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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. 2203

by the Swiss

Accident Investigation Board SAIB

concerning the serious incident (near collision)

involving the Saab 2000 aircraft, registration HB-IZG
operated by Darwin Airline SA
under flight number DWT 124

and the Sportcruiser aircraft, registration HB-WYC

on 22 August 2012

Zurich Airport

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/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

All data refer, unless otherwise indicated, 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 incident, Central European Summer Time (CEST) applied as local time (LT) in Switzerland. The relation between LT, CEST and UTC is:
 $LT = CEST = UTC + 2 \text{ hours}$

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

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Final Report

Synopsis

DWT 124

Owner	Unicredit Leasing S.p.A. 20129 Milan, Italy
Operator	Darwin Airline SA, 6934 Bioggio, Switzerland
Manufacturer	Saab-Scania Flugzeugwerke, Stockholm, Sweden
Aircraft type	Saab 2000
Country of registration	Switzerland
Registration	HB-IZG
Flight number	DWT 124
Radio call sign	Darwin one two four
Flight rules	Instrument flight rules (IFR)
Type of operation	Scheduled flight
Departure point	Zurich (LSZH)
Destination point	Genoa (LIMJ)

HB-WYC

Owner	Motorfluggruppe Thurgau, Flugplatz, 9506 Lommis, Switzerland
Operator	Motorfluggruppe Thurgau, Flugplatz, 9506 Lommis, Switzerland
Manufacturer	Czech Sport Aircraft, Kunovice, Czech Republic
Aircraft type	Sportcruiser
Country of registration	Switzerland
Registration	HB-WYC
Radio call sign	Hotel Bravo Whiskey Yankee Charlie
Flight rules	Visual flight rules (VFR)
Type of operation	Training flight
Departure point	Lommis (LSZT)
Destination point	Lommis (LSZT)

Location	Zurich Airport
Date and time	22 August 2012, 14:16 UTC
ATS unit	Zurich aerodrome control
Airspace	Class D
Minimum separation of the aircraft	205 m 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 22 August 2012 at 14:16 UTC. The notification was received on 23 August 2012 at 18:00 UTC by the Swiss Accident Investigation Board (SAIB). After preliminary clarifications, which are typical with this type of incident, the investigation was opened on 10 September 2012 at 10:00 UTC.

The final report is published by the SAIB.

Summary

On 22 August 2012, a Sportcruiser type aircraft, registration HB-WYC, took off at 13:30 UTC from Lommis aerodrome on a training flight to Zurich airport. The crew consisted of a pilot, who was training for the revalidation of a rating, and a flight instructor. The crew carried out touch-and-go landings on different runways at Zurich airport. At 14:14:00 UTC, HB-WYC was on the right-hand downwind for runway 16, in order to carry out another touch-and-go. After HB-WYC had crossed the centreline of runway 28, the air traffic controller gave the crew of a Darwin Airline Saab 2000, with the radio call sign DWT 124, clearance to take off from runway 28. Shortly after this, the crew of HB-WYC turned onto their final approach on runway 16, and the air traffic controller instructed them to perform a 360° turn to the right. The crew of DWT 124, which was taking off, received a traffic advisory (TA) from their traffic alert and collision avoidance system (TCAS) shortly after lifting off, and then increased their rate of climb. The two aircraft converged to a lateral distance of 205 m and an altitude difference of 75 ft. DWT 124 subsequently continued its scheduled flight to Genoa, whilst HB-WYC carried out further touch-and-go landings and then returned to Lommis.

Causes

The serious incident is attributable to a near collision because the air traffic controller gave a take-off clearance on runway 28 to a commercial aircraft while a light aircraft was on its approach to runway 16.

The incorrect assessment of the situation by the air traffic controller was established as a direct causal factor for the serious incident.

The following factors were identified as systemic factors contributing to the serious incident:

- Risk assessment by air traffic control was inadequate.
- A complex training flight was taking place at a time when the volume of traffic was increasing and at medium complexity.
- Because visual approaches were rarely carried out on runway 16, there were only few values derived from experience on which one could have relied when carrying out ones planning.
- The TCAS fitted in the commercial aircraft did not provide any information to the crew on the ground about other aircraft, and this restricted their situational awareness.

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

- Air traffic control instructed the light aircraft which was in landing configuration and close to the ground to perform a tight 360° turn to resolve the conflict.
- Misinterpreted motivation to provide service on the part of air traffic control.

Safety recommendations

In the context of the investigation, one safety recommendation was 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 History of the flight

1.1.1 General

The recordings of the radiotelephony, radar data, data transmitted to the radar stations via the Mode S downlink and the stored data from the traffic alert and collision avoidance system (TCAS) as well as the statements of crew members and air traffic control officers were used for the following description of the pre-flight history and history of the serious incident. Throughout the flight of DWT 124 the commander was pilot flying (PF) and the copilot was pilot not flying (PNF). On aircraft HB-WYC the pilot in the left-hand seat was PF, whilst the flight instructor in the right-hand seat monitored the pilot.

Air traffic control was conducted from Zurich aerodrome control centre's aerodrome control (ADC) workstation.

Flight DWT 124 was conducted according to instrument flight rules whereas flight HB-WYC was conducted according to visual flight rules (VFR).

There were no operational or technical restrictions.

1.1.2 Pre-flight history

The pilot of HB-WYC intended to carry out a revalidation of his class rating for single-engine piston aircraft on the Sportcruiser aircraft type and made contact with the flight instructor to plan a training flight. The latter suggested planning the training flight from Lommis to Zurich and back and taking the opportunity to conduct training for approaches on the various runways at Zurich airport.

The flight instructor, who was familiar with Zurich airport and who worked part-time for skyguide, coordinated this flight with the Zurich control tower supervisor on the day before the flight and on the day of departure. In the process, it was agreed that it would be possible for the crew of HB-WYC to make a number of visual touch-and-go landings on different runways; the ADC controller himself would schedule these approaches according to the IFR traffic, and holding patterns would have to be taken into consideration.

On the afternoon of 22 August 2012 survey flights were taking place at Zurich airport from 12:00 UTC to 13:30 UTC. Visual flights were therefore only permitted from 13:45 UTC. The survey aircraft took off at 11:58 UTC and concluded the instrument landing system survey flights at 13:44 UTC. As a result of this restriction, the control tower supervisor, at the request of the HB-WYC flight instructor, had the previous day granted authorisation for the planned touch-and-go landings from approximately 14:00 UTC.

The air traffic controller had taken over the ADC workstation approximately five minutes before the serious incident. According to his statement, at the time of the serious incident the volume of traffic was low to average of low to average complexity.

1.1.3 History of the serious incident

On 22 August 2012, at 13:30 UTC, the crew of HB-WYC, consisting of a pilot and a flight instructor, took off from Lommis aerodrome and at 13:43:14 UTC reported on the Zurich aerodrome control centre frequency. The crew then made a visual approach on runway 28 with a touch-and-go landing then repeated the procedure on runway 34. The crew of HB-WYC were then instructed to join the holding pattern via W2. Approximately two minutes later, at 14:07:00 UTC, a visual approach was made on runway 10 with a touch-and-go landing and a subsequent right turn onto a westerly heading parallel to runway 28. At approximately 14:10 UTC, a shift changeover took place at the ADC workstation. Following an enquiry from the new ADC, the crew of HB-WYC expressed their desire to approach runway 16 next. This was cleared by the ADC controller, with an instruction to fly towards W2 first.

After the take-off of a commercial aircraft from runway 28 at 14:10:50 UTC, the ADC controller obtained confirmation from the crew of HB-WYC that they had established visual contact with the aircraft which was taking off. Then, at 14:12:31 UTC, the controller instructed the crew of HB-WYC to join the right-hand downwind of runway 16 and made them aware of possible wake turbulence.

At 14:13:07 UTC, the crew of a Saab 2000, flight number DWT 124, reported on the Zurich tower frequency that they were ready for take-off short of runway 28. Two seconds later, the ADC controller cleared them to taxi into position on runway 28. At 14:13:24 UTC, the ADC controller gave the crew of HB-WYC the following instruction: *"Hotel Yankee Charlie, base turn, then not later than the threshold one six, in order to stay clear of approach track one four."* The crew confirmed this. The air traffic controller then instructed two aircraft to cross runway 28 from north to south. There was a brief private exchange in dialect with one of the crew members. A noise on the carrier frequency of a few seconds duration is also audible twice during this period.

The flight instructor instructed the pilot of HB-WYC to head for the runway 16 aiming point¹ in the base leg. At 14:14:21 UTC the crew of HB-WYC turned onto the right-hand base leg and at 14:14:50 UTC reported: *"right-hand base, runway one six, Hotel Yankee Charlie."* At this point, HB-WYC was approximately 70 seconds before the planned touchdown point on runway 16. The ADC controller confirmed this at 14:14:54 UTC as follows: *"Roger, you are number one, continue approach."* The crew of DWT 124 stated that at this time they were aware of the presence of a light aircraft in the area of the aerodrome but did not know its exact location. Four seconds later, the ADC controller gave the crew of DWT 124 take-off clearance at 14:14:58 UTC: *"Darwin one two four, wind three three zero degrees, seven knots, runway two eight, cleared for take-off."*

The flight instructor subsequently stated that he had perceived something like "28" on the radio and had then instructed the pilot not to descend any further. Shortly afterwards he saw that DWT 124 had commenced its take-off procedure on runway 28. At 14:15:04 UTC the ADC controller instructed the crew of HB-WYC to join the left-hand downwind of runway 28 after the touch-and-go. The trainee immediately confirmed this instruction. The instructor then recognised the impending conflict and prepared himself mentally to avoid the Saab 2000 which was taking off by turning left over the control tower.

After the ADC controller had cleared an aircraft to land on runway 14, according to his own information he was surprised at the early base turn performed by HB-

¹ The aiming point for instrument approaches is a distinctive runway marking located at 500 m after the threshold of runway 16 of Zurich airport (cf. Annex 1).

WYC and recognised the impending conflict with DWT 124, which was taking off. As he subsequently indicated, aborting the take-off was no longer an option for the Saab 2000, since he estimated that its speed was already quite high. At 14:15:30 UTC he instructed the crew of HB-WYC to initiate a 360° turn to the right. This was immediately confirmed by the flight instructor on-board HB-WYC. Five seconds later the instruction followed: *"tight turn, traffic departing out of runway two eight."* The crew of HB-WYC, at a height of approximately 250 ft above ground level (AGL), initiated a tight, slightly ascending turn to the right, which brought them back onto the downwind of runway 16.

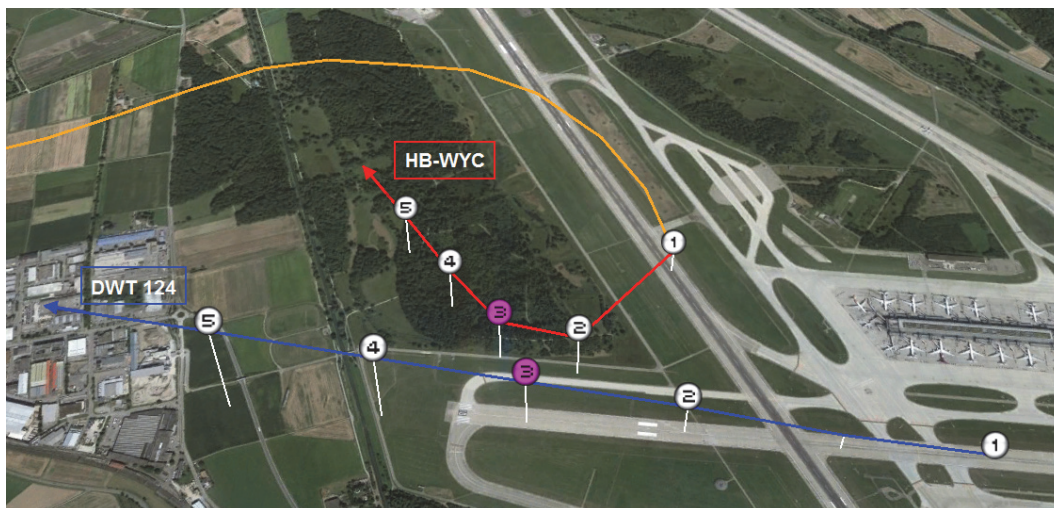


Figure 1: Flight paths of the two aircraft visualised in Google Earth using Mode-S data: Data point 3 corresponds to the time of the closest point of approach at 14:15:52 UTC.

In the meantime, the Saab 2000 had lifted off from runway 28 (see blue flight path in Figure 1) and maintained the direction of the runway 28 centreline. Shortly after take-off, at 14:15:37 UTC the on-board TCAS on DWT 124 generated a traffic advisory (TA) *"traffic, traffic"*, depicted on the commander's primary flight display (PFD). At the same time, the position of HB-WYC was depicted as a yellow icon on the copilot's TCAS screen. On the basis of this alert, both DWT 124 crew members were able to establish visual contact with HB-WYC, and the PF increased the rate of climb of the Saab 2000. The airspeed did not fall below the minimum airspeed for a safe initial climb (minimum take-off safety speed - V_2). After initiating the tight right-hand turn, the crew of HB-WYC lost visual contact with the Saab 2000 which was taking off. They subsequently stated that the tight right-hand turn was flown with flaps extended.

At 14:15:46 UTC, the ADC air traffic controller informed the crew of DWT 124 of the conflict as follows: *"Darwin one two four, just for information, traffic on the right-hand side staying clear of runway two eight is doing an orbit."*

At the time of the closest point of approach of the two aircraft, at 14:15:52 UTC, HB-WYC was in a tight right turn just north of runway 28 at an altitude of 1835 ft QNH, whilst DWT 124 was just west of the 16/28 runway intersection, in a climb at an altitude of 1910 ft QNH. The two aircraft converged to a lateral distance of 205 m and an altitude difference of 75 ft.

After the serious incident, the crew of DWT 124 continued their flight to Genoa, whilst the crew of HB-WYC carried out further touch-and-go landings and then returned to Lommis.

1.1.4 Location of the serious incident

Position

Runways 28 and 16, Zurich Airport

Date and time	22 August 2012, 14:16 UTC
Lighting conditions	Daylight
Altitude or flight level	Approx. 1870 ft QNH / 490 ft above ground

1.2 Personnel information

1.2.1 Crew of DWT 124

1.2.1.1 Commander

1.2.1.1.1 General

Person	Swiss citizen, born 1959
Licence	Airline transport pilot licence aeroplane (ATPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the Federal Office of Civil Aviation (FOCA) on 18 March 1988
Ratings	SAAB 2000 as pilot in command, valid till 11 October 2012 Language proficiency English level 4, valid till 31 October 2013
Instrument flying rating	Instrument flight aircraft IR(A) Night flight NIT(A) Category III instrument approaches (SAAB 2000 (IR)), valid till 11 October 2012
Last proficiency check	Proficiency check on 6 September 2011
Medical fitness certificate	Class 1, no restrictions, valid till 3 March 2013
Last medical examination	20 April 2012

1.2.1.1.2 Flying experience

Total	18,590 hours
on the type involved in the incident	9,400 hours
as commander	16,389 hours
during the last 90 days	137 hours

1.2.1.1.3 Duty times

Start of duty before the serious incident	20 August 2012, 06:43 UTC
	21 August 2012, 12:00 UTC
	22 August 2012, 06:30 UTC
End of duty before the serious incident	20 August 2012, 18:25 UTC
	21 August 2012, 20:30 UTC
Flight duty times before the serious incident	20 August 2012, 11:42 hours
	21 August 2012, 08:30 hours
Rest times before the serious incident	20 / 21 August 2012, 17:35 hours
	21 / 22 August 2012, 10:00 hours

	Flight duty time at the time of the serious incident	22 August 2012, 7:46 hours
1.2.1.2	Co-pilot	
1.2.1.2.1	General	
	Person	Italian citizen, born 1984
	Licence	Commercial pilot licence aeroplane (CPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the FOCA on 20 April 2010
	Ratings	SAAB 2000 as co-pilot, valid till 31 December 2012
		Language proficiency English level 5, valid till 31 October 2016
	Instrument flying rating	Instrument flight aircraft IR(A) Night flight NIT(A) Category III instrument approaches (SAAB 2000 (IR)), valid till 31 December 2012
	Last proficiency check	Proficiency check on 18 November 2011
	Medical fitness certificate	Class 1, no restrictions, valid till 21 August 2013
	Last medical examination	13 August 2012
1.2.1.2.2	Flying experience	
	Total	964 hours
	on the type involved in the incident	744 hours
	as co-pilot	744 hours
	during the last 90 days	108 hours
1.2.1.2.3	Duty times	
	Start of duty before the serious incident	20 August 2012, 06:43 UTC 21 August 2012, 12:00 UTC 22 August 2012, 06:30 UTC
	End of duty before the serious incident	20 August 2012, 18:25 UTC 21 August 2012, 20:30 UTC
	Flight duty times before the serious incident	20 August 2012, 11:42 hours 21 August 2012, 08:30 hours
	Rest times before the serious incident	20 / 21 August 2012, 17:35 hours 21 / 22 August 2012, 10:00 hours
	Flight duty time at the time of the serious incident	22 August 2012, 07:46 hours

1.2.2	Crew of HB-WYC	
1.2.2.1	Pilot	
1.2.2.1.1	General	
	Person	Swiss citizen, born 1978
	Licence	Private pilot licence aeroplane (PPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the FOCA on 12 February 1998
	Ratings	Class rating for single-engine piston aircraft (SEP - land), valid till 5 September 2012 Language proficiency English level 4, valid till 3 November 2012
	Medical fitness certificate	Class 2, no restrictions, valid till 3 February 2017
	Last medical examination	8 March 2012
1.2.2.1.2	Flying experience	
	Total	167 hours
	during the last 90 days	11 hours
	on the type involved in the incident	24 hours
	during the last 90 days	7 hours
1.2.2.2	Flight instructor	
1.2.2.2.1	General	
	Person	Swiss citizen, born 1963
	Licence	Commercial pilot licence aeroplane (CPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the FOCA on 5 August 2002
	Ratings	Flight instructor aeroplanes (FI(A)), valid till 25 March 2013 Class rating for single-engine piston aircraft (SEP – land), valid till 30 September 2014 Language proficiency: English level 6
	Medical fitness certificate	Class 1/2/LAPL with the restriction: shall have available corrective lenses (VNL) Class 1/2, no restrictions, valid till 22 July 2013
	Last medical examination	13 August 2012
1.2.2.2.2	Flying experience	
	Total	1080 hours
	during the last 90 days	79 hours

	on the type involved in the incident	8 hours
	during the last 90 days	00:46 hours
1.2.3	Air traffic control personnel	
1.2.3.1	Air traffic controller	
	Function	Aerodrome control (ADC)
	Person	Swiss citizen, born 1970
	Duty days before the day of the incident	20 August 2012, off duty 21 August 2012, 17:30 UTC – 21:30 UTC
	Start of duty on the day of the incident	13:20 UTC
	Licence	Air traffic controller licence based on European Community Directive 2006/23, first issued by the FOCA on 15 November 1996, valid till 12 March 2013
	Ratings	TWR Tower 12 March 2013 RAD Radar 12 March 2013 Language proficiency: English level 5, valid till 16 March 2015
	Current competences	LSZH approach control surveillance (APS), valid till 12 March 2013 LSZH aerodrome control instrument (ADI), valid till 12 March 2013
	Medical fitness certificate	Class 3, no restrictions, valid till 12 March 2013
1.3	Aircraft information	
1.3.1	Aircraft DWT 124	
1.3.1.1	General	
	Registration	HB-IZG
	Aircraft type	Saab 2000
	Characteristics	Twin-engined turboprop commercial aircraft
	Manufacturer	Saab-Scania Flugzeugwerke, Stockholm, Sweden
	Year of manufacture	1994
	Licence	IFR/VFR
	Owner	Unicredit Leasing S.p.A. 20129 Milan, Italy
	Operator	Darwin Airline SA, 6934 Bioggio, Switzerland
	Equipment	TCAS II

1.3.1.2 Traffic alert and collision avoidance system

The Darwin Airline SA aircraft HB-IZG was equipped with a second generation traffic alert and collision avoidance system (TCAS²).

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 closest point of approach (CPA). In the case of convergence with another aircraft which is capable of communicating 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.

The Saab 2000 TCAS displays aircraft in flight which transmit a transponder signal and which are within a specific range on the navigation display (ND). However, this function is not active on the ground and therefore cannot be used to locate other aircraft. As soon as a Saab 2000 takes off, the visual and aural warnings are available to the crew. However, in order not to provoke any dangerous avoidance manoeuvres close to the ground, avoidance commands are generated only when the aircraft is over 1000 ft above ground. Below 1000 ft, in the event of a traffic advisory, the crew themselves must decide on the basis of their visual perception whether and how they can perform an avoidance manoeuvre.

1.3.2 Aircraft HB-WYC

1.3.2.1 General

Registration	HB-WYC
Aircraft type	Sportcruiser
Characteristics	Single-engined private aircraft
Manufacturer	Czech Sport Aircraft, Kunovice, Czech Republic
Year of manufacture	2009
Licence	VFR
Owner	Motorfluggruppe Thurgau, Flugplatz, 9506 Lommis, Switzerland
Operator	Motorfluggruppe Thurgau, Flugplatz, 9506 Lommis, Switzerland
Equipment	Mode S transponder

Aircraft HB-WYC could be detected as a result of the TCAS transponder on the Saab 2000.

1.3.2.1.1 Performance

The performance of the Sportcruiser aircraft type in relation to a turn flown in level flight with flaps extended is not described in the manufacturer's operating manual.

Analysis of the data from the electronic flight instrument system (EFIS) indicated that the turn was flown at a bank angle between 35 and 40 degrees. The indi-

² 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.

cated airspeed (IAS) was approximately 82 kt on average. The vertical rates of climb and descent were between -600 ft/min and 700 ft/min.

1.4 Meteorological information

1.4.1 General meteorological situation

An extension of the Azores high extended as far as central Europe. At high altitude, a large-scale west-south-westerly air stream prevailed.

1.4.2 Weather at the time of the serious incident

In the vicinity of Zurich-Kloten airport sunny weather prevailed, with a few fine-weather clouds at 4500 ft/AAL.

Weather/cloud	1-2/8 4500 ft/AAL	
Visibility	25 km	
Wind	280 degrees at 6 kt, variable between 250 and 310 degrees	
Temperature/dewpoint	28 °C / 18 °C	
Atmospheric pressure QNH	1018 hPa	
Hazards	None	

1.4.3 Astronomical information

Position of the sun	Azimuth: 238°	Elevation: 40°
Lighting conditions	Daylight	

1.4.4 Webcam



Figure 2: View from Zurich airport in a south-westerly direction (image from 22 August 2012 at 14:00 UTC).

1.5 Aids to navigation

Not applicable.

1.6 Communications

Communication between air traffic control and the two flight crews was conducted without any technical limitations.

1.7 Obligation to report

Serious incidents and dangerous convergences must be reported in accordance with the Aviation Act and the Ordinance on the investigation of accidents and serious incidents (OIASI). The reporting procedure is specified in the relevant sections of the aeronautical information publication (AIP) for Switzerland.

The crew of DWT 124 reported the serious incident immediately after landing in Genoa, in the form of an air safety report (ASR).

The flight instructor on HB-WYC assumed that this serious incident would be reported either by the crew of DWT 124 or by the ADC air traffic controller. Since the flight instructor was employed part-time at skyguide, he did not want to burden the ADC controller with a report and refrained from filing one. The pilot stated that he was not in a position to assess the risk adequately and therefore refrained from filing a report.

The ADC air traffic controller did not consider the incident to be serious and for this reason refrained from filing a report. As an enquiry to representatives of the air navigation services provider indicated, it must be assumed that other air traffic controllers would have assessed this situation in the same way as the air traffic controller involved.

1.8 Aerodrome and airspace information

1.8.1 General

Zurich Airport is in north-east Switzerland.

The Zurich airport runways have the following dimensions:

Runway	Dimensions	Elevation of runway thresholds
16/34	3700 x 60 m	1390/1386 ft AMSL
14/32	3300 x 60 m	1402/1402 ft AMSL
10/28	2500 x 60 m	1391/1416 ft AMSL

The airport reference point (ARP) has the coordinates N 47° 27.5' / E 008° 32.9' and an elevation of 1384 ft. The reference elevation of the airport is 1417 ft AMSL and the reference temperature is 24.0 °C.

According to the AIP, the distance between the runway threshold and the aiming point of runway 16 is 500 m.

1.8.2 Approach procedure according to visual flight rules

The following visual approaches were published for Zurich airport in the aeronautical manual (VFR Manual) for Switzerland: runways 10, 14, 28, 32 and 34. A visual approach procedure on runway 16 was not published.

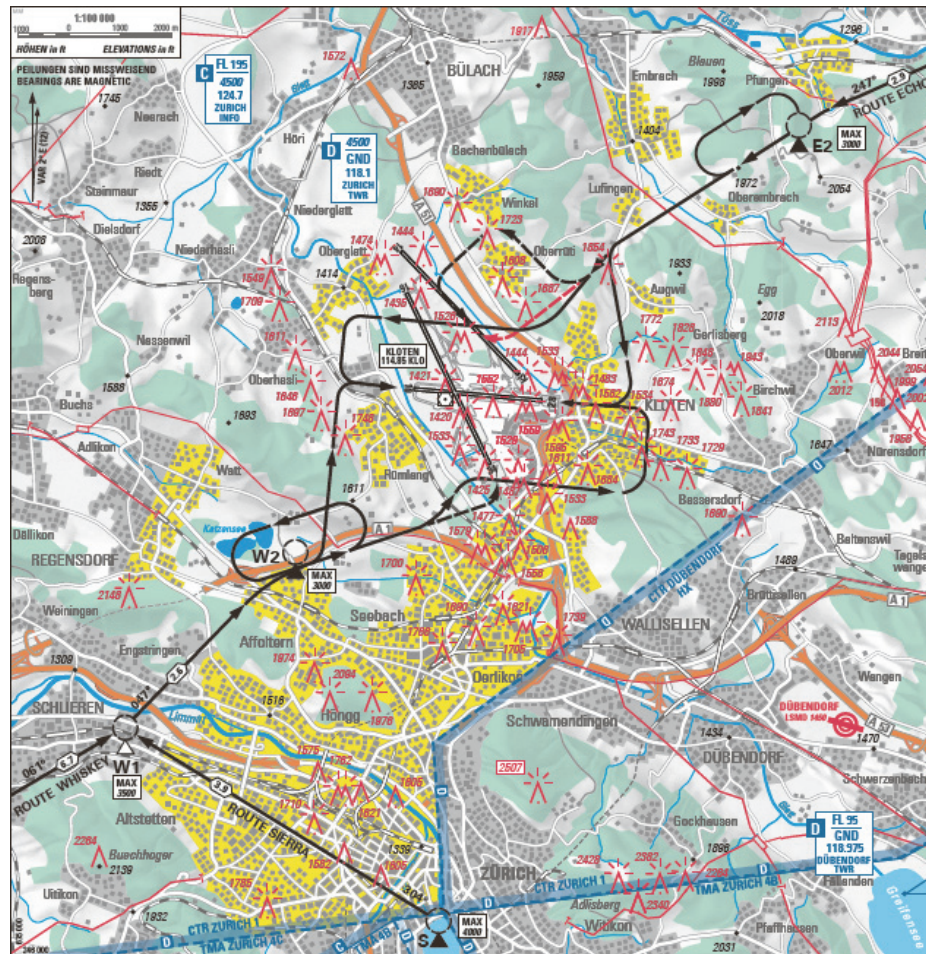


Figure 3: Visual approach chart (VAC) with specified flight paths on runways 10, 14, 28, 32 and 34.

1.8.3 Complexity at Zurich Airport

The procedures and traffic operations at Zurich airport are characterised by a high degree of complexity. Among other things, the SAIB established this in its final report no. 2136 concerning the serious incident at Zurich airport on 15 March 2011 and in the process listed a number of serious incidents in the past decade. The issue of the intersection of the two runways 28 and 16 was a major factor in many of these serious incidents.

At many international airports which are comparable with Zurich in terms of volume of traffic, visual flights are severely restricted and training flights are prohibited.

Visual approaches on runway 16 are seldom carried out on runway 16.

1.8.4 Authorisation of training flights

In principle, arrivals and departures under visual flight rules (VFR) in the Zurich airport control area (CTR) are subject to the slot³ obligation. According to this, in order to regulate the volume of VFR traffic, every pilot is required to apply to the competent body at Zurich airport for an airport slot before a flight.

The approval of training flights in the Zurich CTR was within the competency of the duty supervisor; however, corresponding regulations or standards did not ex-

³ Slot: time window of an air traffic control unit for take-off or landing

ist. The two duty supervisors working on the day before and on the day of the incident indicated that they would in principle authorise touch-and-go landings only during periods of light traffic. Pilots would also be informed by phone that depending on the volume of traffic, changes in the schedule, delays or cancellations could be expected.

Both supervisors referred to the survey flights and the associated potential consequences in their telephone conversations with the flight instructor. On the day before the incident, the supervisor intimated a touch-and-go on runway 14 could probably not be expected, because of the anticipated arrival traffic.

Air traffic management of the authorised training flight lay within the competency of the ADC controller.

1.9 Provision of traffic information

The air traffic management manual (ATMM) for Switzerland states the following, among other things, with regard to traffic in Class D airspace (ATMM Switzerland 4-2.2 Section 4):

In airspace Class D:

- *IFR flights are separated from other IFR flights and receive traffic information in respect of all other flights*
- *VFR flights receive traffic information in respect of all other flights.*

In the present serious incident, the crew of HB-WYC first received traffic information at 14:15:35 UTC, after they had been instructed to initiate a 360° turn to the right: *"tight turn, traffic departing out of runway two eight"*.

The crew of DWT 124 first received traffic information at 14:15:46 UTC, when the aircraft had lifted off and the closest point of approach with HB-WYC occurred: *"Darwin one two four, just for information, traffic on your right-hand side staying clear of runway two eight is doing an orbit."*

1.10 Additional information

1.10.1 RIMCAS collision warning system

In 2010, a collision warning system (runway incursion monitoring and conflict alert sub-system - RIMCAS) was commissioned in the Zurich control tower. The RIMCAS warning system, which was integrated into the Swiss Airport Movement Area Control System (SAMAX) ground radar, supported the air traffic controllers in monitoring the movements of aircraft and vehicles on the runway system at the airport. skyguide noted in this context in service order (SO) OZ 2010-034E:

"The objective of RIMCAS is to assist the controller in preventing collisions on the active RWY(s) between aircraft and/or other mobiles by generating an alert (visual and/or audio) on actual or potential conflicts in a timely manner."

In the event of hazardous convergences, the warning system generates two different types of alert: a stage 1 alert and a stage 2 alert. The two alerts are described in the Skyguide service order as follows:

- *Stage 1 alert – INFORMATION – is used to inform the ATCO that a situation which is potentially hazardous may occur. INFORMATION is visual only.*
- *Stage 2 alert – ALARM – is used to alarm the ATCO that a critical situation is developing or exists which may require immediate attention/action. ALARM alert is both visual and audio.*

The service order states that a stage 1 alert (information) usually precedes a stage 2 alert (alarm), but that there may also be situations - such as in the serious incident currently under investigation - in which the system directly generates an alarm (stage 2 alert) without first generating a stage 1 alert.

Since 2010, the system has undergone continuous further development and the altitude setting was adjusted in such a way that aircraft are visible on the SAMAX-screen not only on the ground but also up to a height of approximately 300 feet above ground.

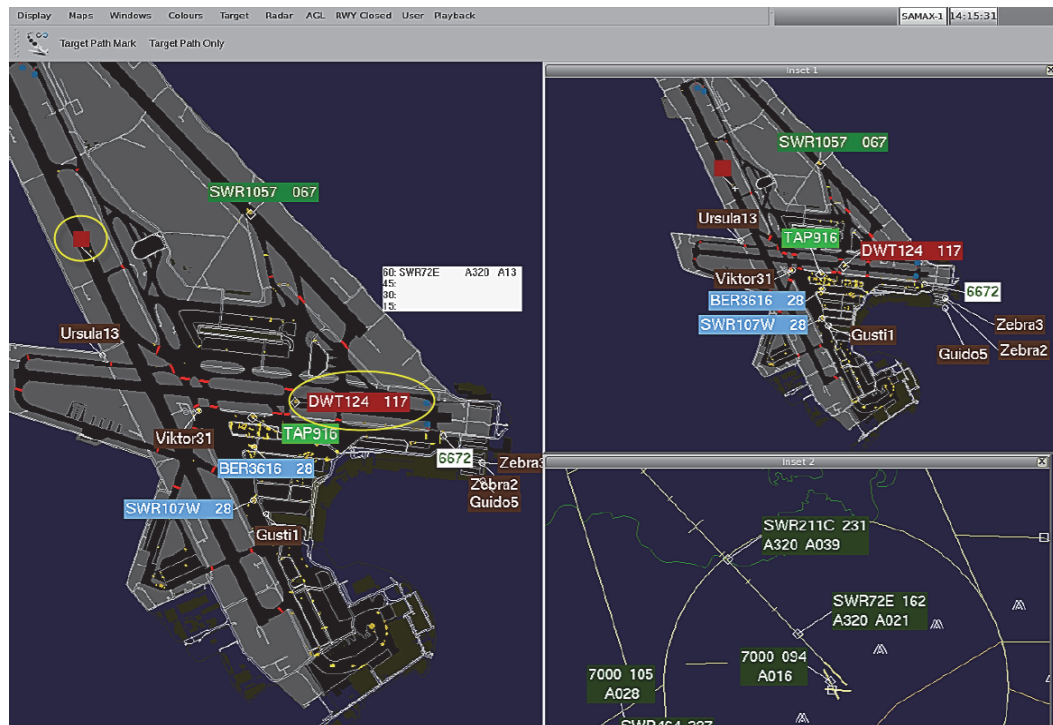


Figure 4: SAMAX image 14:15:31 UTC with the two aircraft circled in yellow, at the moment the RIMCAS alarm was triggered

In the serious incident under investigation, the ground radar detected HB-WYC in a position approximately 1000 m before the intersection of runways 16 and 28. At this point, DWT 124 was also approximately 1000 m from the 16/28 intersection, on its take-off roll. Some four seconds later, at 14:15:31 UTC, the RIMCAS system generated a stage 2 alert; the tags of the two aircraft on the screen changed to red and an aural alarm ("*RIMCAS*") was triggered.

2 Analysis

2.1 Technical aspects

There are no indications of any pre-existing technical faults which might have caused the serious incident.

2.2 Human and operational aspects

2.2.1 Air traffic control

When the air traffic controller took over his ADC workstation at approximately 14:10 UTC, the crew of HB-WYC had already carried out several touch-and-go landings on runways 28, 34 and 10. In response to an enquiry from the ADC controller, the crew expressed their desire to approach runway 16 next.

At 14:10:24 UTC the ADC controller instructed the crew of HB-WYC to head towards reporting point W2. He therefore knew that HB-WYC was south of the centreline of runway 28 and in this way avoided a possible conflict with the planned take-off of a commercial aircraft on runway 28. After the crew of HB-WYC had confirmed visual contact with the aircraft on take-off, the ADC controller instructed the crew of HB-WYC to join the right-hand downwind of runway 16, with a reference to possible wake turbulence. By doing this, he allowed HB-WYC to cross the runway 28 centreline behind the commercial aircraft which was making its initial climb. This instruction was constructive and allowed a controlled crossing of the runway axis of runway 28. At this time this runway was available mainly for departing traffic and therefore represented a potential conflict in the planning of the touch-and-go landings by HB-WYC on runway 16.

Since there was constant arrival traffic on runway 14, HB-WYC was also instructed to turn onto the base leg not later than the threshold of runway 16. In the process, the ADC controller specified only a northern limit to the flight path. However, the lack of a southern limit to the flight path left it to the crew of HB-WYC to define the base leg and the final approach (final) for the touch-and-go landing on runway 16 at their sole discretion. To implement the instruction from the ADC controller, the flight instructor instructed the pilot of HB-WYC to head towards the runway 16 aiming point in the base leg. As a result, the flight path of HB-WYC was significantly shortened.

At 14:14:50 UTC, when the crew of HB-WYC reported their position "*right-hand base, runway one six*" the ADC controller immediately instructed them to continue their approach. Eight seconds later, at 14:14:58 UTC, the ADC controller cleared DWT 124 to take off on runway 28 (cf. Annex 1). This sequence of events suggests that the ADC controller judged the exact position of HB-WYC incorrectly. This is reflected, for example, by the fact that he did not instruct the crew of DWT 124 to speed up their take-off (e.g. expedite departure); nor did he provide traffic information in relation to HB-WYC. Even later, when the air traffic controller was giving an instruction to the crew of DWT 124 then HB-WYC, the situation did not appear to him to be critical.

Only when DWT 124 was already on its take-off roll did the ADC controller become aware of the impending conflict. He instructed the crew of HB-WYC to initiate a 360° turn to the right. A short time later he clarified his instruction, to perform a tight 360° turn together with the justification. A few seconds later, at approximately the time of the closest point of approach, he provided the crew of DWT 124, which was taking off, with traffic information in relation to HB-WYC, which had already initiated its 360° turn.

This sequence of instructions and information to the two crews within a short time meant that each aircraft was informed very late about the position of the other

aircraft. Also, the ADC controller had the intention of resolving the conflict involving the two aircraft by locally restricting the flight path of HB-WYC. The ATCO did not instruct DWT 124 to abort its take-off because its speed, in his estimation, was already too high. With regard to the risks involved at high speeds in the event of an aborted take-off, the ATCO's decision in this situation is understandable. The instruction to the crew of HB-WYC, to perform a tight 360° turn close to the ground, was appropriate from the perspective of the air traffic controller, but demanded exacting piloting requirements and therefore involved additional risks.

The traffic information from the ADC controller to the crew of DWT 124 was given only after the latter had been made aware of the near-collision by the on-board traffic alert and collision avoidance system (TCAS). Because of the low height above ground, the system could not generate a resolution advisory (RA), so the last safety net to prevent two aircraft converging or colliding did not come into play. The traffic information to the crew of DWT 124 came too late and did not help to resolve the conflict in a timely manner.

2.2.2 Crews

2.2.2.1 DWT 124

After the initial call on the aerodrome control centre frequency, the crew of DWT 124 received clearance at 14:13:09 UTC to taxi to the take-off position on runway 28. At this point, HB-WYC was on the downwind of runway 16 and at 14:13:24 UTC received the instruction to turn onto the base leg no later than the threshold of runway 16. At 14:14:50 UTC, the crew of HB-WYC made their position report on the base leg. Before the crew of DWT 124 could begin their take-off from runway 28, two aircraft crossed runway 28. At the time of the take-off clearance, at 14:14:58 UTC, HB-WYC was on the base leg just before turning onto its final approach on runway 16.

For almost two minutes, the crew of DWT 124 was therefore able to monitor the radio conversations on the aerodrome control centre frequency. When turning onto a runway various checklist points are processed in the cockpit of a commercial aircraft, and this means that attention is focused unconsciously on one's own radio call sign. The fact that in this phase the frequency was occupied by unnecessary transmissions of private conversations and noise on the carrier frequency further restricted perception, or was otherwise distracting. This can mean that calls destined for other aircraft are masked out. Although the crew of DWT 124 were aware of the presence of a light aircraft in the area of the aerodrome, they could not accurately estimate its position and so were unable to prevent the dangerous convergence on their own.

When DWT 124 was given take-off clearance, HB-WYC was in a position which is difficult or impossible to perceive visually from the threshold of runway 28. Appropriate traffic information was not provided by the ADC controller. Furthermore, the TCAS on the Saab 2000 (cf. 1.3.1.2) gave the crew on the ground no means of identifying another aircraft on the navigation display (ND). This information is available to the crew only when the aircraft is already in the air and is therefore unsuitable for comprehensive situational awareness on the ground. Since the crew on the ground had no information about aircraft flying within a certain range, their situational awareness was unnecessarily restricted, which was a factor in the origin of the serious incident.

It is therefore not surprising that the crew of DWT 124 were surprised shortly after take-off by the traffic advisory (TA) "*traffic, traffic*" generated by the on-board TCAS. This prompted the commander to look to the right in the direction of the displayed aircraft. When he could then establish visual contact with HB-WYC and

recognize the danger, he increased the rate of climb to avoid this aircraft vertically. In view of the fact that according to the configuration of the TCAS at this low height above ground, no resolution advisories (RA) are generated, this action was appropriate and ensured that the hazard did not increase. The airspeed did not fall below the minimum airspeed for a safe initial climb (minimum take-off safety speed - V_2), which indicates that the manoeuvre was carried out cautiously.

2.2.2.2 HB-WYC

When the crew, after a series of touch-and-go landings, were cleared to join the downwind of runway 16, at 14:13:24 UTC the instruction was given to initiate the base leg no further north than the threshold of runway 16. With the good intention of obeying the ADC controller's instruction, the flight instructor instructed the pilot of HB-WYC to head towards the runway 16 aiming point in the base leg. This tactic significantly shortened the approach, but corresponded to the ADC controller's instruction.

After the flight instructor had heard an instruction for an aircraft on runway 28, he instructed the pilot not to descend any further. A short time later, the flight instructor could see that a Saab 2000 had initiated its take-off procedure on runway 28. When the instructor had become aware of the impending conflict, he prepared himself mentally to avoid the Saab 2000, which was taking off, by turning left over the control tower. The subsequent instruction from the ADC controller to the crew of HB-WYC to initiate a tight 360° turn the right was implemented without delay. Although the flight instructor on-board HB-WYC recognized the impending conflict on the basis of his perceptions and acted foresightedly with his instruction to the trainee pilot, at this moment he did not, however, have an overview of the flow of traffic on the airport. He therefore obeyed the avoidance instruction of the controller and did not adopt any flight path which deviated from this. Owing to time constraints, there was no way to agree a different approach with the ADC controller or to inform him of such.

Performing a tight turn at a high bank angle with flaps extended near the ground is challenging and requires a high degree of concentration. As a result of the instructor's good situational awareness, the crew of HB-WYC were not unprepared when confronted with this near-collision. This is also demonstrated by the fact that the flight instructor confirmed the instruction to make a tight turn without delay, especially as the instruction for the flight path after the touch-and-go on runway 16 had been given just 30 seconds before. The fact that there were two pilots on board HB-WYC undoubtedly contributed to ensuring that this turn close to the ground, which entailed risk, did not lead to an uncontrolled flying condition.

2.2.3 RIMCAS collision warning system

When HB-WYC turned onto the final approach on runway 16, it was detected by the ground radar for the first time. At this point, HB-WYC was at an altitude of less than 1700 ft AMSL. This altitude is covered by the altitude setting of the Swiss Airport Movement Area Control System (SAMAX), which made aircraft visible on the screen up to a height of approximately 300 feet above ground.

At the time of the initial detection by the ground radar, HB-WYC was in a position approximately 1000 m before the intersection of runway 16 with runway 28. At this time, DWT 124 was on its take-off roll and also approximately 1000 m before the 16/28 intersection. The approximately four seconds until the triggering of the stage 2 alert, at 14:15:31 UTC, can be explained by the system's response time.

Immediately before this, at 14:15:30 UTC, the ATCO's instruction to the crew of HB-WYC to initiate a 360° turn to the right was given. The chronological sequence of events indicates that in the present case the Runway Inursion Monitoring and Conflict Alert Sub-System (RIMCAS) was unable to provide an early warning to the ATCO.

However, it should be noted that RIMCAS was primarily designed for the prevention of collisions on the ground.

2.2.4 Procedures

2.2.4.1 Training flights at Zurich Airport

On the day before the incident and on the day of the incident, approximately 30 minutes before take-off in Lommis, the flight instructor had coordinated the planned training flight with the Zurich control tower supervisor and had requested four to five touch-and-go landings on different runways. Telephone reservation of training flights at Zurich airport is intended to ensure that training flights can be made possible at times when the volume of traffic is low. However, this does not preclude mixed traffic involving aircraft with very different performance data and procedures. In addition, the fact that the planned touch-and-go landings were envisaged on runways which differed from, or were even counter to, the runways used for handling regular arrival and departure traffic, increased the complexity. This near-collision makes it clear that insufficient attention was paid to this circumstance at Zurich airport.

In relation to the operation of training flights with touch-and-go landings on different runways, no specific rules are applicable in Zurich. Since a survey flight was already envisaged that same afternoon in the low-traffic period from 12:00 UTC to 13:30 UTC and since no VFR slots were assigned until 13:45 UTC for this reason, on the preceding day the supervisor authorised this flight only after 14:00 UTC. This decision was made by the slot allocation system, which ensured that the training flight time did not coincide with the survey flight. However, this meant that the training flight fell within a period in which increased arrival and departure traffic involving commercial aircraft could be expected. The decision to authorise the HB-WYC training flight at that time and thereby to further increase the complexity unnecessarily therefore makes little sense and contributed to the origin of the serious incident.

The coordination conversations do not give any indication of any restriction in the maximum number of desired touch-and-go landings in advance. In addition to runway 14, which was in active use for arrival traffic in the envisaged timeframe, there were also no restrictions in relation to the runways available for selection for touch-and-go landings. Although the training flight was authorised the previous day for 14:00 UTC without any conditions, the ADC controller is in principle free to refuse such flights, to shorten them or to send aircraft into holding patterns. A high level of motivation to provide service is one of the hallmarks of good air traffic control. In the case in question, the ATCO tried to handle a complex training flight, and at the same time avoid any delay affecting the scheduled traffic. The resulting near-collision shows that the principle of high motivation to provide a good service was taken too far in this instance.

2.2.4.2 Approach procedures according to visual flight rules at Zurich airport

In contrast to approaches according to visual flight rules (VFR) on runways 10, 14, 28, 32 and 34, no regulations exist for the approach on runway 16 (cf. Figure 3).

This fact does give a degree of latitude to the air traffic controller in terms of the configuration of traffic procedures, thereby increasing the essential flexibility in the planning of a visual approach on runway 16, in order to accommodate the complexity at Zurich airport. However, the lack of regulations for a visual approach procedure places an increased workload on the air traffic controller in the form of mandatory instructions to the flight crew regarding the flight path, and a greater focus on monitoring. It seems that this circumstance was an essential prerequisite for the origin of the serious incident.

Visual approaches were seldom carried out on runway 16. Therefore the air traffic controller lacked specific empirical values, and this favoured the origin of the serious incident under investigation.

2.3 Obligation to report

The flight instructor on-board HB-WYC assumed that the other parties involved would report the incident. Just because other parties are involved in an incident does not release one from the obligation to submit a report (cf. 1.7) and may lead to a serious incident not being investigated and no lessons being drawn from it. A personal or professional connection to another involved party cannot be any justification for failing to report a serious incident.

The pilot stated that he was not in a position to assess the risk adequately and therefore refrained from filing a report. Even when one makes a flight as a pilot in the presence of a flight instructor, one is obliged to report irregularities either as crew or, if this is not possible, individually.

The ADC controller assessed the situation as non-critical and therefore refrained from submitting a report. Even though he was at a rather greater distance from the events than the two crews, this evaluation cannot be satisfactorily explained.

As an enquiry addressed to representatives of the air navigation services provider indicated, it must be assumed that other air traffic controllers would have assessed this situation in the same way as the controller involved.

The fact that this situation was perceived to be non-critical, even though it involved a high risk of collision, proves that certain hazards in day-to-day work are not perceived as such. This lack of risk assessment was established as a systematically contributing factor in the origin of the near-collision.

The crew of DWT 124 assessed the hazard correctly and were the only party involved in the serious incident to submit a report. They therefore enabled this investigation to take place and made a contribution to aviation safety.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft involved were licensed for transport.
- The investigation did not produce any indications of pre-existing technical faults which might have caused or influenced the serious incident.

3.1.2 Crew

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

3.1.4 History of the flight

- The crew of HB-WYC reported at 13:43:14 UTC to Zurich tower and requested multiple touch-and-go landings on different runways at Zurich airport.
- The crew of HB-WYC conducted touch-and-go landings on runways 28, 34 and 10 and intended making a touch-and-go landing on runway 16.
- At approximately 14:10 UTC, a shift changeover took place at the ADC workstation.
- At 14:12:31 UTC the crew of HB-WYC received clearance to join the right-hand downwind for runway 16.
- At 14:13:07 UTC the crew of DWT 124 reported to Zurich tower that they were ready for take-off short of runway 28 and received clearance to taxi into position on runway 28.
- At 14:13:24 UTC the ADC air traffic controller instructed the crew of HB-WYC to make the base turn no further north than the threshold of runway 16.
- At 14:14:50 UTC the crew of HB-WYC reported they were on the right-hand base leg of runway 16.
- At 14:14:58 UTC, the ADC controller cleared DWT 124 to take off on runway 28.
- At 14:15:30 UTC the crew of HB-WYC received the instruction to initiate a 360° turn to the right; they did this immediately at a height of approximately 250 ft above the ground.
- At 14:15:35 UTC the crew of HB-WYC received traffic information for the first time regarding DWT 124, which was taking off.
- Shortly after take-off, the crew of DWT 124 received a traffic alert from their TCAS at 14:15:37 UTC: "*traffic, traffic*" and increased their rate of climb.

- At 14:15:46 UTC, the ADC controller provided the crew of DWT 124, which had taken off, with traffic information concerning HB-WYC for the first time.
- At 14:15:52 UTC the two aircraft converged to a lateral distance of 205 m and an altitude difference of 75 ft.
- Only the crew of DWT 124 complied with their reporting obligation and submitted an air safety report (ASR) after the flight.

3.1.5 General conditions

- The HB-WYC training flight had been coordinated with the supervisor of the control tower in Zurich by phone on the day before and on the day of the incident.
- Between 11:58 UTC and 13:44 UTC survey flights took place at Zurich airport. Visual flights were not permitted during this period.
- No visual approach route on runway 16 was published in the visual approach chart (VAC) for Zurich airport.
- The weather conditions had no influence on the near collision.

3.2 Causes

The serious incident is attributable to a near-collision because the air traffic controller gave take-off clearance on runway 28 to a commercial aircraft while a light aircraft was on its approach to runway 16.

The incorrect assessment of the situation by the air traffic controller was established as a direct causal factor for the serious incident.

The following factors were identified as systemic factors contributing to the origin of the serious incident:

- Risk assessment by air traffic control was inadequate.
- A complex training flight was taking place at a time when the volume of traffic was increasing and at medium complexity.
- Because visual approaches were rarely carried out on runway 16, there were only few values derived from experience on which one could have relied when carrying out ones planning.
- The TCAS fitted on the commercial aircraft did not provide any information to the crew on the ground about other aircraft, and this restricted their situational awareness.

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

- Air traffic control instructed the light aircraft which was in landing configuration and close to the ground to perform a tight 360° turn to resolve the conflict.
- Misinterpreted motivation to provide service on the part of air traffic control.

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 Systemic safety deficit

Since 2008, on or in the immediate vicinity of Zurich airport, comparable serious incidents have occurred in which special flights contributed to the origin of the respective serious incident:

- Final Report No. 2047: Oltra 212 vs BER 966Z, 31 July 2008: Helicopter flight for photography purposes over Rümliang.
- Final Report No. 2136: SWR 1326 vs SWR 202W, 15 March 2011: Survey flight.
- Current investigation: SWR 119D vs SWR 18, 22 March 2013: photography flight west of Zurich airport.

Also, in the present case a complex training flight with touch-and-go landings took place on different runways at a time when the volume of traffic was increasing and complex.

4.1.2 Safety Recommendation No. 481

In cooperation with Zurich airport and the skyguide air navigation services provider, the Federal Office of Civil Aviation (FOCA) should define or where necessary amend general conditions for the safe handling of special flights.

4.2 Measures taken since the serious incident

The following measures were taken by the air navigation services provider skyguide since the serious incident:

- Sensitisation of air traffic controllers regarding standardised procedures to reduce complexity
- Addressing the importance of traffic information to aerodrome traffic (IFR and VFR) to increase situational awareness of flight crews

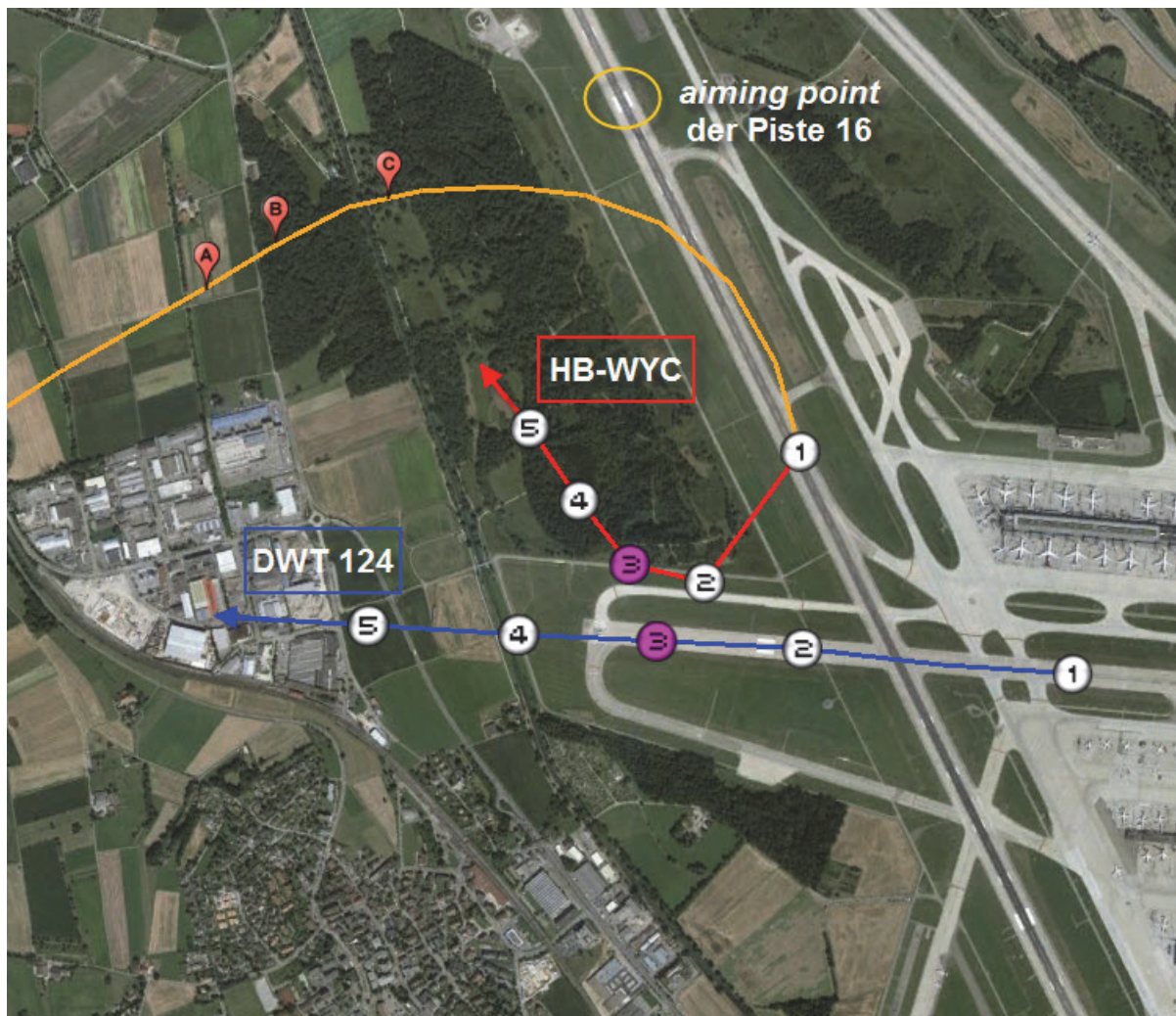
Payerne, 21 January 2014

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, 4 September 2014

Annex 1: Recording of the two flight paths using Mode-S data

**Legend:**

- Blue line** Flight path of the Saab 2000 (DWT 124).
- Orange line** Flight path of HB-WYC before take-off of the Saab 2000 from runway 28.
- Red line** Flight path of HB-WYC after take-off of the Saab 2000 from runway 28.
- 1 – 5 Positions of the two aircraft at the same time from 14:15:37 UTC to 14:16:02 UTC.
- 3 Position of the two aircraft at the time of the closest point of approach (14:15:52 UTC)
- A HB-WYC: "Right-hand base, runway one six, Hotel Yankee Charlie."
- B ADC: "Darwin one two four, wind three three zero degrees, seven knots, runway two eight, cleared for take off."
- C ADC: "Hotel Yankee Charlie, after touch and go then, join a left-hand downwind for runway two eight."