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Schweizerische Unfalluntersuchungsstelle SUST
Service d'enquête suisse sur les accidents SESA
Servizio d'inchiesta svizzero sugli infortuni SISI
Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2220

by the Swiss Accident

Investigation Board SAIB

concerning the serious incident (Airprox)

involving a Fokker 100 aircraft, HB-JVH, operated by
Helvetic Airways
under flightplan call sign OAW 5311

and an EC 145 helicopter, HB-ZRC, operated by
Schweizerische Luft-Ambulanz AG under radio call sign
Rega Romeo Charlie

on 24 May 2012

Bern-Belp airport control zone

General information on this report

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

In accordance with Art 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 and serious incident causes and circumstances is expressly no concern of the incident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the 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	HB-JV Hotel AG, 8832 Wilen, Switzerland
Operator	Helvetic Airways AG, 8058 Zurich, Switzerland
Manufacturer	Fokker Aircraft B.V., Amsterdam, Netherlands
Aircraft type	Fokker 100
Country of registration	Switzerland
Registration	HB-JVH
Commercial flight number	2L5311
Flightplan call sign	OAW 5311
Radio call sign	Helvetic five three one one
Flight rules	Instrument flight rules (IFR)
Type of operation	Charter flight
Departure point	Kos (LGKO)
Destination point	Bern-Belp (LSZB)
Aircraft 2	
Owner	Schweizerische Luft-Ambulanz AG, 8058 Zurich
Operator	Schweizerische Luft-Ambulanz AG, 8058 Zurich
Manufacturer	Eurocopter Deutschland GmbH, Donauwörth, Germany
Aircraft type	EC 145
Country of registration	Switzerland
Registration	HB-ZRC
Radio call sign	Rega Romeo Charlie
Flight rules	Visual flight rules (VFR)
Type of operation	Ferry flight
Departure point	Lausanne (LSGL)
Destination point	Zurich (LSZH)
Location	2.5 NM north-east of Bern-Belp Airport, Swiss sovereign territory
Date and time	24 May 2012, 11:47 UTC
ATS unit	Bern aerodrome control
Airspace	Class D
Minimum separation of the two aircraft	0.7 NM horizontally and 75 ft vertically
Minimum prescribed separation	None, traffic information obligatory
Airprox category	ICAO category A (high risk of collision)

Investigation

The serious incident occurred on 24 May 2012 at 11:47 UTC. The notification was received on 29 May 2012 at 13:36 UTC by the Swiss Accident Investigation Board (SAIB). After preliminary clarifications, which are typical with this type of serious incident, the investigation was opened on 19 June 2012 at 13:33 UTC.

The final report is published by the SAIB.

Summary

On 24 May 2012 at 11:37:58 UTC the pilot of an EC 145 helicopter, registration HB-ZRC, operated by Schweizerische Luft-Ambulanz AG (REGA) under radio call sign Rega Romeo Charlie, received clearance from the Bern tower air traffic control officer (ATCO) to cross the Bern-Belp airport control zone on the route VOR FRI - VOR WIL at an altitude of 4500 ft QNH.

At the same time a Fokker 100 aircraft, registration HB-JVH, operated by Helvetic Airways AG under radio call sign OAW 5311, was approaching Bern-Belp airport. After receiving clearance from Bern approach for a visual approach on runway 32 via the right-hand downwind, the crew first contacted Bern tower. The ATCO requested the crew to continue the approach via the downwind leg for runway 32 and at the same time issued initial traffic information about the helicopter. Immediately thereafter, the Rega Romeo Charlie pilot received corresponding traffic information regarding OAW 5311, which was on an approach.

Shortly thereafter, the ATCO again issued both crews with traffic information.

Approximately one minute later, the Rega Romeo Charlie pilot reported "*traffic in sight*". The helicopter was in level flight at an altitude of 4500 ft QNH. A little later the pilot received an aural warning on his traffic advisory system. The pilot then initiated a heading change to the left in order to cross behind OAW 5311.

Four seconds after the Rega Romeo Charlie pilot reported visual contact, the crew of OAW 5311 reported that they had a helicopter in sight and would avoid it. OAW 5311 was descending and passing 5000 ft QNH. At approximately the same time, the crew received on their traffic alert and collision avoidance system (TCAS) at first a traffic advisory (TA) and a little later the resolution advisory (RA) "*climb, climb*". The crew attributed the resolution advisory to the helicopter they had in sight and therefore decided not to comply with the resolution advisory and continued the approach while descending. As a result of the continued descent, the TCAS generated the RA reversal "*descend, descend NOW!*" when the aircraft was passing 4500 ft QNH. Even after this command the crew did not change the aircraft's rate of descent.

The two aircraft crossed at 11:47:03 UTC with a lateral distance of 0.7 NM and an altitude difference of 75 ft.

Air traffic control's short term conflict alert system (STCA) was not activated at any point since it had been disabled for Bern air traffic control many years before.

OAW 5311 subsequently landed uneventfully in Bern-Belp and the helicopter continued its flight to Zurich.

Causes

The serious incident is attributable to the fact that there was a dangerous convergence of a commercial aircraft and a helicopter despite mutual visual contact, because no appropriate avoidance manoeuvre had been performed.

The limited effectiveness of the "see and avoid" principle was identified as the systemic cause of this serious incident.

The fact that air traffic control cleared the commercial aircraft for a visual approach on runway 32 created a condition that allowed the two flight paths to cross with dangerous proximity.

The fact that the crew of the commercial aircraft did not comply with the TCAS resolution advisory reduced the minimum separation of the convergence and thus exacerbated the hazard.

The following factors were identified as neither causal nor contributing, but were in the context of the investigation recognised as factors to risk:

- The ground-based short term conflict alert system (STCA) was not available to Bern air traffic control.
- The crews had insufficient knowledge of air traffic control services in class D airspace.

Safety recommendations

In the context of the investigation, three safety recommendations were issued.

In accordance with Annex 13 of the ICAO, all safety recommendations listed in this report are addressed to the supervisory authority of the competent state, which must decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, establishment or individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

In the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents (OIAASI), the Swiss legislation provides for the following regulation regarding implementation:

"Art. 32 Safety recommendations

¹ DETEC, on the basis of the safety recommendations in the SAIB reports and in the foreign reports, shall address implementation orders or recommendations to the FOCA.

² The FOCA shall inform DETEC periodically about the implementation of the orders or recommendations pronounced.

³ DETEC shall inform the SAIB at least twice a year on the state of implementation by the FOCA."

1 Factual information

1.1 Pre-history and history of the serious incident

1.1.1 General

The recordings of radio communication, radar data sent to the radar stations via the Mode S downlink, the OAW 5311 flight data recorder and the statements of the flight crews and the air traffic controller were used for the following description of the pre-flight history and history of the serious incident. The traffic alert and collision avoidance system (TCAS) on the Fokker 100 was from an older device generation and could not be evaluated.

1.1.2 Pre-flight history

Flight OAW 5311 was a charter flight from Kos (LGKO) to Bern-Belp (LSZB). The commander was pilot flying (PF) and the co-pilot was pilot not flying (PNF).

Flight RC Rega was a ferry flight from Lausanne (LSGL) to Zurich (LSZH). In the Schweizerische Luft-Ambulanz AG (REGA) helicopter, in addition to the pilot there were two passengers, neither with aviation experience.

Flight OAW 5311 was conducted according to instrument flight rules with a subsequent visual approach; flight Rega Romeo Charlie was conducted according to visual flight rules (VFR).

At the time of the serious incident, the Bern tower aerodrome control (ADC) and Bern approach workstations were occupied. The two air traffic control officers (ATCO) were sitting approximately one metre apart from each other; each had a tower air situation display (TASD) at his workstation. The aerodrome control officer involved in the serious incident assessed the volume of traffic and complexity as low. He came on duty at his workstation in his role as ADC at approx. 10:00 UTC.

1.1.3 History of the serious incident

On 24 May 2012 at 11:37:42 UTC, the pilot of the Rega helicopter EC 145, registration HB-ZRC, radio call sign Rega Romeo Charlie, reported to the Bern tower ATCO for the first time. The pilot reported that he was on a VFR flight from Lausanne to Zurich, was over the VHF omnidirectional radio beacon (VOR) FRI at 4500 ft QNH and requested clearance to cross the control zone in the direction of VOR WIL. The ATCO subsequently authorized the crossing at 4500 ft QNH.

At the same time the Fokker 100 aircraft, registration HB-JVH, radio call sign Helvetic 5311, was approaching Bern-Belp airport and was still in radio contact with the Sector West ATCO of the Zurich Area Control Centre. The crew received clearance to descend to flight level (FL) 130 at 11:39:26 UTC and FL 110 at 11:40:50 UTC. At 11:40:59 UTC the crew was requested to change to the Bern approach frequency. They complied with this request and at 11:41:23 UTC received the following clearance from the ATCO: *"Helvetic five three one one Bern arrival, 'Guete Tag' identified descend to flight level seven zero ROTOS two Mike arrival, number one."* The crew immediately confirmed this clearance and requested a visual approach. After that the ATCO issued at 11:42:28 UTC the following clearance to the crew: *"Helvetic five three one one cleared visual approach via right-hand downwind runway three two, QNH one zero two one."* The crew confirmed this clearance and were then instructed to change to the Bern tower frequency. After the serious incident, the commander of OAW 5311 stated that he turned off the autopilot immediately after receiving clearance for a visual approach.

At 11:43:04 UTC the crew of OAW 5311 reported to the Bern tower ATCO as follows: *"Bern tower 'guete Namittag' Helvetic five three one one, ten thousand eight hundred feet, descending five thousand feet, south of Herzogenbuchsee joining right-hand visual downwind runway three two."* At 11:43:18 UTC the ATCO replied and at the same time issued the crew with traffic information about the Rega helicopter which was crossing the control zone: *"Helvetic five three one hello continue for er downwind three two and er VFR traffic a Rega helicopter four miles west of the field crossing at four thousand five hundred feet via overhead direction Willisau."* The crew reported that they would be on the lookout.

At 11:43:36 UTC, the ATCO issued the pilot of the Rega helicopter the following traffic information: *"REGA Romeo Charlie look out for a Fokker one hundred from Burgdorf direction right downwind three two."* The pilot confirmed this information and said that he would be on the lookout. According to his statement there was some cloud above his flight altitude, but no closed ceiling. He therefore wanted to stay at a maximum of 4500 ft QNH in order to continue flying under visual meteorological conditions.

At 11:45:20 UTC, the ATCO updated the traffic information to the helicopter pilot: *"REGA Romeo Charlie the advised traffic is coming November¹ six thousand five hundred feet descending to downwind."* Nine seconds later he updated the traffic information to the crew of OAW 5311: *"Helvetic five three one one the advised helicopter is coming slightly north of the field squawking four thousand five hundred feet, crossing right left."* Both crews reported that they would be on the lookout.

At 11:46:34 UTC the helicopter pilot reported that he had visual contact with the aircraft. According to the radar data, the helicopter was at this time in level flight at 4500 ft QNH (see Annex 1). The pilot later commented that he had seen the aircraft relatively late, but that he had already seen an intruder on his traffic advisory system (TAS), which he attributed to the aircraft. According to his statement, at approximately the same time as he had visual contact with the Fokker he received the following aural traffic advisory (TA) generated by the TAS: *"traffic, eleven o'clock, less than one mile, same altitude"*. The TAS cannot generate resolution advisories (RA). At 11:46:50 UTC, the pilot informed the ATCO as follows: *"(...) Romeo Charlie we cross behind "*, switched off the autopilot and initiated a heading correction of approximately 40 degrees to the north in order to cross behind OAW 5311 (see Annex 1). After the serious incident, the pilot stated that he did not observe any avoidance manoeuvre on the part of OAW 5311.

The crew members of OAW 5311 agreed that the visibility was somewhat hazy. According to their statements, several aircraft were displayed on their traffic alert and collision avoidance system (TCAS) during the approach to Bern-Belp. They attributed one of these intruders to the helicopter. The commander instructed the copilot to initiate a visual search for the helicopter. Due to the special lighting conditions as a result of direct sunlight, the copilot was only able to identify the helicopter after an intensive search, whereupon he immediately informed the commander. At 11:46:38 UTC, four seconds after the helicopter pilot had reported visual contact, the copilot of OAW 5311 reported: *"Helvetic five three one one, the helicopter is in sight and we're avoiding"*. He later stated that he had reported *"we're avoiding"* of his own accord in order to indicate to the helicopter pilot and the ATCO that the conflict was resolved. According to the radar data, the aircraft was at this time descending and passing 5000 ft QNH (see Annexes 1 and 3). At approximately the same time as visual contact was established, the TCAS in the cockpit of the Fokker 100 generated a traffic advisory (TA), whereupon, accord-

¹ Reporting point "N" (November) north of Bern-Belp airport (see Annex 2).

ing to his statement, the commander slightly reduced the rate of descent. A little later the TCAS generated the resolution advisory (RA) "*climb, climb*". According to the statement of the copilot of OAW 5311, at the time the RA was triggered the aircraft was descending and at approximately the same altitude as the helicopter. The crew reported that they had established visual contact at the 2-3 o'clock position. The commander decided not to comply with the resolution advisory and continued the approach while descending because the copilot had permanent visual contact with the helicopter and also observed it turning north. The copilot later stated that the commander had carried out a minor heading correction to the left. As a result of the continued descent, the TCAS generated the RA reversal "*descend, descend NOW!*" when the aircraft passed 4500 ft QNH (the flight altitude of the helicopter). This reversal did not cause the commander to alter the rate of descent, which was approximately 1200 ft/min. According to the data sent via the Mode S downlink, a resolution advisory was generated in the cockpit of OAW 5311 for 29 seconds. The copilot was in agreement with the decision not to comply with the resolution advisory and therefore did not report any RA to the ATCO. According to the recordings of the flight data recorder there was at this stage no change in the rate of descent (see Annex 3) and no marked change of course (see Annex 1).

The two aircraft crossed at 11:47:03 UTC with a lateral distance of 0.7 NM and an altitude difference of 75 ft.

The Rega helicopter subsequently continued its flight to Zurich and OAW 5311 landed uneventfully on runway 32 in Bern-Belp.

After the serious incident the ATCO stated that he had the impression that the two crews had reacted relatively late given the good weather conditions. He was not given any warning regarding the dangerous convergence on the ground-based short term conflict alert system (STCA), because the system at Bern air traffic control had been disabled many years before.

As the commander of OAW 5311 visited air traffic control after the flight for reasons unrelated to the serious incident, the ATCO learned in passing of the triggered RA and subsequently wrote an internal report. The commander also filed an internal report for the operator.

1.1.4	Location of the serious incident	
	Position	2.5 NM north-north-east of Bern-Belp airport
	Date and time	24 May 2012, 11:47 UTC
	Lighting conditions	Daylight
	Altitude	4500 ft QNH

1.2 Personnel information

1.2.1 Crew of OAW 5311

1.2.1.1 Commander

Person	Swiss citizen, born 1967
Licence	Airline transport pilot licence aeroplane (ATPL(A)) according to joint aviation requirements (JAR), first issued by the Federal Office of Civil Aviation (FOCA) on 5 April 2000

	Ratings	Type rating Fokker F70/100 as pilot in command, valid till 14 February 2013 Radiotelephony R/T in English Language proficiency English level 4, valid till 14 February 2014 Night flight NIT(A)
	Instrument flying rating	Instrument flight aircraft IR(A) Category III instrument approaches (IR Cat. III), valid till 14 February 2013
	Last proficiency check	Licence proficiency check (LPC) on 9 June 2011 Operator proficiency check (OPC) with TCAS refresher on 24/25 January 2012
	Medical fitness certificate	Class 1, no restrictions, issued on 26 October 2011, valid till 3 November 2012
1.2.1.1.1	Flying experience	
	Total	8231 hours
	on the type involved in the serious incident	4343 hours
	during the last 90 days	140 hours, all on the incident type
1.2.1.1.2	Duty times	
	Duty time before the day of the serious incident	22 May 2012, 17:00 - 24:00 UTC 23 May 2012, 00:00 - 08:45 UTC
	Start of duty on the day of the serious incident	04:00 UTC
	Flight duty time at the time of the serious incident	7:47 hours
	The duty times on 22/23 May 2012 were in line with "split duty", which is defined in chapter 7.1.10 " <i>Expanded Flight Duty Period (Split Duty)</i> " of the operator's operations manual A (OM A). Split duty is subject to a number of conditions including a maximum of 20 hours, which must be followed by a rest time which is at least equal to the duty time and a minimum of twelve hours.	
1.2.1.2	Copilot	
	Person	Swiss citizen, born 1984
	Licence	Airline transport pilot licence aeroplane (ATPL(A)) according to joint aviation requirements (JAR), first issued by the FOCA on 3 May 2012
	Ratings	Type rating Fokker F70/100 as copilot, valid till 27 April 2013 Radiotelephony R/T in English Language proficiency English level 4, valid till 18 November 2014 Night flight NIT(A)

	Instrument flying rating	Instrument flight aircraft IR(A) Category III instrument approaches (IR Cat. III), valid till 27 April 2014
	Last proficiency check	LPC on 9 June 2011 OPC on 27 April 2012 TCAS refresher on 14/15 November 2011
	Medical fitness certificate	Class 1 with restrictions VDL (shall wear corrective lenses), issued on 1 December 2011, valid till 13 December 2012
1.2.1.2.1	Flying experience	
	Total	1649 hours
	on the type involved in the serious incident	1153 hours
	during the last 90 days	156 hours, all on the incident type
1.2.1.2.2	Duty times	
	Duty time before the day of the serious incident	22 May 2012, off duty 23 May 2012, 04:40 - 12:55 UTC
	Start of duty on the day of the serious incident	04:00 UTC
	Flight duty time at the time of the serious incident	7:47 hours
1.2.2	Crew of Rega Romeo Charlie	
1.2.2.1	Pilot	
	Person	Swiss citizen, born 1956
	Licence	Commercial pilot licence helicopter (CPL(H)) in accordance with the European Aviation Safety Agency standards, first issued by the FOCA on 15 June 1984
	Ratings	Type rating BK117 ² , valid till 31 May 2013 Radiotelephony R/T in English Language proficiency English level 4, valid till 25 October 2015 Night flight (NIT(H)) Mountain flight training (MOU(H)) Helicopter take-off in fog (HDF(H))
	Last proficiency check	Operator proficiency check (OPC) on 22 May 2012
	Medical fitness certificate	Class 1 with restrictions VDL (shall wear multifocal lenses), issued on 26 March 2012, valid till 16 October 2012

² BK117 is the official type designation for the Eurocopter EC 145 helicopter.

1.2.2.1.1	Flying experience	
	Total	5562 hours
	on the type involved in the serious incident	1849 hours
	during the last 90 days	63 hours, all on the incident type
1.2.2.1.2	Duty times	
	Duty time before the day of the serious incident	22 May 2012, 06:00 - 15:00 UTC 23 May 2012, off duty
	Start of duty on the day of the serious incident	10:00 UTC
	Flight duty time at the time of the serious incident	1:47 hours
1.2.3	Air traffic control personnel	
1.2.3.1	Air traffic control officer	
	Function	Aerodrome control (ADC)
	Person	Swiss citizen, born 1967
	Start of duty on the day of the serious incident	04:50 UTC
	Licence	Air traffic control officer licence based on European Community Directive 2006/23, first issued by the FOCA on 31 October 1991
	Ratings	Approach Control Surveillance (APS) and Aerodrome Control Instrument (ADI) in Bern-Belp, valid till 5 October 2012
	Medical fitness certificate	Class 3, no restrictions, valid till 5 October 2012
1.3	Aircraft information	
1.3.1	Aircraft 1	
	Registration	HB-JVH
	Aircraft type	Fokker 100
	Characteristics	Twin-jet short-haul aircraft
	Manufacturer	Fokker Aircraft B.V., Amsterdam, Netherlands
	Year of manufacture	1993
	Owner	HB-JV Hotel AG, Egglirain, 8832 Wilen, Switzerland
	Operator	Helvetic Airways AG, Postfach 250, 8058 Zurich, Switzerland
	Relevant equipment	Collins TCAS II

1.3.2	Aircraft 2	
	Registration	HB-ZRC
	Aircraft type	Eurocopter EC 145
	Characteristics	Twin-engine multi-purpose helicopter with landing skids and medical equipment
	Manufacturer	Eurocopter Deutschland GmbH, Donauwörth, Germany
	Year of manufacture	2003
	Owner	Schweizerische Luft-Ambulanz AG Postfach 1414, 8058 Zurich, Switzerland
	Operator	Schweizerische Luft-Ambulanz AG Postfach 1414, 8058 Zurich, Switzerland
	Relevant equipment	Avidyne TAS600

1.4 Meteorological information

1.4.1 General meteorological situation

A pronounced high over Fennoscandia caused a distinct north-easterly air stream over the northern foothills of the Alps.

1.4.2 Weather in Bern and environs at the time of the serious incident

On the north side of the Alps there was a moderate to strong Bise wind with a low-level jet character. The maximum speed was 36 knots at around 6000 ft AMSL. The weather was sunny. Along the Jura and the foothills of the Alps there were some fair-weather cumulus clouds. Over the Black Forest, convection resulted in storm clouds.

At 4500 ft AMSL, the wind was from 070 degrees at approximately 25 knots. The temperature was 14 degrees and the dewpoint 10 degrees.

1.4.3 Astronomical information

Position of the sun	Azimuth: 187°	Elevation: 64°
Lighting conditions	Daylight	

1.4.4 Aerodrome meteorological reports

In the period from 11:20 UTC up to the time of the serious incident, the following aerodrome routine meteorological report (METAR) was valid:

LSZB 241120Z VRB06KT CAVOK 24/14 Q1021 NOSIG=

In clear text, this means:

On 24 May 2012, shortly before the 11:20 UTC issue time of the aerodrome meteorological report, the following weather conditions were observed at Bern-Belp airport:

Wind	Variable direction at 6 kt
CAVOK	The code word CAVOK is an abbreviation of "ceiling and visibility OK" and is used for visibility, weather and cloud if the following conditions are met (at the time of observation):

- Meteorological visibility 10 km or more.
- No cloud below 5000 ft AAL or below the highest minimum sector altitude (MSA) if this is greater than 5000 ft AAL.
- No cumulonimbus or towering cumulus.
- No significant weather phenomena.

Temperature	24 °C
Dewpoint	14 °C
Atmospheric pressure	QNH 1021 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Changes	No significant changes expected in the two hours following the time of observation with regard to wind, visibility, weather and cloud.

At 11:50 UTC the following METAR was issued for Bern-Belp Airport:

LSZB 241150Z 03006KT 300V110 9999 FEW042 24/14 Q1021 NOSIG=

In clear text, this means:

On 24 May 2012, shortly before the 11:50 UTC issue time of the aerodrome meteorological report, the following weather conditions were observed at Bern-Belp Airport:

Wind	From 30° at 6 kt, variable between 300° and 110°
Meteorological visibility	Over 10 km
Cloud	1-2/8 at 4200 ft AAL
Temperature	24 °C
Dewpoint	14 °C
Atmospheric pressure	QNH 1021 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Changes	No significant changes expected in the two hours following the time of observation with regard to wind, visibility, weather and cloud.

1.4.5 Webcam images

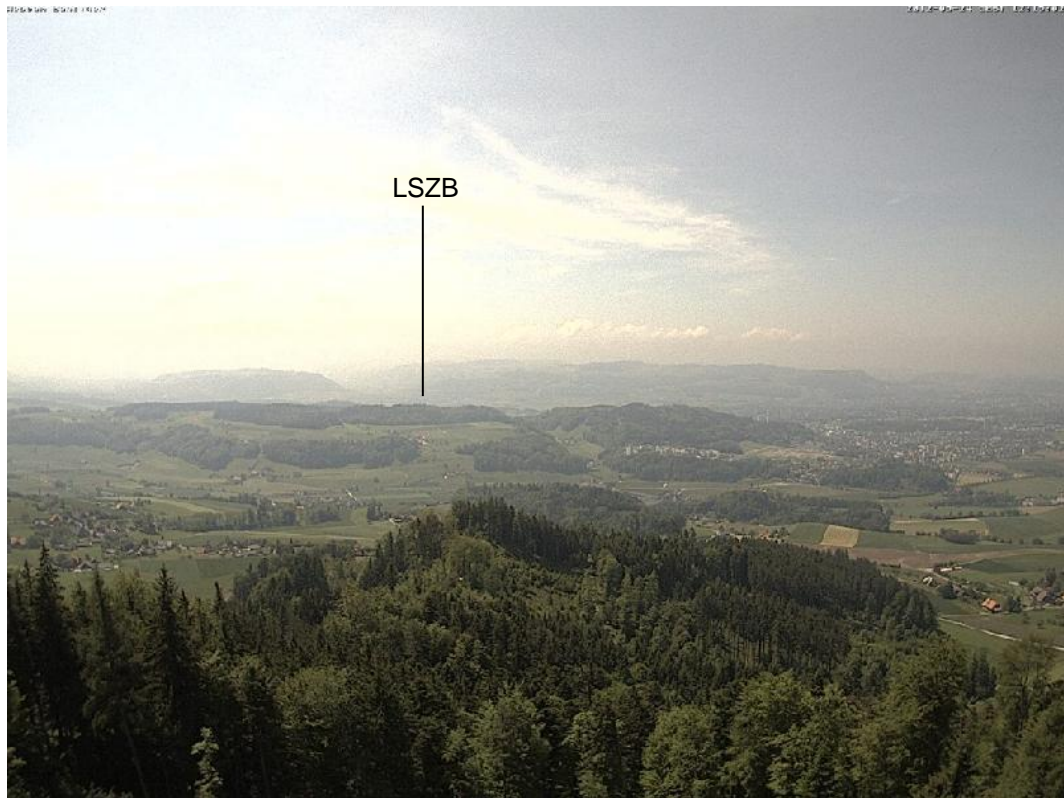


Figure 1: Bantiger webcam, looking south-south-west, 24 Mai 2012, 10:15 UTC

1.5 Aerodrome information

1.5.1 Airspace structure

The Bern-Belp airport control zone (CTR) extends from ground level to 5000 ft. Above this is the terminal control area (TMA), which extends to an altitude of FL 100 (see Annex 2). Both the CTR and the TMA are classed as class D airspace. In such airspace, there is no prescribed minimum separation between IFR and VFR traffic or between VFR and VFR traffic. The responsibility lies with the crews to maintain a sufficient distance from other aircraft according to the "see-and-avoid" principle. However, traffic information between IFR and VFR traffic are assured as an air traffic control service. Avoidance recommendations are issued to the crews upon request.

The area of responsibility (AoR) of Bern-Belp airport (LSZB) air traffic control is defined as follows in section 20 of the Air Traffic Management Manual (ATMM) Switzerland, Chapter 5, subsection 5.2.1:

"BERN is responsible for the provision of air traffic service, flight information service and alerting service in the Bern CTR/TMA area and adjacent airspace in accordance with the following chart [Figure 2], not including the Grenchen CTR. (...)"

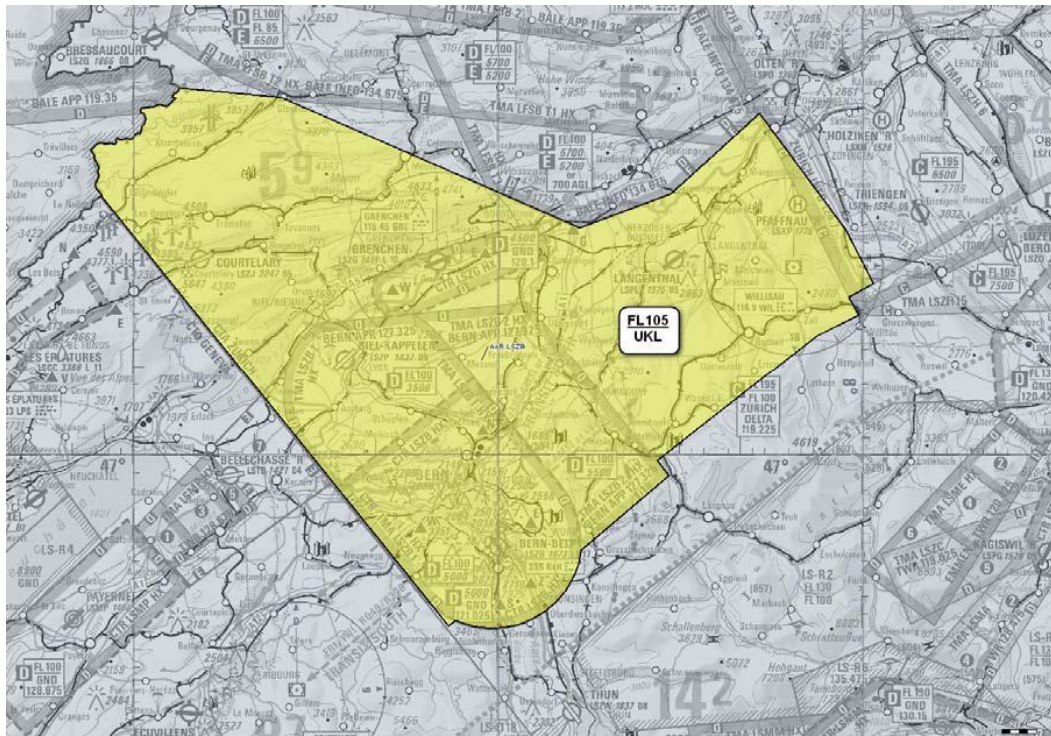


Figure 2: Area of Responsibility (AoR) LSZB, lower limit of controlled airspace (UKL)

1.5.2 Aerodrome and approach air traffic control unit

The Bern aerodrome and approach air traffic control unit workstations (Bern approach and Bern tower) are both equipped with a radar display screen (Tower Air Situation Display -TASD). The radar display on these screens is provided for implementing radar services identification, monitoring, management and separation of aircraft. The aircraft symbol data is derived from different radar stations; this data is evaluated by a central computer and finally displayed on the TASD as the best available signal. The aircraft symbols displayed include the aircraft's position, altitude, ground speed and rate of climb or descent. This data is updated and re-displayed every four seconds.

In the present case, the APP air traffic control officer's TASD was used to identify OAW 5311. The ADC air traffic control officer used the radar display on his TASD to provide traffic information to the two aircraft involved.

1.5.3 Visual approaches for IFR flights

According to the ATMM Switzerland, section 8, chapter 11.3, the following rules, amongst others, apply if the pilot of an aircraft flying in accordance with an IFR flight plan requires a visual approach:

"ATCO may clear an IFR flight, at the flight crews request or on his own initiative, to execute a visual approach provided that the flight crew can maintain visual reference to the terrain and (...)"

"Provide separation and traffic information between aircraft cleared to execute a visual approach, as required by the airspace classification."

"(...), be aware that the flight crew of an aircraft cleared to execute a visual approach is free to choose the flight path of the aircraft until reaching final approach."

1.5.4 VFR transit procedures

A northern and a southern VFR transit route are shown for crossing the Bern-Belp CTR and TMA on both the aeronautical map of Switzerland and in the Aeronautical Information Publication (AIP) for Switzerland (see Annex 2). The southern route passes from VOR FRI to VOR WIL and, according to notes on the map, aircraft should fly at 6000 ft or higher. The AIP also states the following [translated from German]:

"Unless weather conditions make it impossible or they are instructed otherwise by air traffic control, transit flights should use the published transit routes during airport operating hours. If gliding sector LIMA BRAVO (ATIS) is active the minimum flight altitude on TRANSIT SOUTH is 6000 ft AMSL."

Section 3 "VFR TRANSIT FLIGHTS" of Bern-Belp air traffic control's air traffic management manual (ATMM LSZB II) states in subsection 3.7.4:

"Usage of the transit routes is not mandatory. If a transit route is assigned, the following restrictions should be followed by the ATCO:

- (...)
- *VFR traffic on TRANSIT SOUTH should be cleared at an altitude of 3500 ft AMSL or above if glider sector LIMA BRAVO is not active, or at an altitude of 6000 ft AMSL or above if glider sector LIMA BRAVO is active.*

ATCOs may assign different altitudes if deemed necessary."

At the time of the serious incident sector LIMA BRAVO was not active.

1.6 Warning systems

1.6.1 Aircraft-based warning systems

1.6.1.1 OAW 5311

The Helvetic Airways aircraft HB-JVH was equipped with a Collins TCAS II (Version 7.0) traffic alert and collision avoidance system (TCAS³).

The system is independent of ground-based systems. It transmits signals and on the basis of the radar response signals from the transponders of other aircraft determines their relative positions and motion vectors. From this it calculates the time to the closest point of approach (CPA). In the event of convergence with another aircraft, which is capable of communicating with the system in the manner described, an initial aural and visual traffic advisory (TA) is generated and, in the case of more impending, dangerous convergences, an aural and visual resolution advisory (RA) is generated. There are two types of resolution advisory: corrective RAs, which order a change in vertical speed, and preventive RAs, which order monitoring of the vertical speed.

The thresholds for triggering the traffic advisories and resolution advisories depend on the respective heights above ground of the two aircraft. If one of the two aircraft suddenly alters its motion vector, it may also directly trigger a resolution advisory.

The aural traffic advisory (TA) "*traffic, traffic*" can be expected when the aircraft are within 30 seconds of the CPA. In the present case, this traffic advisory was triggered due to the convergence of OAW 5311, which was descending from

³ The basic concept of this collision avoidance system is known as an airborne collision avoidance system (ACAS). The International Civil Aviation Organization (ICAO) uses this term when drawing up the standards with which the system must comply. The traffic alert and collision avoidance system (TCAS) is a concrete implementation of this concept.

4900 to 4500 ft QNH and the helicopter, which was in level flight at 4500 ft QNH, shortly after both crews had reported visual contact.

In the present case, the aural and visual resolution advisory (RA) "*climb, climb*" was activated when the aircraft were 20 seconds from the CPA. According to the statement of the copilot of OAW 5311, they would at the time it was triggered have been descending to approximately the same level as the helicopter and would have had visual contact with the helicopter at the 2-3 o'clock position.

Because the crew did not comply with the resolution advisory, the TCAS generated the RA reversal "*descend, descend NOW!*" as the aircraft descended and passed 4500 ft QNH, the helicopter's flight level. Such a reversal is only generated if the resolution advisory (RA) is triggered for at least nine seconds and in this time failure to comply or insufficient compliance with the RA means that the situation has not changed sufficiently that the original resolution advisory can achieve a predefined altitude difference. Such a change of circumstances took place in the present case because the RA was not complied with and it would no longer have been purposeful for OAW 5311 to have climbed after passing the helicopter's flight level during its descent.

The international guidelines for dealing with resolution advisories require that RAs must be performed even if visual contact has been acquired with the aircraft presumed to have triggered the warning. The reason for this rule is that there is no certainty as to whether the aircraft with which visual contact has been established is actually the cause of the resolution advisory; or whether there may be another, as yet undetected, aircraft in the vicinity which has generated the resolution advisory. This regulation also applies to the operator Helvetic Airways (cf. chapter 1.7.1).

In ACAS II Bulletin No. 4 of the European Organization for the Safety of Air Navigation (Eurocontrol) it is mentioned that according to the experience of a major European Airline, around eight percent of TCAS resolution advisories are triggered by dangerous convergence of IFR and VFR traffic. In the vast majority of cases, these warnings indicate a significant risk of collision and thus represent a significant improvement in flight safety.

1.6.1.2 Rega Romeo Charlie

The Rega HB-ZRC helicopter was equipped with an Avidyne TAS600 traffic advisory system (TAS).

The system essentially works like a TCAS, with the difference that no resolution advisories (RA) can be generated. All aircraft which are equipped with a transponder and are within a maximum lateral distance of 7 NM and a maximum altitude difference of ± 3500 ft are displayed on the pilot's navigation display. 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 on the navigation display, an additional aural warning is generated in the event of a TA. According to the manufacturer's definition a TA is "*an advisory indicating the current track of an intruder could result in a near-hit or collision*". Technically, as in the case of the TCAS the time until the CPA is primarily used to trigger a TA. It is also triggered when another aircraft is within immediate horizontal and vertical proximity. In sensitivity level B, which is relevant for the present case, the TA is triggered if the CPA is less than 30 seconds away or if the horizontal distance is less than 0.55 NM and the altitude difference is less than 800 ft.

The aural warning always starts with a warning tone and the word "traffic". There then follows an indication of the relative position (e.g. "two o'clock") and the relative altitude and distance of the dangerously converging aircraft. If the relative altitude is less than ± 200 ft, the notification is "same altitude"; if the effective altitude is greater than ± 200 ft, it is "high" or "low".

In the present case, according to the statement of the Rega pilot the following warning was generated: "traffic, eleven o'clock, less than one mile, same altitude". The two aircraft were thus within 30 seconds of the CPA when the TA was triggered in the helicopter. The helicopter was in level flight at 4500 ft QNH, while OAW 5311 was descending and still above 4500 ft QNH.

1.6.2 Ground-based warning systems

Bern aerodrome control was equipped with a short term conflict alert system (STCA). This system and its application are described in section 7, chapter 14 "SHORT TERM CONFLICT ALERT" of the Air Traffic Management Manual (ATMM) Switzerland. Section 14.1 "INTRODUCTION" includes, amongst others, the following:

"The generation of STCA is a function – a "safety net" – based on surveillance data integrated into an ATC system. The objective of the STCA function is to assist the ATCO in preventing collision between aircraft, by generating in a timely manner an alert, of a potential or actual infringement of separation minima.

In the STCA function the current (proximity alarm) and predicted (predicting alarm) three-dimensional positions of aircraft with pressure altitude reporting capability are monitored for proximity. If the distance between the three-dimensional positions of two (or more) aircraft is, or is predicted to be, reduced to less than the defined applicable separation minima within a specified time period, an acoustic and visual alarm will be generated at the CWP(s) where the control of the aircraft involved is accepted ("assumed").

Although STCA and TCAS are independent and non coordinated systems, the two alerts may occur almost simultaneously.

(...)

Note: STCA does not suggest conflict resolution actions."

Regarding application, section 14.2 "OPERATING PROCEDURES" states, amongst others, the measures to be taken with regard to separation when an alarm sounds.

According to the statement of Bern air traffic control, the triggering of the STCA alarm has been suppressed for years at Bern-Belp. Bern air traffic control stated that the reason lies in the fact that Bern-Belp is part of ACC Zurich Area West and any alarms would therefore also be triggered on the radar screens of ACC Zurich Sector West. The alarm system for Bern was suppressed to avoid this disturbing representation for air traffic control officers in this sector. According to information from skyguide, plans to alter this critical safety situation were made a considerable time ago. These plans have not yet been realised.

The air navigation services provider skyguide defines several STCA "suppressed areas" (SSA) throughout Switzerland, in which the triggering of alarms is suppressed. One of these zones, area 12 inhibition BERN, corresponds to the area of responsibility (AoR) of Bern air traffic control between FL 25 and FL 105 (cf. chapter 1.5.1, Figure 2).

In the present case, the STCA could therefore at no time respond to warn the ATCO of the dangerous convergence of the two aircraft.

1.7 Information regarding the various organisations

1.7.1 Operator Helvetic Airways

1.7.1.1 Guidelines regarding TCAS

The operator specifies the procedures for the operation of their aircraft, amongst others, in their operations manuals (OM) OM A and OM B.

Under chapter 8.3.6 *"Policy and procedures for the use of TCAS / ACAS"*, chapter 8.3.6.2 *"Avoidance of aircraft collision"* states, amongst others, the following:

"An early engagement of the autopilot is required in order to facilitate the look out. Irrespective of the type of clearance received from ATC, the flight crew is still responsible for collision avoidance with other aircraft. Thus, a look out for conflicting traffic in VMC is an absolute necessity.

Traffic information given by ATC is of great value. It must, however, always be kept in mind that ATC information includes known traffic only and therefore may be incomplete."

In relation to dealing with resolution advisories (RA), chapter 8.3.6.4 *"Reaction to TCAS Traffic Advisories and TCAS Resolution Advisories"* states, amongst others, the following:

"The required maneuver must be initiated immediately by the Pilot Flying (PF); the maneuvers shall follow the indication of the advisory and never be made in a direction opposite to that given by the system.

(...)

If an instruction to maneuver is received simultaneously from a Resolution Advisory (RA) and from ATC, and both instructions are in conflict, the advice given by the Traffic Collision Avoidance System (TCAS) must be given preference. ATC should be informed about the avoiding maneuver as soon as possible."

Furthermore, sub-chapter 8.3.6.5 *"Unwanted warnings"* states, amongst others, the following:

"Even if TCAS Traffic Advisories (TA) and TCAS Resolution Advisories (RA) are suspected to be nuisance or false advisories, they shall be treated as genuine, because it is difficult to evaluate, if the traffic is of an existing danger in a short time. Therefore, in any case immediate action is required by the flight crew."

The operator's OM B provides, amongst others, a detailed description of what actions the two pilots (pilot flying (PF) and pilot not flying (PNF)) should perform when an RA sounds and is displayed. Under chapter B 3 *"Abnormal and Emergency Procedures"*, subchapter 3.12.2 *"TCAS Resolution Advisory (RA)"* states, amongst others, the following:

"The PF:

- *disconnects AP, if engaged*
- *manually adjusts the pitch to establish climb or descent at the rate indicated by the VSI green area on the PFD*

The PNF:

- *tries to visually acquire the intruder*
- *"TCAS RA" has to be reported if a deviation from ATC clearance is required, or*
- *"unable TCAS RA" if unable to comply with an ATC instruction*

Important:

- *do not use the AP or FD V/S selections is too slow to provide adequate TCAS response*
- *do not change the selected FMP altitude"*

1.7.1.2 Reporting and processing of the serious incident

In relation to the crew's obligation to report, subchapter 8.3.6.6 "Reporting" of the OM A states, amongst others, the following:

"Whenever a Helvetic flight crew has received a Resolution Advisory (RA), an Air Traffic Incident Report (ATIR) Form must be completed."

The commander of OAW 5311 did not immediately complete an ATIR form following the serious incident, but did write an internal report, in which he stated, amongst others, the following:

"TCAS RA Climb in Downwind RWY 32 In BRN with REGA HELI crossing runway axis west to east. Both acknowledge visual contact and visual correction of flight path without following the TCAS instruction. Safe separation was always guaranteed."

According to the statements made by the crew in July 2012, there had up to this point not been any internal incident debriefing with either the commander or the copilot within the operator. Upon request, the operator stated in June 2013 that the incident had in the meantime been discussed with the crew and that it had been pointed out to them that a resolution advisory (RA) is always to be complied with.

1.7.2 Operator Schweizerische Luft-Ambulanz AG

The operator operates both the Agusta Westland AW109SP and Eurocopter EC 145 helicopter types in accordance with the flight operations manual (FOM).

Section 5.9 "Crew coordination concept", 8 Annex A "AW109SP" and 9 Annex B "EC 145" describe, amongst others, the standard operating procedures (SOP) in relation to handling the Floice and TAS. Section 8.5 "TAS 600" states, amongst others, the following for AW109SP [translated from German]:

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

There are two main options:

Type of warning	Category	Display	Audio	Status
Traffic caution	Caution	TRAFFIC	"Traffic"	Traffic display
Traffic warning	Warning	TRAFFIC	"Traffic"	Traffic conflict

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 and ND, which makes identification of traffic much easier for the crew."

A corresponding entry for the EC 145 in the FOM was missing at the time of the serious incident, but will, according to the statement of the operator's flight safety officer, be incorporated into the next revision of the FOM. With the exception of substituting "PFD and ND" with "Euronav" the entry was adopted one to one. "Euronav" is the EC 145 navigation display.

1.7.3 Air navigation services provider skyguide

In section 5, chapter 3 of its operating manual for this aerodrome (Air Traffic Management Manual (ATMM) LSZB II the air navigation services provider skyguide states, amongst others, the following regarding radar use at Bern-Belp Airport:

- *"The radar procedures, services and functions defined in the ATMM CH shall apply.*
- *The responsibility for provision of radar services and radar functions may be delegated from APP to ADC.*
- *The Bright Display (TASD) serves as a radar display for the provision of radar services."*

There is no mention of the suppression of the ground-based short term conflict alert (STCA) in the ATMM II LSZB.

1.8 Flying in class D airspace

1.8.1 General information deficit

On 10 September 2010 there was a dangerous convergence between a commercial aircraft approaching on runway 19 in Lugano and a military aircraft crossing the control zone. Lugano airport's control zone is also classed as Class D airspace. The investigation of the serious incident and an associated anonymous survey of pilots regardless of licence, age or experience revealed that there were information deficits in particular in relation to the options and tasks of air traffic control in class D airspace and in view of the consequences of the traffic alert and collision avoidance system (TCAS).

Amongst others, the following points were especially noticed:

- Less than half of the pilots surveyed knew that there is no minimum separation between IFR and VFR traffic.
- Only approximately half of the pilots surveyed knew that the flight crews of IFR and VFR traffic are themselves responsible for ensuring sufficient separation from the other aircraft.
- The vast majority of the pilots surveyed were of the opinion that air traffic control, e.g. in control zones are in a position to ensure sufficient separation between IFR and VFR traffic by using radar to give course and altitude instructions.
- The majority of the pilots surveyed were of the opinion that TCAS is not for use in Class D airspace or is not suitable for a combination of IFR and VFR traffic and in this environment often leads to false alarms.

1.8.2 Information deficit in the present case

In the serious incident, which is the subject of the investigation, both the helicopter pilot and the copilot of the Fokker 100 were of the opinion that the air traffic control officer was responsible for aircraft separation and that appropriate instructions should have been issued.

The helicopter pilot also expressed surprise that a commercial aircraft operating according to IFR can adopt a visual approach without a clearly defined flight path.

2 Analysis

2.1 Technical aspects

There are no indications of any pre-existing technical defects, which might have caused or influenced the serious incident.

The fact that the STCA had been disabled in Bern air traffic control's area of responsibility meant that no collision warning system was available. In the present case, there was therefore no safety net which, given corresponding parametrisation, could warn of such conflicts. The absence of this system therefore presents a factor to risk.

2.2 Human and operational aspects

2.2.1 Crews

2.2.1.1 OAW 5311

The crew of the Fokker 100 HB-JVH agreed that the visibility was somewhat hazy and that an intruder was present on the TCAS display, which they attributed to the helicopter. This was difficult to identify by sight. The commander therefore explicitly instructed the copilot to establish visual contact by means of intense searching, which was ultimately successful. This division of labour made sense and was appropriate to the situation. In class D airspace with heavy VFR traffic, airspace monitoring becomes very important. It is therefore necessary to divide work so that there is as much available capacity as possible in the cockpit. Flying without autopilot could in this respect lead to a loss of available capacity for the crew.

Both pilots confirmed that they did not comply with the TCAS resolution advisory because they had permanent visual contact with the helicopter and maintained the necessary distance. It must be noted that an aircraft with which visual contact has been established cannot be attributed to a corresponding display on the TCAS/TAS with certainty and need not necessarily be the cause of a traffic advisory (TA) or resolution advisory (RA). In addition, experience from many investigations shows that visual estimation of distances in three-dimensional space and how this changes over time is difficult and therefore prone to errors, especially at relatively high speeds (cf. chapter 2.2.4). Compared to subjective human assessment, TCAS is a technically objective warning system; this was one reason for the development of this system. For the above reasons, therefore, all resolution advisories must be complied with in order to reliably prevent collisions. Only if the safe operation of the aircraft is jeopardized it is allowed not to comply with this policy. This is for instance possible when being close to terrain or in case of windshears or rather stall warning conditions. In the present case none of these conditions applied. The international guidelines for dealing with resolution advisories are accordingly formulated (cf. chapter 1.6.1.1). The operator's regulations also state this (cf. chapter 1.7.1).

By failing to comply with the TCAS resolution advisory, the crew's behaviour was therefore neither safety-conscious nor appropriate to the situation. Their behaviour also provoked the generation of a resolution advisory reversal. Such a reversal occurs when the original resolution advisory will no longer achieve the minimum vertical separation at the closest point of approach, but a resolution advisory in the other direction will lead to greater vertical separation.

One crew member was of the opinion that there is an article in the OM A which gives permission to not necessarily comply with an RA if conditions are clear and there is visual contact with the conflicting traffic. The other crew member knew the binding requirements of the OM A, but believed it was correct not to comply

with the RA in the present case for the following reasons: "common sense, passenger comfort, economic reasons, reduction of the workload and the associated stress for the flight crew". Furthermore it was explained that within the operator, the question of whether it is mandatory to comply with a resolution advisory is controversial.

Looking at the reasons for this inappropriate behaviour, the conclusion can be drawn that there was on the one hand a lack of knowledge of the essential contexts and procedures associated with the TCAS, and on the other the fact that familiar procedures were deliberately not complied with. It is self-evident that a crew may deviate from guidelines or defined procedures if it is a matter of safety. In the present case, however, no condition can be identified which would justify such action. In fact, the arguments presented by the crew to explain their unilateral action have been shown to be untenable.

2.2.1.2 Rega Romeo Charlie

The pilot of the Eurocopter EC 145, registration HB-ZRC, chose to cross the control zone using the officially published TRANSIT SOUTH route from VOR FRI to VOR WIL. Some cloud above him meant that he chose an altitude of 4500 ft QNH so as to allow continuous flying in VMC. This was authorized by the ATCO. This action was appropriate to the situation and corresponded to the procedures specified in the AIP and ATMM II LSZB.

Despite good visibility conditions he saw the converging Fokker 100, which was descending, relatively late; however, the ATCO's traffic information and the TAS display meant that he always had good situational awareness. The use of the autopilot was also useful for this purpose.

Shortly after visual contact with the Fokker 100 was established there was a TAS traffic advisory, whereupon the pilot disabled the autopilot and carried out an avoidance manoeuvre, turning left in a northerly direction. This reaction was appropriate to the situation. The fact that there was consequently a dangerous convergence between the two aircraft is due partly to the fact that the distance between the two aircraft was already minimal before the avoidance manoeuvre, and partly due to the fact that the Fokker 100 was travelling much faster than the helicopter. In addition, the crew of the Fokker 100 maintained the aircraft's motion vector.

2.2.2 Operator Helvetic Airways

The procedures in the operator's manuals (OM A and OM B) regarding behaviour in the case of TCAS warnings are clearly defined and in accordance with the international guidelines for dealing with resolution advisories.

It is therefore surprising that those responsible at the operator did not immediately react to the commander's internal report, in which he explicitly stated that these guidelines had not been followed. According to the statement of the crew in July 2012, they had not been involved in any debriefing regarding the serious incident. Upon request, the operator stated in June 2013 that the serious incident had in the meantime been discussed with the crew. Those responsible at Helvetic Airways were convinced that the failure to comply with the TCAS resolution advisory in the present case was due to the error of an individual crew. They stated that in the context of the company's internal training and regulations it had always been clear that resolution advisories (RA) must always be complied with.

If an operator's unambiguous guidelines are ignored by a crew, this should always be immediately addressed within the company.

2.2.3 Air traffic control

According to the statement of air traffic control, it is not uncommon at Bern-Belp for an aircraft approaching under IFR from the north and with good visibility to make an early request for a visual approach, in order to allow a shorter and therefore more economical approach on runway 32.

In the present case, air traffic control had already cleared the Rega helicopter to cross the airspace under its control at an altitude of 4500 ft QNH when the crew of OAW 5311 was cleared for a visual approach. As a visual approach can to a large extent be divided freely with regard to the vertical and lateral flight paths, it was difficult to predict whether the two aircraft would converge dangerously. The decision to allow OAW 5311 a visual approach with free choice of flight path created a situation, the consequences of which could only be predicted to a limited extent. Air traffic control attempted to resolve the impending hazard by issuing traffic information to the crews. This helped the pilots involved to establish visual contact. However, their chosen flight path could no longer prevent a dangerous convergence.

Air traffic control therefore behaved in accordance with the valid rules for operating in class D airspace. However, this case also indicates that even repeated traffic information does not automatically ensure a safe choice of flight path.

2.2.4 Flying in class D airspace

In class D airspace the "see and avoid" principle applies between IFR and VFR traffic and between VFR and VFR traffic, i.e. the responsibility lies with the crews to maintain sufficient distance from other aircraft. In the present case both a crew member of the aircraft and the helicopter pilot were of the incorrect opinion that air traffic control should have ensured sufficient separation. It cannot be excluded that this inaccurate expectation of air traffic control gave the crews a false sense of security during the dangerous convergence.

Experience from the investigation of collisions and dangerous convergences has indicated that visual estimation of distances in three-dimensional space and how this changes over time is difficult and therefore prone to errors, especially at relatively high speeds. This means that the actual distance between the two aircraft can be significantly less than the crews involved are prepared to believe on the basis of their visual assessment.

Compared to subjective human assessment, the TCAS is a technically objective warning system. The warnings generated by the TCAS, in particular the resolution advisories (RA) therefore indicate at least a significant risk of collision. This is also one of the reasons why international regulations stipulate that all RAs are to be complied with without exception - regardless of the subjective assessment of the crew.

The triggering of a resolution advisory indicates that the subjective assessment of those involved did not accurately reflect the actual situation, which also indicates that the "see and avoid" principle is subject to certain limits.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft were licensed for VFR/IFR traffic.
- The investigation did not produce any indications of pre-existing technical faults which might have caused or influenced the serious incident.
- The Fokker 100 aircraft was equipped with a TCAS II. The TCAS II can generate traffic advisories and resolution advisories.
- The Eurocopter EC 145 helicopter was equipped with a TAS. The TAS can generate traffic advisories, but cannot generate resolution advisories.

3.1.2 Crews

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

3.1.3 Air traffic control personnel

- The air traffic control officer was in possession of the licences necessary to exercise his activities.
- There are no indications of the air traffic control officer suffering health problems at the time of the serious incident.

3.1.4 History of the serious incident

- At 11:37:58 UTC the pilot of the Rega Romeo Charlie helicopter, registration HB-ZRC, received clearance from Bern-Belp aerodrome control to cross the control zone from VOR FRI to VOR WIL at an altitude of 4500 ft QNH.
- The crew of the OAW 5311 aircraft, registration HB-JVH, received clearance from Bern approach control for a visual approach on runway 32 via a right-hand downwind.
- A little later aerodrome control confirmed this clearance and issued the crew of OAW 5311 with traffic information regarding the Rega Romeo Charlie helicopter, which was crossing the control zone at 4500 ft QNH.
- Immediately thereafter, the pilot of the Rega Romeo Charlie received from aerodrome control corresponding traffic information regarding OAW 5311, which was making an approach on runway 32.
- At 11:45:20 UTC the ATCO communicated to the helicopter pilot the current position of OAW 5311 and at 11:45:29 UTC he communicated to the crew of OAW 5311 the current position of the helicopter.
- At 11:46:34 UTC the helicopter pilot confirmed visual contact; four seconds later the crew of OAW 5311 confirmed visual contact with the helicopter and at the same time announced they would avoid it.
- At this time the Rega Romeo Charlie was in level flight at 4500 ft QNH, while OAW 5311 was still descending and passing 5000 ft QNH.
- Shortly after visual contact with the Fokker 100 had been established, the pilot of the Rega Romeo Charlie received the aural traffic advisory *"traffic, eleven o'clock, less than one mile, same altitude"* on his TAS.
- The helicopter pilot then disabled the autopilot and changed course, turning left in a northerly direction to cross behind OAW 5311.

- At about the same time as they had established visual contact, the crew of OAW 5311 received a traffic advisory (TA) on their TCAS and a little later the resolution advisory (RA) "*climb, climb*".
- The OAW 5311 TCAS generated the resolution advisory to climb for ten seconds and then generated an RA reversal, i.e. it ordered the crew to descend for nineteen seconds.
- The crew attributed the RA to the helicopter with which they had permanent visual contact and therefore decided not to comply with the RA and continued to descend.
- At 11:47:03 UTC the two aircraft crossed at a lateral distance of 0.7 NM and an altitude difference of 75 ft.

3.1.5 General conditions

- There is no minimum separation between IFR and VFR traffic in class D airspace. The responsibility lies with the crews to maintain a sufficient distance from other aircraft according to the "see and avoid" principle.
- However, traffic information between IFR and VFR traffic are assured as an air traffic control service. Avoidance recommendations are issued upon request.
- Air traffic control's short term conflict alert system (STCA) had been suppressed for years at Bern-Belp Airport.
- Both the international guidelines for dealing with TCAS and the operator's guidelines require that resolution advisories must be complied with without exception.
- The weather conditions had no influence on the serious incident.

3.2 Causes

The serious incident is attributable to the fact that there was a dangerous convergence of a commercial aircraft and a helicopter despite mutual visual contact, because no appropriate avoidance manoeuvre had been performed.

The limited effectiveness of the "see and avoid" principle was identified as the systemic cause of this serious incident.

The fact that air traffic control cleared the commercial aircraft for a visual approach on runway 32 created a condition that allowed the two flight paths to cross with dangerous proximity.

The fact that the crew of the commercial aircraft did not comply with the TCAS resolution advisory reduced the minimum separation of the convergence and thus exacerbated the hazard.

The following factors were identified as neither causal nor contributing, but were in the context of the investigation recognised as factors to risk:

- The ground-based short term conflict alert system (STCA) was not available to Bern air traffic control.
- The crews had insufficient knowledge of air traffic control services in class D airspace.

4 Safety recommendations and measures taken since the serious incident

In accordance with Annex 13 of the ICAO, all safety recommendations listed in this report are addressed to the supervisory authority of the competent state, which must decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, establishment or individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

In the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents (OIAASI), the Swiss legislation provides for the following regulation regarding implementation:

"Art. 32 Safety recommendations

¹ *DETEC, on the basis of the safety recommendations in the SAIB reports and in the foreign reports, shall address implementation orders or recommendations to the FOCA.*

² *The FOCA shall inform DETEC periodically about the implementation of the orders or recommendations pronounced.*

³ *DETEC shall inform the SAIB at least twice a year on the state of implementation by the FOCA."*

4.1 Safety recommendations

4.1.1 Area of conflict between "see and avoid" and TCAS

4.1.1.1 Safety deficit

On 24 May 2012 a Fokker 100 flying according to IFR was making a visual approach on runway 32 in Bern-Belp. At the same time, an EC 145 helicopter, which was flying according to VFR, was crossing the control zone. Each aircraft was issued with traffic information twice and the crews confirmed that they had visual contact with each other. Soon after, a TCAS resolution advisory (RA) was triggered in the Fokker 100. The two aircraft crossed at a lateral distance of 0.7 NM and an altitude difference of 75 ft.

Since 2006, there have been several similar serious incidents at various Swiss airports classed as class D airspace, all of which were related to the dangerous convergence of two aircraft. In each case at least one of the two aircraft was equipped with a traffic alert and collision avoidance system (TCAS).

8 November 2006

The crew of a Saab 2000 on an IFR flight from Geneva requested a visual approach on runway 19 in Lugano. Immediately thereafter, the pilot of a Piper PA-28R flying according to VFR over waypoint MEZZO requested clearance to cross the control zone at an altitude of 3500 ft QNH direction ECHO-CAPOLAGO; this was authorized with regard to the existing traffic. One and a half minutes later, the crew of the Saab 2000 reported on the downwind leg for runway 19 and were cleared to continue the approach. Shortly thereafter, a resolution advisory was triggered in the Saab 2000. The Saab 2000 and the Piper PA-28R crossed at a lateral distance of 0.22 NM and an altitude difference of 100 ft.

Safety recommendations: None.

10 September 2010

The crew of a Saab 2000 flying according to IFR received clearance for a visual approach on runway 19 in Lugano. Shortly afterwards a Swiss Air Force PC-7 training aircraft received clearance to cross the control zone from north to south at 3500 ft QNH. The crew of the PC-7A received traffic information regarding two approaching aircraft and reported visual contact. A TCAS resolution advisory was triggered in the Saab 2000 on the left-hand base leg on runway 19. An RA was also triggered in the Beech 300 aircraft that followed the Saab 2000. The Saab 2000 and the PC-7 crossed at a lateral distance of 0.5 NM and an altitude difference of 200 ft.

Safety Recommendations No. 463 and 464

"Das Bundesamt für Zivilluftfahrt sollte sicherstellen, dass Ausbildungslehrgänge zum Erwerb aller Lizenzstufen ausreichende Kenntnisse vermitteln, dass die Lizenzträger die praktischen Konsequenzen des traffic alert and collision avoidance system (TCAS) sowie des Nutzungskonzepts von Lufträumen der Klasse D verstehen und sich in solchen Lufträumen sicher bewegen können."

[The Federal Office of Civil Aviation should ensure that training courses for the acquisition of all licence levels impart sufficient knowledge, and that licence-holders understand the practical consequences of the traffic alert and collision avoidance system (TCAS) and the utilisation concept for class D airspace, and are able to manoeuvre safely within such airspace.]

"Das Bundesamt für Zivilluftfahrt sollte in Zusammenarbeit mit der Luftwaffe und massgeblichen Luftfahrtverbänden einfache und effektive Mittel entwickeln, um die Kenntnisse von Flugbesatzungen bezüglich dem Umgang mit TCAS und dem Fliegen in Mischlufträumen aufzufrischen und zu vertiefen."

[The Federal Office of Civil Aviation should, in cooperation with the air force and relevant aviation associations, develop simple and effective means to refresh and improve flight crews' knowledge in relation to dealing with TCAS and flying in mixed airspaces.]

Conclusion

The investigation of the serious incident and an associated anonymous survey of pilots regardless of licence, age or experience revealed that there were information deficits, particularly with regard to the options and tasks of air traffic control in class D airspace and with regard to the consequences of traffic alert and collision avoidance systems (TCAS).

Furthermore, these investigations indicate that visual estimation of distances in three-dimensional space and how this changes over time is difficult and therefore prone to errors. Compared to subjective human assessment, the TCAS is a technically objective warning system. The warnings generated by the TCAS, especially resolution advisories (RA) therefore indicate at least a significant risk of collision.

The triggering of a resolution advisory shows that the subjective assessment of those involved did not accurately reflect the actual situation, which also indicates that the "see and avoid" principle is subject to certain limits.

4.1.1.2 Safety Recommendation no. 489

"Die Europäische Agentur für Flugsicherheit (european aviation safety agency – EASA) sollte in Zusammenarbeit mit anderen massgeblichen internationalen Organisationen überprüfen, inwiefern die Nutzung des traffic collision and

avoidance system (TCAS) und das Prinzip "see and avoid" insbesondere in Lufträumen ohne festgelegte Separationskriterien besser aufeinander abgestimmt werden können."

[The European Aviation Safety Agency (EASA) should, in cooperation with other relevant international organisations, verify the extent to which the use of traffic alert and collision avoidance systems (TCAS) and the "see-and-avoid" principle can be better coordinated, particularly in airspace without established separation criteria.]

4.1.1.3 Safety Recommendation no. 490

"Das Bundesamt für Zivilluftfahrt sollte in Zusammenarbeit mit skyguide wirksame und einfache Massnahmen ergreifen, die sicherstellen, dass insbesondere in Lufträumen der Klasse D oder anderen durch Verkehrsflugzeuge genutzten Lufträumen ohne festgelegte Separationskriterien zumindest der Schutzbereich der Verkehrsflugzeuge, in dem es zur Auslösung eines Ausweichbefehls des Verkehrswarn- und Kollisionsverhinderungssystems kommt, nicht verletzt wird."

[The Federal Office of Civil Aviation should, together with skyguide, take simple and effective measures to ensure that at least the protective envelope of commercial aircraft, in which resolution advisories will be triggered by the traffic alert and collision avoidance system is not violated, particularly in class D airspace and other airspace used by commercial aircraft without established separation criteria.]

4.1.2 Lack of safety nets in air traffic control

4.1.2.1 Safety deficit

On 24 May 2012 a Fokker 100 flying according to IFR was making a visual approach on runway 32 in Bern-Belp. At the same time, an EC 145 helicopter, which was flying according to VFR, was crossing the control zone. Each aircraft was issued with traffic information twice and the crews confirmed that they had visual contact with each other. Soon after, the TCAS resolution advisory "*climb, climb*" was triggered in the Fokker 100. The helicopter was equipped with a TAS, which cannot generate avoidance commands, but can generate a visual and aural traffic advisory in the event of dangerous convergence. The helicopter pilot received the aural traffic advisory "*traffic, eleven o'clock, less than one mile, same altitude*". The two aircraft crossed at a lateral distance of 0.7 NM and an altitude difference of 75 ft.

Bern-Belp aerodrome control was equipped with a short term conflict alert system (STCA). However, the triggering of the alert has been suppressed for years. The STCA could therefore at no time respond to warn the ATCO of the dangerous convergence of the two aircraft.

Previous serious incidents have already indicated that impending conflicts could have been detected earlier and resolved accordingly if the STCA safety net had been available.

17 December 2003

The HB-SCO aircraft, which was flying according to VFR, took off from Grenchen aerodrome and flew east. At the same time, ISK210, a scheduled flight operating according to IFR, took off in Bern and climbed in a north-easterly direction. The two aircraft converged dangerously in the Zurich TMA, such that the Sector SW air traffic controller's (ATCO) STCA generated an alarm.

Between leaving the Grenchen CTR and entering the Zurich TMA, HB-SCO was in a to Bern delegated airspace class E. After activating the transponder, the Bern ATCO was not sure whether he had ever seen the aircraft between Grenchen and WIL VOR. The final report states that the Bern ATCO did not have an STCA alarm because Bern airspace from ground level to FL 105 is a permanent "STCA suppression area", i.e. the triggering of STCA alarms is technically suppressed in this airspace.

The fact that air traffic control noticed the convergence of the two aircraft in their airspace too late was a contributing factor to the serious incident.

Safety Recommendation No. 370:

"Das Bundesamt für Zivilluftfahrt sollte überprüfen:

- *Ob die Aufgabenverteilung und Zuständigkeiten der FVL in der Schweiz zweifelsfrei und einheitlich definiert sind.*
- *Ob die Aus- und Weiterbildung der FVL diesbezüglich ausführlich genug durchgeführt wird."*

[The Federal Office of Civil Aviation should verify:

- whether the distribution of ATCOs' tasks and responsibilities in Switzerland are clearly and uniformly defined.
- whether ATCO training and development is extensive enough in this regard.]

24 June 2008

A flight instructor with a student on board took off from Bern on board a Cirrus SR20 on an IFR flight intending to subsequently carry out two approaches in Bern. At the same time, a pilot on board a Piper PA-28 was on a VFR flight from Grenchen to Bern. Both aircraft had their transponders switched on. Both crews received corresponding traffic information from the ATCO. The Cirrus SR20 which had taken off was made aware of the Piper by a visual and aural traffic warning on its traffic advisory system (TAS). The two crews only had visual contact with each other shortly before crossing. The two aircraft crossed at a lateral distance of 0.1 NM and an altitude difference of 200 ft.

It was not possible for the STCA to alert the ATCO to the impending conflict because the triggering of the alert had been technically suppressed.

Safety Recommendation No. 418 - 420:

"Das BAZL sollte veranlassen, ein Modul im Lehrplan der Pilotenausbildung zu integrieren mit dem Ziel, die Einschränkungen des Prinzips ‚Sehen und Vermeiden‘ zu thematisieren."

[The FOCA should ensure that a module is integrated into the pilot training curriculum with the aim of addressing the limitations of the 'see and avoid' principle.]

"Das BAZL sollte veranlassen, die IFR- von den VFR Routen in der CTR Bern zu entflechten. Bereits im Februar 2008 hat das BFU in diesem Sinne die Sicherheitsempfehlung Nr. 399 erlassen."

[The FOCA should ensure that IFR and VFR routes in the Bern CTR are spatially separated. The AAIB issued Safety Recommendation No. 399 to this effect as long ago as February 2008.]

"Das BAZL sollte veranlassen, dass die bestehende Pflicht für die Benützung des Transponders in den Lufträumen der Klassen G und E auf den Luftraum der Klasse D in den Kontrollzonen ausgeweitet wird."

[The FOCA should ensure that the existing obligation to use transponders in class G and E airspace is extended to class D airspace in control zones.]

4.1.2.2 Safety Recommendation no. 491

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit dem Flugsicherungsunternehmen skyguide alle notwendigen Massnahmen ergreifen, dass vorhandene Sicherheitsnetze den betroffenen Flugsicherungsstellen zur Verfügung gestellt werden können."

[The Federal Office of Civil Aviation should, together with the air navigation service provider skyguide, take all necessary measures to allow existing safety nets to be offered to the air traffic control units affected.]

4.2 Measures taken since the serious incident

4.2.1 Air Navigation Services Provider

In a letter, dated 2 September 2014, the air navigation services provider skyguide states that he has put into operation the STCA in Bern on 17 October 2013.

Skyguide further states that for some time they intend to introduce improved visual approach charts (VAC) for Bern without success.

4.2.2 European Aviation Safety Agency

In a letter, dated 18 September 2014, the EASA points out that they had issued, in July 2013, the Safety Information Bulletin (SIB) No. 2013-11: "ACAS II – Manoeuvres based on Visual Acquisition of Traffic" which deals with the same problem as the investigation in the present case (cf. Annex 4).

Payerne, 3 November 2014

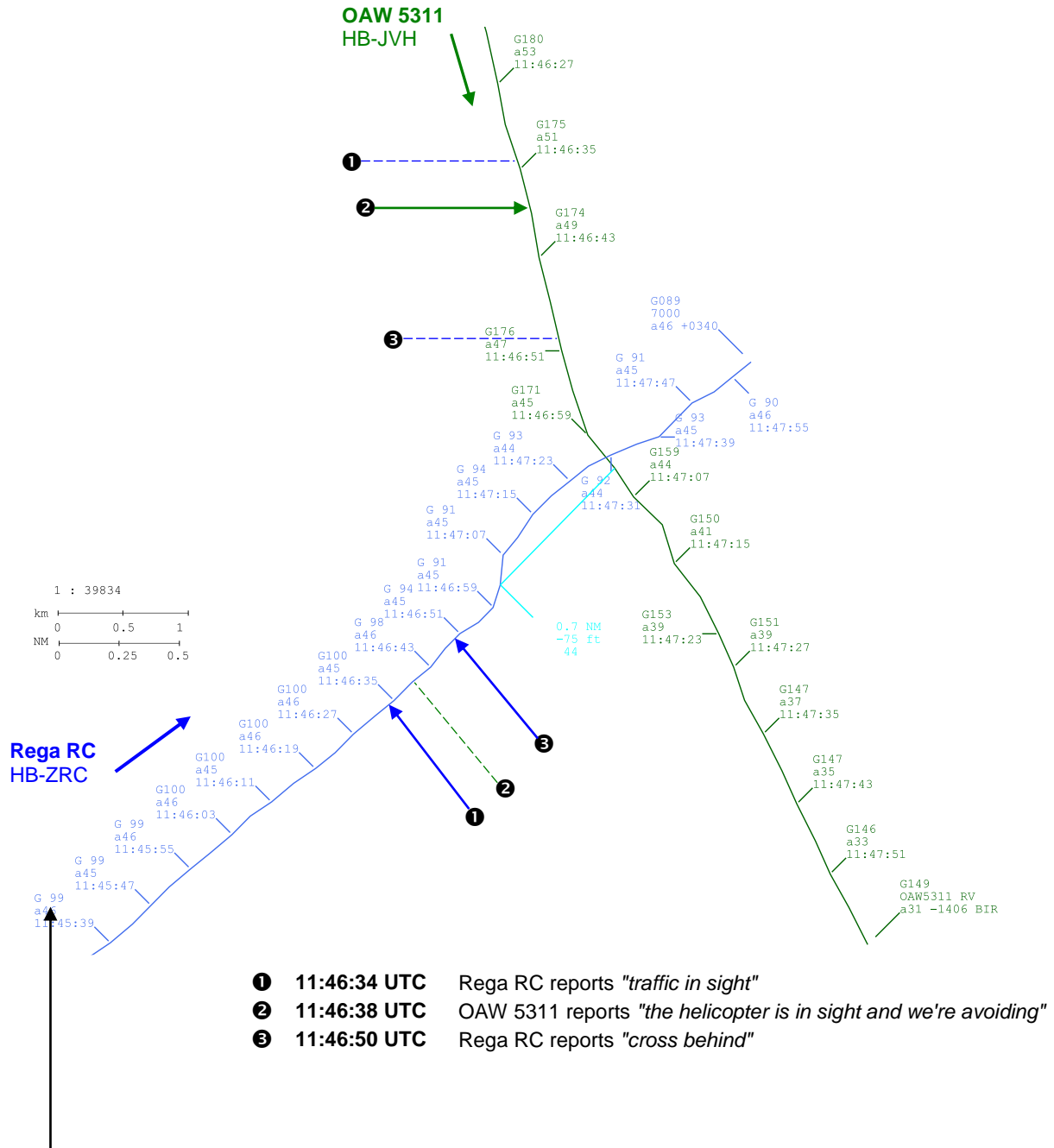
Swiss Accident Investigation Board

This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

Berne, 18 November 2014

Annexes

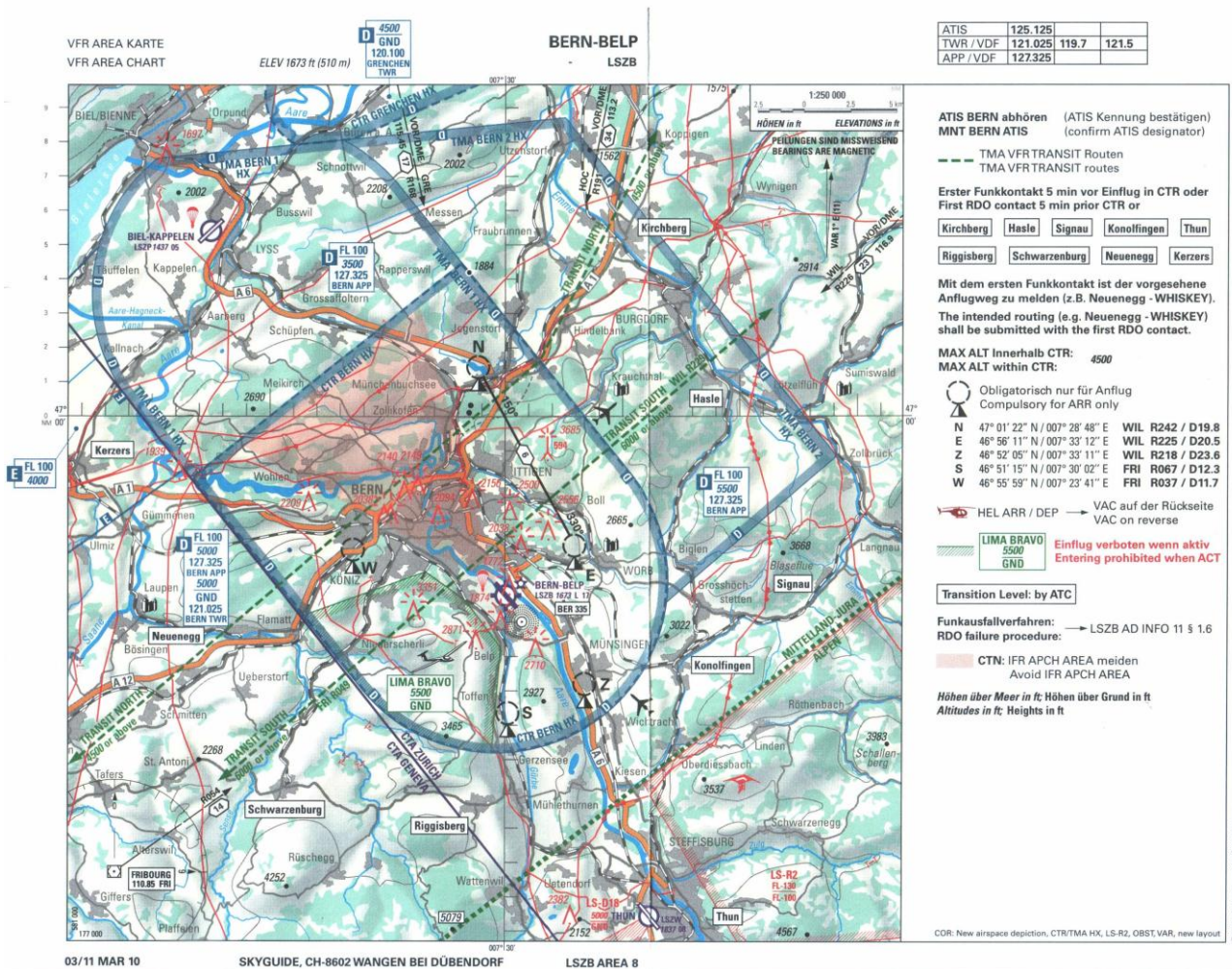
Annex 1: Flight path of the aircraft involved according to radar data



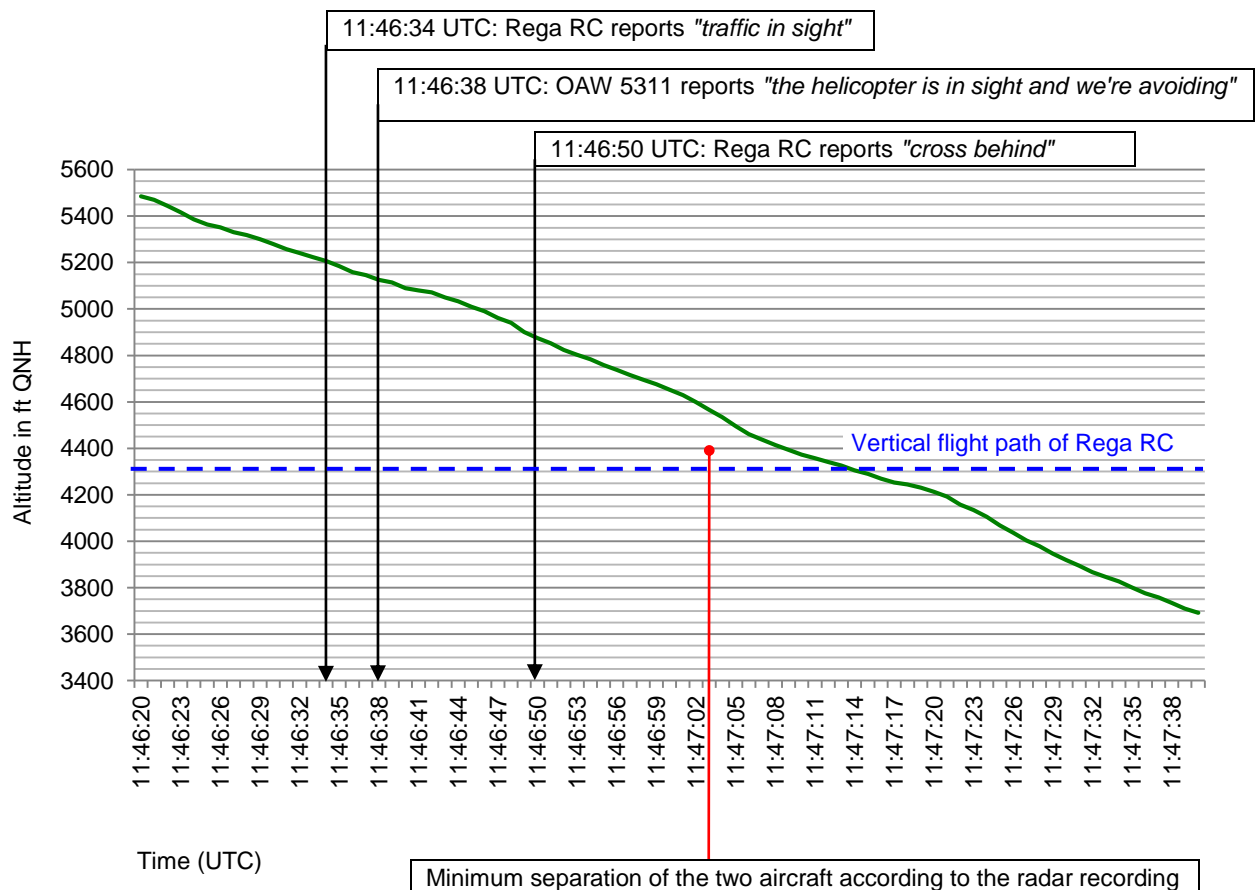
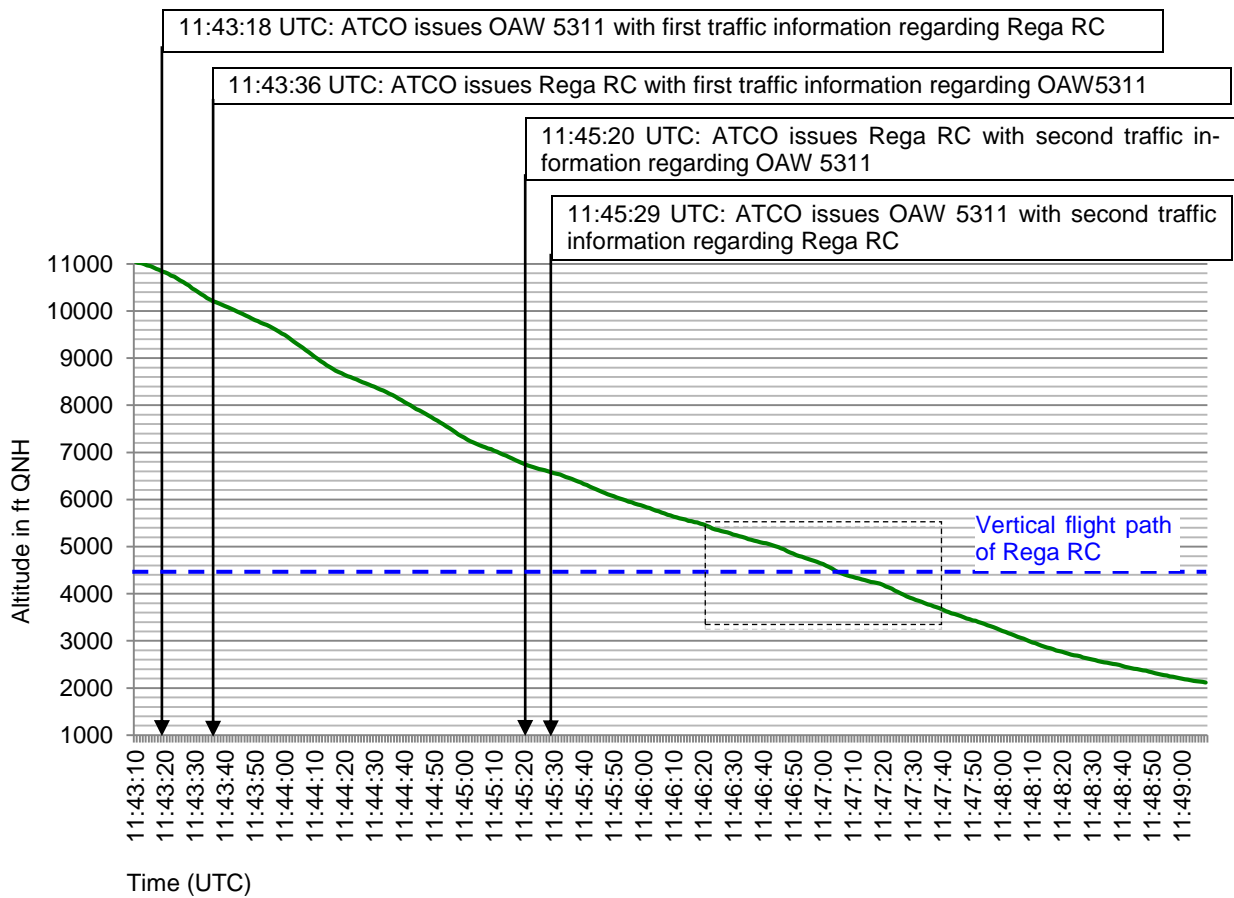
Legend:

- G Groundspeed in knots
- a Altitude QNH in hundreds of feet
- xx:xx:xx Time (UTC)

Annex 2: VFR area map of Bern-Belp



Annex 3: Vertical flight path of OAW 5311 according to FDR



Annex 4: Safety Information Bulletin published by EASA

EASA SIB No: 2013-11

**EASA Safety Information Bulletin****SIB No.: 2013-11**
Issued: 19 July 2013

- Subject:** **ACAS II – Manoeuvres based on Visual Acquisition of Traffic**
- Ref. Publications:** None
- Applicability:** All aircraft, having a collision avoidance system such as ACAS II (also referred to as TCAS II), installed.
- Description:** It has been observed that some Aircraft Flight Manuals (AFM) and Aircraft/Equipment Operating Manuals do not provide sufficient guidance regarding visual acquisition of, and safe separation from, nearby aircraft.
- The flight crew could interpret the available guidance as authorisation to disregard an ACAS 'Resolution Advisory' (RA) based on the crew's visual perception of the situation.
- Avoidance manoeuvres based on visual acquisition of traffic may not always provide the appropriate means of avoiding conflicting traffic.
- At this time, insufficient information is available to determine whether the airworthiness concern described in this SIB can be considered an unsafe condition that would warrant Airworthiness Directive (AD) action under EU [748/2012](#), Part 21.A.3B.
- Recommendations:** EASA recommends that the flight crew should be made aware of the following guidance:
1. When an RA occurs, the pilot flying (PF) shall respond immediately by direct attention to RA displays and manoeuvre as indicated, unless doing so would jeopardize the safe operation of the aircraft.

This is information only. Recommendations are not mandatory.

2. By not responding to an RA, the flight crew effectively take responsibility for achieving safe separation. In so choosing, they should consider the following cautions:
 - i. The traffic acquired by the TCAS may also be equipped with TCAS and it may manoeuvre in response to an RA coordinated with your own TCAS.
 - ii. The traffic acquired visually may not be the same traffic causing the RA.
 - iii. Visual perception of the encounter may be misleading. Unless it is unequivocally clear that the traffic acquired visually is the one generating the RA, and there are no complicating circumstances, the pilot's instinctive reaction should always be to respond to RAs in the direction and to the degree displayed.
 - iv. ATC may not be providing separation service or be communicating with the traffic causing the RA.
 - v. Disregarding RA during a coordinated encounter with another TCAS-equipped aircraft can result in loss of safe separation.

Contacts: For further information contact the Safety Information Section, Executive Directorate, EASA; E-mail: ADs@easa.europa.eu.

This is information only. Recommendations are not mandatory.