was generated, or the aural alert (and hence also the display) occurred very late, sometimes only after the two aircraft had crossed. In this respect it was found that the functioning of the TAS had a certain directional dependence.

1.9.1.4.2 Manufacturer's information

The manufacturer of the helicopter and the manufacturer of the TAS were informed of the serious incident and the findings described in the previous section.

The manufacturer of the helicopter stated that cases were known in which the direction indicator (azimuth) of the TAS was not displayed correctly. However, the manufacturer stated that there were no known cases in which the TAS does not provide any display or alert at all. That manufacturer also stated in particular that specific tests and test flights are carried out on the TAS to verify the correct functioning of the device before each new aircraft is delivered. They claim it would also be possible to conduct such a test flight programme at a later date to inspect the device.

The programme described is similar to the manoeuvres that were conducted in the context of the test flights.

The manufacturer of the TAS stated that no cases of the described behaviour are known in either the AW109SP or other types, but that there may be various aspects connected to the installation that might cause such behaviour, including, for example, the wiring or the placement of the antennas. The manufacturer stated that unfavourable placement of the antennas could lead to shadowing by the cell or protruding parts of the cell.

The manufacturer of the TAS also made the following comments: *"Since the issue was observed on two separate, but similar, helicopters, it can reasonably be concluded that it is not the result of a defect in either of the TAS units. There is no known system failure mode that would cause exactly the described behavior in a systematic way involving more than one unit."*

The two manufacturers contacted each other to conduct further investigations.

1.10 Organisational and management information

1.10.1 BB Heli

1.10.1.1 General

BB Heli AG, which is based at Zurich Airport, was founded in 1991. It primarily offers sightseeing and taxi flights and operates its own flight school. The helicopters can also be chartered.

At the time of the serious incident, the company operated two Eurocopter EC 120B type helicopters and an Agusta-Bell 206B type helicopter.

The flight instructor involved in the serious incident was also the owner and managing director of the company.

1.10.1.2 Operational guidelines

The aviation operator’s operational guidelines are defined in the flight operation manual (FOM) for commercial flights and in the training manual (TM) for training flights.

Since the present flight of HB-ZBB was neither a commercial flight nor a training flight of educational character neither the operational guidelines in the FOM nor the ones in the TM did apply. Therefore, no special operational guidelines did apply for the present flight.

1.10.2 Swiss Air-Rescue

1.10.2.1 General

Swiss Air-Rescue (Rega) is a charitable foundation established in 1952. It aims to help persons in need in accordance with the principles of the Red Cross. To this effect it has a fleet of helicopters and air ambulance jets and provides a permanent emergency service.

At the time of the serious incident, Rega operated twelve helicopter bases across Switzerland, including one at Mollis Aerodrome. The head office is located at Zurich Airport.

The standard crew for a rescue helicopter consists of a pilot, a helicopter emergency medical services crew member (HCM) and a doctor.

Schweizerische Luft-Ambulanz AG is the aviation operator for Rega aircraft. At the time of the serious incident it operated eleven AgustaWestland AW109SP type helicopters, six Eurocopter EC 145 type helicopters and three ambulance jets.

1.10.2.2 Operational guidelines

1.10.2.2.1 General

The aviation operator operates both the AgustaWestland AW109SP and Eurocopter EC 145 helicopter types in accordance with the flight operation manual (FOM). At the time of the incident, Addendum No. 98 of 6 March 2013 was valid. The relevant passages for the present case are described in the following sections.

1.10.2.2.2 Airspace monitoring

Section 5.9 *"Crew coordination concept", "General Rules"* stipulates the following:

"Airspace and obstacle observation is part of aviation safety and is an important task for every crew member. The sectors are usually divided as follows:

PIC	*10 – 4 o'clock*
HCM/COPI (co-pilot seat)	*8 – 2 o'clock*
Doctor cabin right	*1 – 5 o'clock*

[…]"

The following is stipulated under *"Crew"*, *"Tasks"*:

"[...] *All crew members, regardless of task assignments, are required to monitor the airspace and helicopter systems insofar as they are visible and to report any abnormalities to the PIC."*

The following is stipulated under *"Normal procedure"*, *"Climb/Cruise/Descend"*:

"Each crew member shall actively monitor the airspace in his assigned sector."

1.10.2.2.3 FLOICE and traffic advisory system

Section 5.9 *"Crew coordination concept",* Annex *"AW109SP"* includes the standard operating procedures (SOP) in relation to operating the FLOICE and the TAS.

The following is stipulated under *"FLOICE"*:

"When a green FLOICE warning sounds, all communication should be interrupted (silent cockpit) and airspace monitoring intensified by all parties. FLOICE warnings shall only be acknowledged by the crew once the other aircraft has been identified by the flight crew members.

[…]

When the red FLOICE warning and siren sounds, the sector indicated by the device should be monitored and an avoidance manoeuvre initiated, even if the traffic is not visible.

[…]"

The following is stipulated under *"TAS 600":*

"The pilot must react at least verbally to any TAS warning. If this does not occur, the HCM / co-pilot must intervene / ask why.

[...]

When a traffic warning sounds, all communication should be interrupted (silent cockpit) and airspace monitoring intensified by all parties. Traffic is displayed on the PFD [*primary flight display*] *and ND* [*navigation display*]*, which makes identification of traffic much easier for the crew.*

[…]"

1.10.2.2.4 Long-line

Section 21.8 *"SOP for Long-Line Evacuation on Cargo Hook"* describes the standard operating procedures for the long-line rescue technique.

Section 4 *"Crew"* stipulates that for the application of this technique at least one pilot in the right seat, one HCM, one or more rescue personnel on the long-line and one marshaller must be used, all with appropriate training and accreditation. The duties and powers of such personnel are then listed. In relation to airspace monitoring the following passage can be found with the marshaller: *"*[*he shall*] *monitor the landing area and accompanying airspace"*.

Section 5 *"Operational procedures"* firstly describes the normal and then the emergency procedures. This stipulates that a briefing should initially be conducted. The additional task of airspace monitoring is assigned to the doctor, who in an actual emergency situation waits for rescued persons at the take-off and landing site.

1.11 Additional information

1.11.1 Transponder and radar detection

1.11.1.1 HB-ZBB

The transponder was in altitude transmission mode and the code was set to 7000 throughout the flight.

The radar recordings indicate the path of HB-ZBB up to 08:11:30 UTC, when the helicopter entered the Klöntal valley at an altitude of 4800 ft QNH in a slight descent. HB-ZBB then disappeared from the radar. This can be attributed to the lack of radar coverage at low altitudes in this mountainous terrain.

1.11.1.2 HB-ZRY

According to the statement of the pilot, the transponder was in altitude transmission mode and the set code throughout the flight was either 7000 or 7100.

During the relevant period HB-ZRY was not covered by the radar – this is attributable to the lack of radar coverage.

1.11.2 FLARM/FLOICE collision warning devices

1.11.2.1 Operation

Collision warning devices, which rely on FLARM technology, warn both of other aircraft that are also equipped with the appropriate equipment and air navigation obstacles, which are stored in a database, if there is a risk of collision.

To do this the devices use the position and velocity vectors of the aircraft on which they are installed using GPS and continuously extrapolate the flight path by using an algorithm for a certain amount of time in the future. The algorithm takes into account the current state of motion of the aircraft and generally also the configuration of the device. The configuration includes the aircraft type, which can be selected from a predefined list and saved. The following options are available (amongst others):

1 = glider	5 = drop plane
2 = tow plane	6 = fixed hang-glider
3 = helicopter	7 = soft para-glider
4 = parachute	8 = powered aircraft

The calculated extrapolation of the aircraft's own flight path is continuously broadcast via an antenna, which simultaneously receives all such signals from other aircraft within range. If the device determines, on the basis of the extrapolation of the flight path of the aircraft on which it is installed and one or more received flight extrapolations, that there could be a dangerous convergence in the near future, it issues a warning. The device works analogously for obstacles in the stored database.

The warnings can be designed in different ways depending on the device model and whether a warning is issued regarding another aircraft or obstacle. A common factor is that the time until the calculated point of collision is decisive and not the distance. In this regard there are three warning levels in the case of risk of collision with another aircraft:

Level 1: 13 - 18 seconds before the calculated point of collision

Level 2: 8 - 13 seconds before the calculated point of collision

Level 3: 8 seconds or less before the calculated point of collision

All devices are designed in such a way that the warnings issued are more urgent with increasing warning level.

Additionally, certain devices can provide information about aircraft located in the reception area but not yet within warning level 1 by issuing a traffic information.

The range of the antenna depends primarily on its installation and can vary in different directions as well as from aircraft to aircraft. There are often used interior antennae, whose range in certain directions can be limited due to shadowing. The typical range is approximately 2 km, but it can be up to 5 km in the best cases.

The devices record both the flight path of the aircraft on which they are installed and certain data received from other aircraft during the flight.

1.11.2.2 HB-ZBB

1.11.2.2.1 Device

On board HB-ZBB was an Ediatec ECW100 type FLARM. The 57 mm display was integrated into the lower part of the instrument panel slightly to the right of centre (cf. Figure 6). The unit was equipped with an internal antenna, which was located on the cover of the instrument panel slightly to the right of centre (cf. Figure 7). The aural alerts were fed into the intercom via the audio panel.

Figure 6: Ediatec ECW100 FLARM on the instrument panel of HB-ZBB. The relative position of other aircraft is displayed in the horizontal plane by the circle of LEDs in the middle of the display; in the vertical plane it is displayed by the LEDs on the right edge. The upper digital display gives the horizontal distance in 100 m increments (e.g. 0.1 km).

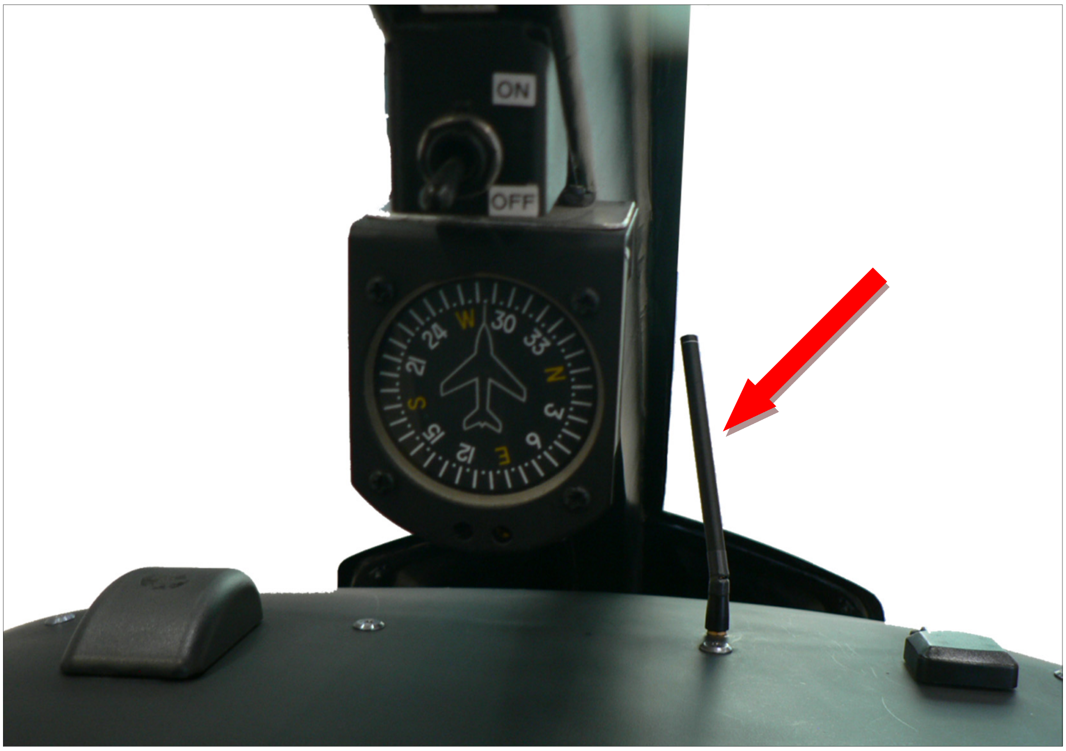

Figure 7: FLARM antenna on the cover of the instrument panel of HB-ZBB.

In "*nearest mode*", which is automatically activated after switching on the device, other aircraft in the vicinity appear, even if they pose no hazard according to the calculation. By default, such traffic information is limited to a radius of 3 km and a vertical separation of 500 m. Only one other aircraft is displayed at one time. Visual representation by means of LEDs (cf. Figure 6) is static, i.e. no flashes, and there is no sound. Once an aircraft closes to less than 1.5 km horizontally and 500 m vertically, two short beeps are triggered.

If, according to its calculation, the device determines a hazard, the following warnings are generated based on the intensity of the hazard, i.e. warning level:

Level 1 (13 - 18 secs):	1 (horizontal) LED flashes slowly (2 Hz)
Level 2 (8 - 13 secs):	2 (horizontal) LEDs flash at medium speed (4 Hz)
Level 3 (under 8 secs):	3 (horizontal) LEDs flash rapidly (6 Hz)

In addition the corresponding LED flashes synchronously to represent the relative position in the vertical plane insofar as this is more than 7° above or below the horizon. There is also an aural warning in the form of a beep. The type of beep is also dependent on the warning level.

1.11.2.2.2 Configuration and software

The device can be configured and the software updated via the memory card on the bottom of the display (cf. Figure 6) or via the serial interface on the rear of the device. The obstacle database can also be loaded and updated in this way.

The analysis after the serious incident revealed that the FLARM on board HB-ZBB was configured as *"glider"*. This is the default setting of the device.

The device was running FLARM Software Version 5.04 from July 2011 with an obstacle database from April 2007.

1.11.2.2.3 Recording

It is possible to download the most recent 20 files of the flight path recording via the memory card whereas all stored data can be downloaded via the serial interface. The duration of a flight is the interval between the detection of take-off to the detection of landing – these events are determined on the basis of forward speed.

When analysis of the flight path recording was performed via the memory card, it was only possible to retrieve data regarding flights that had taken place after the flight involved in the incident. As the result of a mistake, analysis via the serial interface was only performed after the relevant data had already been overwritten.

There is therefore no data from the FLARM regarding the flight involved in the incident.

Of the 20 files backed-up on the memory card, 15 files were created in Vorauen immediately before the return flight took off for Zurich and each contained only one data point. The reason for storing these useless files could not be completely clarified. According to the statement of the company FLARM, there was a bug in software versions prior to Version 5.13 of February 2014. They stated that this bug could in certain circumstances lead to the creation of many files with only one data point in the flight path recording, especially if the device lost GPS reception during the flight.

1.11.2.2.4 Range analysis

An analysis of the reception range of the device can be performed using flight path recording files which contain sufficient interactions with other FLARM devices. The company FLARM provides a corresponding service for all users on its website.

An analysis of the reception range of the FLARM in the horizontal plane, which was conducted using a large number of files, indicated that the range was on average less than 50 m. The best range was at approximately the eleven o'clock position, but here it was only approximately 100 m.

1.11.2.2.5 Investigation of the device

The FLARM device was examined at the manufacturer's laboratory. It was found that the device still had the same transmission power and reception sensitivity as it had upon delivery. When the ECW100 installed on HB-ZBB was compared to the production series from which it came, both the transmission power and reception sensitivity of the device were better than average.

The manufacturer installed the device on a fixed wing aircraft with an external antenna in order to perform test flights. It was possible to obtain significantly better, but not outstanding, results in terms of reception range.

1.11.2.2.6 Investigation of the installation

The installation of the FLARM device and the antennas on HB-ZBB was investigated in cooperation with the manufacturer of the device. It was possible to determine that the positioning of the FLARM antenna (cf. Figure 7) was essentially appropriate and should be able to achieve a good range at least in the forward direction. The FLARM antenna itself was checked and showed parameters in the normal range. Furthermore, it was found that the connecting cable between the device and the FLARM antenna was very long and was therefore wound several times during the installation. This can have a negative influence on transmission and reception efficiency.

During these investigations the flight instructor mentioned that the FLARM antenna was regularly unscrewed and screwed back again in order to put a cloth over the cover of the instrument panel to protect it against solar radiation during the ground time of the helicopter. This procedure holds the risk of damage or excessive wear of the contact points of the antenna. Furthermore the antenna can be forgotten or screwed incorrectly.

After a new FLARM antenna and a shorter connecting cable had been installed, it was possible to obtain indications for a better, but not outstanding, result in terms of reception range. Since there is no possibility to check the reception range of the installed device on ground, it was not possible to verify the correct functioning of the device in a conclusive way in the context of the investigation after these modifications had been made.

1.11.2.2.7 Pilot's experience with FLARM

The pilot stated that he had *"not very much experience with FLARM"*. He stated that he had already experienced occasional alerts, but did not really know how to interpret the display. He stated that he only knew that he must take a good look around in the event of *"beeps and flashes"*.

He expressed the opinion that FLARM training should be improved if such a useful tool was installed and that he himself should practice more.

When the pilot retrained for the EC 120B at BB Heli in 2011, HB-ZBB already had a built-in FLARM. According to the statement of the pilot, the FLARM was only a marginal issue within the context of this retraining.

In the opinion of the pilot, in the present case the FLARM alert immediately before the dangerous convergence had a significant influence on the course of the serious incident.

1.11.2.2.8 Flight instructor's experience with FLARM

In his role as owner and manager of BB Heli AG, the flight instructor had met one of the developers of the FLARM technology a few times when the first FLARM devices came onto the market. According to the statement of the instructor, BB Heli was one of the first helicopter companies to install FLARM. The developer had explained how FLARM and the device work.

HB-ZBB was delivered to BB Heli in 1999. In 2000, one of the first FLARM models was mounted on the cover of the instrument panel of the helicopter. According to the statement of the flight instructor, a newer Ediatec device was installed on the instrument panel of the helicopter when it became available approximately six to seven years ago. According to his statement, the device was installed and configured by a company specialising in avionics.

In the present case, the warning immediately before the dangerous convergence was the first warning issued by the FLARM. The flight instructor had not previously seen anything on the display.

1.11.2.3 HB-ZRY

1.11.2.3.1 Device

HB-ZRY had a built in FLOICE, which features an additional voice module compared to conventional FLARM devices, and which generates all messages and warnings by means of a synthetic voice and feeds them directly into the intercom via the audio panel. A visual indication is also provided.

A Triadis FLOICE 256 device type (cf. Figure 8 and 9) was installed on the instrument panel of HB-ZRY and was equipped with an external antenna above the cockpit.

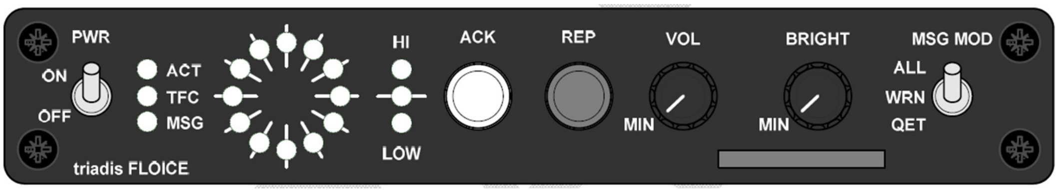

Figure 8: Triadis FLOICE 256 (manufacturer's image). The relative position of other aircraft is displayed in the horizontal plane by the circle of LEDs; in the vertical plane it is displayed by the LEDs to the right.

In message mode *"ALL"* up to four objects in the reception area are reported, even if according to the calculation there is no hazard posed by the objects. Such objects are displayed with green LEDs. In message mode *"WRN"* only those objects are reported that represent a hazard according to the calculation. These objects are displayed with red LEDs. In message mode *"QET"* only system messages are issued.

Reports of aircraft have the following format:

<warning tone> <direction> <altitude> <object type> <distance>

The type of warning tone determines the hazard intensity: There is no warning tone for objects that pose no hazard. For objects that pose a hazard the following warnings are generated, based on the warning level:

Level 1 (13 - 18 secs):	Beep
Level 2 (8 - 13 secs):	Two beeps
Level 3 (under 8 secs):	Siren tone

The direction is issued according to the relative position in the horizontal plane with a clock position, e.g. *"eleven o'clock"*.

The altitude is reported relative to the altitude of the aircraft in which the device is installed in six levels: If it is less than 6° above or below the horizon, the information is omitted. If it is between 6° and 12°, *"higher"* or *"lower"* is reported. If it is more than 12°, *"high"* or *"low" is* reported. If the object is located in a cylinder of 200 m diameter above or below the aircraft in which the device is installed, *"above"* or *"below" is* reported.

The object type corresponds to the type of aircraft received according to the FLARM configuration, e.g. *"glider"* or *"helicopter"*. Unknown object types are reported as *"traffic"*.

Distances are reported in hectometres, e.g. *"four"* corresponds to 400 m. At high approach speeds, distances up to more than 1000 m are reported, e.g. *"one two"* corresponds to 1200 m. Distances less than 50 m are not reported. Distances are rounded.

1.11.2.3.2 Configuration and software

The device can be configured and the software updated via the memory card on the bottom right of the display (cf. Figure 8) or the serial interface on the rear of the device. The obstacle database can also be loaded and updated in this way.

The analysis after the serious incident revealed that the FLOICE on board HB-ZRY was configured as *"helicopter"*.

The device was running FLARM Software Version 5.06 from July 2012 and an obstacle database from June 2013.

1.11.2.3.3 Recording

It is possible to download the most recent 20 files of the flight path recording via the memory card, whereas all stored data can be downloaded via the serial interface.

It was possible to recover the data of the flight involved in the serious incident. It provided the entire flight path of HB-ZRY according to the recording by the FLOICE GPS receiver on board HB-ZRY with a recording interval of two seconds. At irregular intervals it also acquired the flight path recordings of HB-ZBB according to the recording of the FLARM GPS receiver on board HB-ZBB for the time that the FLOICE was able to receive the FLARM on HB-ZBB. This period included the time window from 08:11:10 UTC to 08:12:26 UTC and contained a total of eleven data points for HB-ZBB (cf. Annex 1).

When analysing the files, it was found that some of the training flights performed with HB-ZRY on the day of the incident before the flight involved in the incident were not recorded, or not recorded correctly. It was not possible to completely clarify the cause of the faulty recording of these flights, but according to the statement of the company FLARM the cause may be the same as that of the storing of useless files by the FLARM.

1.11.2.3.4 Range analysis

An analysis of the reception range of the FLOICE in the horizontal plane indicated that the average range was approximately 5 km, with relatively large fluctuations depending on the direction. The minimum value was just under 2 km. The reception range for the two o'clock position was approximately 3 km.

1.11.2.3.5 Satellite positioning

From time to time, the number and exact designation of the satellites received is registered in the flight path recording files.

An analysis of the data recorded by the FLOICE in the period around the time of the incident indicated that between seven and eight satellites were being received. Since a minimum of four received satellites are necessary for the GPS system to function properly, it can be concluded that good coverage was ensured in the area of the serious incident during this period.

The points of the flight path of HB-ZBB that were registered by the FLOICE, which are in agreement with the tablet computer data, mean that it can be assumed the FLARM also had sufficient GPS coverage in the period around the time of the incident.

1.11.2.3.6 Pilot's experience with FLOICE

According to the statement of the pilot, he usually operates the FLOICE in message mode *"ALL"*. This was also the case during the flight involved in the incident. He stated that he only switches to message mode *"WRN"* when there is heavy glider traffic.

According to the statement of the pilot, in the present case, the FLOICE again reported *"glider"* after the first message, but he was no longer consciously aware of it, because the message *"glider"* had irritated him. The pilot was no longer certain whether the FLOICE had provided any further warnings.

1.11.2.3.7 Information regarding FLOICE provided by the HCM

According to the statement of the HCM, in the present case the FLOICE again reported *"glider"* after the first report. In his opinion the direction given was different to the first message. After this the FLOICE issued no further messages.

According to the estimation of the HCM the time between the first FLOICE message and the time the two aircraft crossed was a maximum of one minute.

The HCM was also able to perceive other FLOICE messages on the day of the incident.

1.11.3 Traffic advisory system

1.11.3.1 Operation

A traffic advisory system (TAS) sends signals and receives transponder response signals from other aircraft within range of the system via antennae. The position of the received aircraft in the horizontal plane (azimuth and distance) is plotted in relation to the position of the aircraft on which the device is installed as a symbol on a display screen in the cockpit. This information is obtained using radar time of arrival technique and the directional sensitivity of the antennae. If the transponder on board the detected aircraft is in altitude transmission mode, the device also plots the altitude relative to the altitude of the detecting aircraft with a corresponding numerical value next to the symbol. This information is obtained by comparing the received altitude with the altitude of the detecting aircraft.

Sometimes three-dimensional representations of the relative position are used on display screens in the cockpit.

If, based on the algorithms used, the system determines a dangerous convergence in the near future, it generates an aural and visual alert. The nature of the alert depends on the device model.

In contrast to a traffic alert and collision avoidance system (TCAS II) the TAS does not provide resolution advisories.

1.11.3.2 HB-ZRY

1.11.3.2.1 Device

An Avidyne TAS620 type TAS with one antenna above and one below the cockpit was installed on HB-ZRY. Graphic representation was on the primary flight display (PFD) and the navigation display (ND) (cf. Figure 9). The aural alerts were fed into the intercom via the audio panel.

Figure 9: HB-ZRY instrument panel (Photo: Rega). The PFD and ND are on the right. The FLOICE is to the left above the PFD.

The device displays aircraft at a distance of up to 21 NM horizontally and ±9900 ft vertically. There are three levels of traffic information: traffic advisories (TA), proximate advisories (PA) and other traffic (OT). While OT and PA are only symbolically represented, an additional aural warning is generated in the event of a TA. The aural alert consists of a warning tone and the words *"traffic, traffic"*. At the same time the visual alert *"traffic"* is displayed on the PFD.

According to the manufacturer a TA is defined as follows: *"an advisory indicating the current track of an intruder could result in a near-hit or collision"*. Technically, it is the time until the closest point of approach (CPA) that is primarily used to trigger a TA. It is also triggered when another aircraft is within immediate horizontal and vertical proximity. The TA is triggered if the CPA is less than 30 seconds away or if the lateral separation is less than 0.55 NM and the altitude difference is less than 800 ft.

The aural warning and visual alert are suppressed if the aircraft is below 400 feet AGL according to the radioaltimeter. The aural warning and visual alert are suppressed as well if the other aircraft is below 200 ft AGL. In both cases the graphical representation on the PFD and ND is not affected.

1.11.3.2.2 Recording

TAS data is not recorded. There is therefore no data available for the flight involved in the incident.

1.11.3.2.3 Self-test

The TAS has an internal self-test function that is performed each time the device is turned on and is continuously repeated during operation. If a failure of the system is detected, *"~~traffic~~"* is displayed on the ND in a crossed font.

According to the Rega statement, no checks were conducted on the TAS on board HB-ZRY either before or after the serious incident, as there was no sign of a malfunction. At Rega, the checks described in the aircraft maintenance manual (AMM) are conducted after the installation of the TAS in the helicopter. The AMM does not prescribe periodic checks.

1.11.3.2.4 Pilot's experience with traffic advisory system

The pilot undertook TAS training as part of his retraining for the AW109SP type.

According to the statement of the pilot, the TAS is always turned on by default. This was also the case during the flight involved in the incident. In his opinion, the TAS did not issue an aural alert at any point during the serious incident. Later on the day of the incident he was able to perceive other TAS traffic on the PFD.

He stated that his general experience in the mountains was that the TAS azimuth indication was poor, but that the altitude information was correct. He stated that the TAS essentially functioned well in his experience.

According to the statement of the pilot, it was not known whether the TAS on board HB-ZRY functioned poorly or at least not as well as the TAS on the other Rega helicopters.

1.11.3.2.5 Information regarding traffic advisory system provided by the HCM

According to the statement of the HCM, the TAS did not issue an aural alert at any point during the serious incident.

He was not able to perceive other TAS alerts on the day of the incident.

1.11.4 External lights

1.11.4.1 HB-ZBB

According to information provided by the crew, the anti-collision light was operational at the time of the serious incident. The landing light was not turned on.

The crew of HB-ZBB did not notice external lights on HB-ZRY. The pilot stated that due to the relative position and orientation of HB-ZRY it would have been difficult to see any illuminated landing light on HB-ZRY.

1.11.4.2 HB-ZRY

According to the statement of the pilot, at the time of the serious incident the anti-collision lights on HB-ZRY were operational on red. The position lights and landing lights were in operation. He stated that this was standard for this type of operation.

1.11.5 Airspace monitoring

1.11.5.1 HB-ZBB

1.11.5.1.1 Pilot

According to the statement of the pilot, during the approach to the landing site at Vorauen they consciously monitored the airspace in this direction, i.e. towards the Klöntalersee lake. The crew did not see any other traffic.

The pilot stated that when the FLARM alert sounded, he and the flight instructor both looked momentarily into the cockpit because the flight instructor had shown him the correct sequence for the points to be checked on the instrument panel during the check for approach.

At the time of the serious incident the pilot was not wearing sunglasses.

1.11.5.1.2 Flight instructor

According to the statement of the flight instructor, he consciously looked outside in the direction of the intended flight path during the phase in which the pilot was conducting the check for approach.

The encounter was a surprise to him, since HB-ZRY came from an unexpected direction: *"(...) I can only explain it like this: When I last looked forward the other helicopter was still very low, even though it was already close to us. Then the helicopter probably entered our field of vision quickly from below. I was a hundred percent sure that there was nothing in front of us, so I was very surprised."*

The flight instructor stated that he was "pretty sure" that he was wearing sunglasses at the time of the serious incident.

1.11.5.2 HB-ZRY

1.11.5.2.1 Pilot

The pilot was unable to say whether the issue of airspace monitoring had been specifically addressed at the briefing before the training flights started. However he stated that the rescue personnel, who were being specifically trained for the long-line rescue technique, were also trained to monitor airspace and report other traffic and obstacles. He also stated that since these rescue personnel often came from the region in which the operations were performed, they usually had good local knowledge. The pilot stated that the HCM was also monitoring the airspace.

According to the statement of the pilot, after the HCM's report regarding the other helicopter, he initially looked through the right side window. During the reduction in speed he then turned the nose of the helicopter slightly to the right in order to get a better view of the area to the front right.

At the time of the serious incident, the pilot was not wearing sunglasses and was not using the visor on his helmet.

1.11.5.2.2 HCM

According to the statement of the HCM, the issue of airspace monitoring was not specifically addressed at the briefing before the training flights started.

On this type of operation, with angled seat and open right sliding door, the HCM oversees the entire right sector from twelve to six o'clock.

At the time of the serious incident, the HCM was not wearing sunglasses and was not using the visor on his helmet.

The HCM also stated that the take-off and landing site at Hinter Saggberg was a little behind the trees and did not offer particularly good visibility down the valley towards the main valley. He stated that it was only after the aircraft crossed HB-ZBB that they received a message from Hinter Saggberg that another helicopter was in the area.

1.11.6 Releasing the long-line and evasive manoeuvres

It is possible to release the long-line suspension gear on HB-ZRY. Each of the two cargo hooks needs to be released separately: either electrically by means of two switches on the cyclic or mechanically by means of two levers next to the collective.

According to the statement of the pilot, in the phase immediately before the two aircraft crossed he was temporarily unaware that he had a sandbag on the long-line. Releasing the line was therefore not an option for him.

He deliberated whether he should climb or descend. Climbing was not an option for him because the other helicopter might then collide with the long-line. Descending was also not an option, because he did not know the exact height above ground of the end of the long-line at that time.

1.11.7 Take-off and landing site Hinter Saggberg

The alpine meadow on Hinter Saggberg is flat and wide and therefore offers favourable conditions for helicopter take-offs and landings. The site offers a free line of sight towards the Klöntalersee lake, and it is good for approaches from this direction, especially with a long-line.

Towards the Glarner Haupttal valley, however, the visibility is severely restricted due to rising terrain and trees. Visibility is also restricted in the direction of Unter Stafel (cf. Figure 10).

Figure 10: Take-off and landing site Hinter Saggberg. Left: Looking towards Unter Stafel. Right: Looking towards Glarner Haupttal valley (Photos: June 2014).

At the time of the incident, the Rega pilot responsible for organising the training day was also on site at Hinter Saggberg. He made the following statement:

"During the second training block we saw an aircraft in the Hinterklöntal valley and informed the flying crew. At no time did this aircraft approach the airspace in which the Rega helicopter was operating.

A few minutes later I heard a helicopter in the Glärnisch/Vrenelisgärtli area, but I could not see it.

Then in the next training block it happened. I couldn't see it from where I was, but the BB helicopter approached the Rega helicopter. Everything happened very quickly and then it was over."

1.12 Useful or effective investigation techniques

Not applicable

2 Analysis

2.1 Technical aspects

2.1.1 FLARM/FLOICE collision warning devices

The recordings of the FLOICE indicate that it was first able to receive the FLARM at 08:11:10 UTC. At this time HB-ZBB was at HB-ZRY's two o'clock position, just over 3 km away and approximately 100 m higher. This is consistent with the general range analysis of the FLOICE reception for the two o'clock position and indicates that the transmission power of the FLARM was apparently within the normal range.

A little later the FLOICE generated the first message, which in spite of the term *"glider"* caused the HCM to establish visual contact and monitor HB-ZBB from this point on. In this respect, the FLOICE collision warning device therefore served its purpose, as it drew the crew's attention to the other traffic and allowed the targeted establishment of visual contact.

It was not possible to determine why the FLOICE did not continue to provide warnings despite the increasing convergence, though this may be related to the limited functionality of the FLARM. However, at the very most this played a minor role in the course of the serious incident.

In contrast to the transmission power, the reception range of the FLARM was very limited - on average it was less than 50 m and at the eleven o'clock position is was around 100 m. This explains why the FLARM recognised the FLOICE so late and why the flight instructor did not see anything on the display until the warning.

When the FLARM was able to receive the FLOICE, the distance between the two helicopters was in the range of approximately 100 m – this was observed on the display by the flight instructor. The approach speed of HB-ZBB was 120 to 130 kt (approx. 60 m/s), which meant that the time interval before collision or crossing was approximately two seconds. This corresponds to the highest warning level, which is why the device correctly issued the appropriate alert, whereupon the crew were able to see HB-ZRY. In this respect the FLARM ultimately fulfilled its purpose, since the warning made the crew aware of HB-ZRY and allowed a collision to be avoided by an abrupt avoidance manoeuvre. However, the warning provided by the device was very late due to the reduced reception range and it therefore did not function as intended.

Apart from the very limited reception range there is no evidence of a FLARM malfunction. Since the device met the transmission and reception specifications, the reason for the limited reception range should probably be sought in relation to the installation conditions and FLARM antenna. The respective analysis revealed some factors which were not in favor of an optimal range. Nevertheless, the exact cause of the limited reception range could not be determined in detail.

According to the statement of the manufacturer, the incorrect configuration of the FLARM as *"glider"* in the present case did not affect either the calculation algorithms used or the course of the serious incident in a technical sense. However, the *"glider"* message irritated the pilot of HB-ZRY.

According to the statement of the manufacturer, the use of an older FLARM software version on board HB-ZBB is unlikely to have had any influence on the course of the serious incident. In general, however, the company FLARM states that insufficient importance is often attached to the maintenance of equipment, including installation and updates.

The FLARM website offers a simple tool to check the reception range of the devices. However, this is only possible in retrospect, i.e. after completion of flights with sufficient interactions with other FLARM devices, and only in the horizontal plane. This is unsatisfactory and in particular did not allow in the present case to check the functionality of the FLARM device on ground after the modifications on the installation had been made.

2.1.2 Traffic advisory system

Since HB-ZBB was flying with an activated and (as the radar detection proves) functioning transponder, the traffic advisory system (TAS) on board HB-ZRY should have detected HB-ZBB and displayed it on the display screens in the cockpit. Moreover, since the separations during the course of the serious incident were significantly lower than criteria for triggering a traffic advisory (TA) and HB-ZRY was at a height of more than 400 ft AGL at 08:11 UTC at the latest, there should have been an additional aural alert.

Neither the pilot nor the HCM perceived any aural TAS alert during the course of the serious incident. Whether anything was displayed on the screens in the cockpit cannot be determined, but is unlikely given the lack of an aural alert in the same time period. Since there is no record of the TAS data, a reconstruction is not possible in this respect.

The TAS therefore did not function as intended: this represents a fundamental safety hazard.

However, the faulty functioning of the TAS had at most a minor influence on the present case because the crew had already been made aware of HB-ZBB by the FLOICE and could then establish visual contact with HB-ZBB.

In the context of the test flights in situations comparable to those during the serious incident, it was repeatedly determined that the TAS identified and displayed other traffic very late or not at all. In this respect the behaviour of the TAS described by the crew of HB-ZRY during the flight involved in the incident could at least be partly reconstructed.

There are two other reasons that it appears unlikely that there was a specific technical defect on the TAS on board HB-ZRY: according to Rega there is no evidence of the TAS malfunctioning either before or after the incident, and according to the pilot of HB-ZRY, he had been able to recognise other traffic on the display screens in subsequent flights on the day of the incident. It appears far more likely that the directional dependence of the TAS performance is a systemic problem. This assessment was shared by the manufacturer of the TAS, which also listed possible reasons for this behaviour.

The exact reasons for this problem could not be determined in the context of the investigation. The phenomenon was previously known to neither the manufacturer of the helicopter nor the manufacturer of the TAS. Both manufacturers indicated that they wish to make more in-depth inquiries in this regard.

2.1.3 Data backup

This serious incident indicates that rapid and comprehensive data backup is of decisive importance after such an event. This requires that the SAIB is informed immediately so that the necessary steps can be made to back up the data.

In the present case, for example, the data of the electronic flight instrument system (EFIS) on board HB-ZRY was lost because the analysis was conducted only after the data on the flight involved in the incident had already been overwritten. Since only five flights are saved, the data must be backed up quickly.

No data concerning the flight involved in the incident was available on the FLARM memory card on board HB-ZBB because the relevant flight, one of 20 files stored on the memory card, had been overwritten by the storage of many useless files in Vorauen. An analysis of the entire memory of the FLARM at the time would probably have provided the file from the flight involved in the incident. However, the analysis was mistakenly conducted at a time when the relevant data had already been overwritten.

In the present case, the missing or lost data were only peripheral to the investigation, as it was possible to reconstruct nearly all the details using the redundant data and indirect methods available. However, this may be different with any future incidents.

2.2 Human and operational aspects

2.2.1 Crew of HB-ZBB

Upon entering the Klöntal valley the crew monitored the airspace in the direction of the planned approach route to the landing site at Vorauen because they were aware that this landing area was regularly approached by helicopters. The focus of the airspace monitoring was therefore primarily forwards, in the direction of the Klöntalersee lake and less in the direction of the position of HB-ZRY. The crew did not detect any other traffic and then devoted themselves to preparing for the approach.

The recordings of the FLOICE indicate that HB-ZRY had ended its vertical climb and was in slow forward flight when HB-ZBB entered the Klöntal valley. Geometrically, HB-ZRY could therefore have been detected by the crew. However, the recordings indicate that HB-ZRY was practically always approximately at HB-ZBB's eleven o'clock position and therefore there was almost no relative motion. This is called constant bearing and made it difficult for the crew to recognise HB-ZRY, since the human eye responds primarily to movement. The reconstruction flights also showed that AW109SP was difficult to detect despite illuminated external lights and being in a known position.

This may explain why the crew were not able to establish early visual contact with HB-ZRY. It is probable that the landing preparations and completing the check for approach (including the corrections by the flight instructor as described by the pilot) temporarily led to reduced airspace monitoring with the result that the crew only became aware of HB-ZRY via the FLARM alert.

The crew then responded immediately and initiated an abrupt evasive manoeuvre to the right in order to avoid HB-ZRY and the attached long-line. The long-line also posed a potential risk factor as it was difficult to see. Any attempt by HB-ZBB to fly under HB-ZRY could therefore have had serious consequences.

The fact that the pilot of HB-ZBB was not familiar with the FLARM indications and alerts, and did not know how to interpret these correctly, is unsatisfactory in terms of flight safety. Even if the FLARM had worked as intended, it would have been of limited use for the pilot. Fundamentally, inadequate knowledge of safety systems on board an aircraft constitute an unused safety net, and in the event of misinterpretation, even a risk.

The crew decided not to make blind transmissions on the Mollis Aerodrome frequency as they passed to the east of the aerodrome at an altitude of approximately 5000 ft QNH and then turned into the Klöntal valley and began to descend. This meant that the option of exchanging information with other traffic in the area around the aerodrome was not utilised. In the present case there is a chance that the pilot of HB-ZRY would have heard a call from HB-ZBB on the aerodrome frequency and reacted accordingly.

No specific radio procedures are defined for landings on field landing sites such as the one involved in this case at Vorauen, which is not an official mountain landing site and is not within a controlled airspace with air traffic control.

2.2.2 Crew of HB-ZRY

The FLOICE message meant that the crew was aware of HB-ZBB in good time. Even though the *"glider"* message irritated the pilot, the notification meant that the HCM was able to establish and then maintain visual contact with HB-ZBB. He had ideal conditions to do this, because he was looking through the open right sliding door at approximately the three o’clock position in relation to HB-ZRY and the visibility under the cloud layer was very good.

The HCM therefore had good situational awareness of the overall situation at all times and attempted by repeated and increasingly insistent messages to the pilot to inform the latter of developments regarding the convergence with HB-ZBB. Nevertheless, the pilot could not see HB-ZBB for a long time. This is probably attributable to the fact that the pilot's concentration was for the most part focused on this demanding type of flying with a long-line and he therefore had only limited resources for targeted airspace monitoring. As crew not flying, the HCM certainly had greater capacity and better conditions for airspace monitoring. In addition, until just before the two aircraft crossed, HB-ZBB was always at approximately the two o’clock position to HB-ZRY, which meant that the lack of relative motion hindered recognition.

Intuitively, the pilot reduced forward speed, which is understandable given his lack of visual contact with HB-ZBB. The fact that the pilot did not release the long-line suspension gear is understandable given that he did not see the imminent risk of collision until very late in the convergence.

Overall, the crew was unable to avert the impending risk of collision by way of appropriate manoeuvres or other action despite the HCM's early visual contact with HB-ZBB. This is because the pilot was late in establishing visual contact with HB-ZBB and also because HB-ZRY had limited manoeuvrability due to the long-line suspension gear. Ultimately, the crew relied on the crew of HB-ZBB detecting them and initiating an appropriate avoidance manoeuvre.

A safety-conscious approach by the crew in particular on this type of operation should aim to make it possible for other traffic to detect the aircraft in as many different ways as possible. The use of the transponder and FLOICE as well as turning on all external lights all served this purpose. Deliberate dissemination of blind transmissions can also help, although there are no specifically defined radio procedures for this type of operation. Furthermore, the constant communication on the R-channel can make dissemination of blind transmissions on different channels somewhat onerous or even disturbing. In the present case, the dissemination of blind transmissions on the Mollis Aerodrome frequency would not have prevented the serious incident, as this frequency was not selected in HB-ZBB.

2.2.3 Procedures

The topic of airspace monitoring is mentioned at various points in the Rega flight operations manual. It emphasises the importance of the participation of all crew members several times and explicitly assigns the corresponding sectors. For long-line operations it also assigns additional airspace monitoring tasks to the marshaller and the doctor on the ground. The statements of the pilot and the

HCM indicate that the necessary attention is also devoted to this issue in practice.

In the present case, a combination of the FLOICE message and the HCM's airspace monitoring meant that the crew of HB-ZRY was able to detect HB-ZBB in good time. In this respect, the safety net of various possible components of airspace monitoring worked, although several of them (e.g. the TAS and monitoring from the ground) failed.

In general, the choice of the Hinter Saggberg site was unfavourable with regard to airspace monitoring because visibility was severely limited in both the direction of the Glarner Haupttal valley and the direction of the drop-off point on the Unter Stafel. The site was also relatively close to Mollis Aerodrome and it was always necessary to cross the Klöntal valley.

It is unsatisfactory that a dangerous convergence was possible despite ultimately effective airspace monitoring on the part of HB-ZRY. This demonstrates that it is not sufficient for the crew of a helicopter equipped with a long-line to detect other traffic; the crew is dependent on being identified by other traffic in good time. In purely probabilistic terms this asymmetric situation involves a significantly increased risk of collision.

This problem was at least partially addressed by the publication of flights via NOTAM, as was introduced by Rega as a result of the serious incident (cf. Section 4.3.1). However, this only covers pre-planned training flights and not the emergencies occurring unexpectedly.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The helicopters were licensed for VFR traffic.
- HB-ZBB was equipped with a FLARM collision warning device, which only provided a warning immediately before the aircraft crossed.
- The FLARM had a very limited reception range.
- The FLARM was configured as *"glider"*.
- HB-ZRY was equipped with a FLOICE collision warning device, which issued an early message, but no further warning.
- There are no indications of any technical defects on the HB-ZRY FLOICE.
- HB-ZRY was equipped with a traffic advisory system (TAS), which did not provide a warning, even though HB-ZBB was flying with an activated transponder.
- There are no indications of any specific technical defects on the TAS.
- In the context of test flights with an AW109SP it was found that the functioning of the TAS had a certain directional dependence, insofar as approaches from the right and rear right were sometimes not recognised by the TAS.

3.1.2 Crews

- The crews were in possession of the necessary licences for the flight.
- There are no indications of the crews suffering any health problems during the flight involved in the incident.

3.1.3 History of the flights

- The crew of HB-ZBB took off on a training flight from Zurich Airport shortly after 07:15 UTC.
- In the Säntis area, the crew decided to perform a landing in Vorauen, on the western shore of the Klöntalersee lake.
- The crew passed east of Mollis Aerodrome at approximately 5000 ft QNH and then at approximately 08:11 UTC turned right towards the Klöntal valley and began a slight descent.
- The groundspeed during this phase was 120 - 130 kt.
- At approximately 08:09 UTC the crew of HB-ZRY took off on a training flight with a long-line from Hinter Saggberg, east of the Klöntalersee lake.
- At 08:10:55 UTC the vertical climb to tension the long-line, which measured 160 m, and lift the sandbag attached to it from the ground, ended at approximately 1300 m AMSL.
- The helicopter began to slowly increase forward speed and continued to climb slightly in the direction of the planned drop-off point.
- Approximately 30 seconds after the vertical climb ended, the FLOICE issued the message *"glider"*.

- The HCM saw a helicopter at approximately the three o'clock position at the same altitude and an estimated distance of 1 to 2 km, which he reported to the pilot.
- The pilot could not see the helicopter and began to slowly reduce forward speed to zero.
- The HCM reported to the pilot that the helicopter was on a collision course, and at the same altitude at approximately the one or two o'clock position.
- The pilot was then also able to see the helicopter flying directly towards them at an estimated distance of just a few hundred metres.
- The crew of HB-ZBB was busy with the preparations for the approach to Vorauen.
- The pilot was completing the check for approach when the aural and visual FLARM alert was activated.
- The flight instructor then saw a distance of 0.1 km on the FLARM display.
- The crew saw another helicopter and then the long-line attached to it directly in front of, and slightly above them at approximately the eleven o'clock position.
- The crew initiated an abrupt avoidance manoeuvre to the right while descending slightly.
- At this time, HB-ZRY was almost hovering.
- According to the two crews, the two helicopters crossed with a lateral separation of 10 to 30 m and an altitude difference of 5 to 20 m.
- Both helicopters then continued their flights, the remainder of which were both uneventful.

3.1.4 General conditions

- The crew of HB-ZBB had made no blind transmissions on the radio before the serious incident.
- The crew of HB-ZBB had switched on one of the two VHF radios. The Mollis Aerodrome frequency was not selected.
- The FM radio on board HB-ZBB was not turned on.
- The crew of HB-ZRY made no blind transmissions on the radio before the serious incident during training flight.
- The pilot of HB-ZRY switched on both VHF radios and both FM radios. Among the selected channels were the Mollis Aerodrome frequency, the R-channel and the channel Heli 1.
- Communication between those involved in the long-line exercise was conducted on the R-channel.
- No specific radio procedures are defined for landings on field landing sites such as the one involved in this case at Vorauen or for flying with a long-line.
- HB-ZBB had the anti-collision light in operation.
- HB-ZRY had switched on its position and landing lights and the anti-collision lights were set to red.

- In the context of reconstruction flights, an AW109SP, which had similar colours and high visibility main rotor blades as HB-ZRY, was difficult to detect from the helicopter repeating the flight path of HB-ZBB.
- The take-off and landing site at Hinter Saggberg did not offer good visibility down the valley towards the main valley.
- HB-ZRY was informed of another helicopter in the area by the personnel at Hinter Saggberg only after the aircraft had crossed HB-ZBB.
- It was necessary to cross the Klöntal valley to reach the drop-off point.
- The weather conditions had no influence on the serious incident.

3.2 Causes

The serious incident is attributable to the dangerous convergence of a helicopter A and a helicopter B, which was carrying a suspended load on a long-line; it was able to occur because of a combination of the following factors:

- Late visual detection of helicopter B by the crew of helicopter A.
- Inadequate reception range of the FLARM collision warning device on board helicopter A.

The following factors contributed to the serious incident:

- The choice of a training location that made it necessary for helicopter B to repeatedly cross the valley.
- Limited capacity for airspace monitoring by the pilot of helicopter B due to flying with a suspended load.
- Difficult mutual visual recognition due to a constant bearing.
- Temporary reduced airspace monitoring by the crew of helicopter A due to approach preparations.

The following factor may have facilitated the occurrence of the serious incident:

- Lack of blind transmissions by the crew of helicopter A on the frequency of the nearby Mollis Aerodrome.

The following factors were established as neither causal nor directly contributory but were recognised as risky (factors to risk):

- Lack of warning by the traffic advisory system in helicopter B.
- Choice of a take-off and landing site with restricted visibility for the training flight of helicopter B.

4 Safety recommendations, safety advices and measures taken since the serious incident

4.1 Safety recommendations

None

4.2 Safety advices

None

4.3 Measures taken since the serious incident

4.3.1 Swiss Air-Rescue

On 5 December 2013 Rega issued an internal directive that a NOTAM should be submitted for future training flights with a long-line. The first publication of this type via NOTAM and DABS was for a training flight in the Bernese Oberland in May 2014. In June 2014 there was a publication of this type for a training flight from Hinter Saggberg.

Payerne, 10 March 2015 Investigation Bureau STSB

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014).

Berne, 26 March 2015

Annexes

Annex 1: Flight paths according to recording by the FLOICE on board HB-ZRY