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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report no. 2136 of the Swiss Accident Investigation Board SAIB

concerning the serious incident - airprox

involving the Airbus A320-214 aircraft, registration HB-IJH,

operated by Swiss International Airlines

under radio callsign SWR 1326

and the Airbus A320-214 aircraft, registration HB-IJW,

operated by Swiss International Airlines

under radio callsign SWR 202W

on 15 March 2011

at Zurich airport

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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 times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the serious incident, Central European Time (CET) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is:
LT = CET = UTC + 1 hour.

Contents

Final Report

Synopsis

Aircraft 1	
Owner	NBB Owl Co. Ltd., 8034 Zurich, Switzerland
Operator	Swiss International Airlines
Manufacturer	Airbus S.A.S., Toulouse, France
Aircraft type	A320-214
Country of registration	Switzerland
Registration	HB-IJH
Commercial flight number	LX1326
ATC callsign	SWR 1326
Radio callsign	Swiss one three two six
Flight rules	IFR
Type of operation	Scheduled flight
Departure airport	Zurich (LSZH)
Destination	Moscow Domodedovo International Airport (UUDD)
Aircraft 2	
Owner	International Lease Finance Corp., Los Angeles, USA
Operator	Swiss International Airlines
Manufacturer	Airbus S.A.S., Toulouse, France
Aircraft type	A320-214
Country of registration	Switzerland
Registration	HB-IJW
Commercial flight number	LX2026
ATC callsign	SWR 202W
Radio callsign	Swiss two zero two whiskey
Flight rules	IFR
Type of operation	Scheduled flight
Departure airport	Zurich (LSZH)
Destination	Madrid-Barajas Airport (LEMD)
Location	Zurich Airport LSZH, runways 16 and 28 Swiss territory
Date, time	15 March 2011, 11:43 UTC
ATS unit	Aerodrome control Zurich, ADC workstation
Airspace	Class D
AIRPROX category	ICAO category A - high risk of collision

Investigation

The serious incident occurred on 15 March 2011 at 11:43 UTC. The notification was received by the Aircraft Accident Investigation Bureau (AAIB) on the same day at 13:00 UTC. After preliminary clarifications, which are usual with this type of serious incident, the investigation was opened on 17 March 2011.

The investigation report is published by the Swiss Accident Investigation Board (SAIB).

Summary

On 15 March 2011 at 11:41:15 UTC, the Swiss International Airlines Airbus A320-214 aircraft, with the ATC callsign SWR 1326, received clearance to taxi to the take-off position on runway 16. While taxiing to the take-off position, the air traffic control officer (ATCO) of aerodrome control (ADC), cleared SWR 1326 for take-off at 11:42:19 UTC. The crew of SWR 1326 acknowledged this clearance and initiated their take-off roll at 11:43:12 UTC.

At 11:43:05 UTC the Swiss International Airlines Airbus A320-214 aircraft, with the ATC callsign SWR 202W, which was waiting in the take-off position on runway 28, received clearance for take-off. The crew acknowledged this clearance and immediately initiated their take-off roll.

During the take-off roll, at 11:43:47 UTC, the crew of SWR 202W noticed SWR 1326, which was converging from the right on runway 16, and immediately initiated an aborted take-off. At approximately the same time, the ADC air traffic control officer gave the crew of SWR 202W the order to immediately abort their take-off.

The speed of SWR 202W at this time was 135 kt. The aircraft came to a standstill in the safety area of runway 16 and then taxied to the assigned stand.

The crew of SWR 1326 had not noticed the serious incident and continued their flight to their destination.

Causes

The serious incident is attributable to the fact that the air traffic control officer concerned gave take-off clearance to an aircraft on runway 28 although another aircraft on runway 16, to which he had given take-off clearance shortly before, was still on its take-off roll. The result was that an inadvertent convergence of these aircraft occurred, involving a high risk of collision.

The following factors significantly contributed to the genesis of the serious incident:

- At a time with a very high volume of traffic at Zurich airport, survey flights were being carried out, which increased the complexity of operation for air traffic control.
- The air traffic control officer concerned was engaged on tasks which did not have a high priority at this time.
- The aerodrome control centre work concept allowed only inadequate mutual support in the case of a high volume of traffic and in general did not feature any monitoring for early detection and correction of errors.
- The air traffic control's collision warning system was inappropriate for resolving the impending conflict.

The genesis of the serious incident was favoured by the complex operation on two intersecting runways which is subject to a small error tolerance in the event of a high volume of traffic.

Safety recommendations

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

According to the provisions of Annex 13 of the ICAO, all safety recommendations listed in this report are intended for the supervisory authority of the competent state, which has to 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, addresses implementation orders or recommendations to the FOCA.

[2] The FOCA informs DETEC periodically about the implementation of the orders or recommendations pronounced.

[3] DETEC informs 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

For the following description of the pre-history and the history of the serious incident, the recordings of the radiocommunication, the cockpit voice recorder (CVR), the digital flight data recorder (DFDR), various radar systems and the statements of the crew members, air traffic control officers and technical specialists were used. In addition, a simulation of the events was analysed in the Skyguide tower simulator (TOSIM).

On the aircraft involved, the respective crews consisted of a commander and a copilot.

On aircraft SWR 1326 on runway 16 the commander was pilot not flying (PNF) and the copilot was pilot flying (PF).

On runway 28, the commander was acting as pilot flying (PF) and the copilot was acting as pilot not flying (PNF) in the SR 202W aircraft.

In the Zurich tower (TWR) the aerodrome control (ADC), ground control (GRO), clearance delivery (CLD) and supervisor (SPVR) workstations were occupied.

The serious incident occurred within the area of responsibility of the aerodrome control (ADC) air traffic control officer. Radiocommunications took place on the 118.100 MHz frequency.

1.1.2 Pre-history

The ADC air traffic control officer had been working at the GRO workstation until approximately ten minutes before the serious incident.

According to the statement by the air traffic control officer (ATCO) at the ADC workstation, a high volume of traffic with a high degree of complexity prevailed at the time of the serious incident. The high volume of traffic related to the increasing departure traffic. The air traffic control officer justified this assessment mainly with reference to the mission of a survey aircraft which took off a few minutes before the serious incident (cf. chapter 1.7.2). During his activity as GRO he had already received the flight programme of this survey aircraft and dealt with it. After the switch to the ADC workstation, he continued to deal with it.

The ATCO at the GRO workstation assessed the traffic volume as high and the complexity as normal.

At the ADC workstation a warning system was installed which is intended to warn ATCOs of potential collisions on the ground between aircraft and between aircraft and vehicles (cf. chapter 1.9 and Annex 1).

1.1.3 History of the serious incident

On 15 March 2011 the crew of the Swiss International Airlines Airbus A320-214 aircraft, registration HB-IJW, with the ATC callsign SWR 202W, reported to Zurich tower at 11:37:34 UTC. The aircraft was behind other aircraft and ready for take-off short of runway 28. At 11:37:38 UTC, the crew received the following clearance: *"Hello Swiss two zero two whiskey, tower, behind company airbus, line up runway two eight behind."*

Originally it was intended to let SWR 202W take off from runway 28 before SWR 1326 on runway 16. However, the ADC air traffic control officer decided for the following reason to have SWR 1326 take off on runway 16 before SWR 202W on

runway 28: an aircraft was approaching runway 14 and was at a distance of eleven nautical miles (NM) from the runway threshold. Once this aircraft reached a distance of 8 NM from the runway threshold, a take-off from runway 16 would have been possible only after this aircraft had landed[1]. The decision was agreed with the GRO controller. The latter changed the order of the departure strips at 11:39:56 UTC, and this was displayed accordingly in the tower and approach communication system (TACO) (cf. chapter 1.10).

The crew of the other airbus A320-214, registration HB-IJH, of Swiss International Airlines, with the ATC callsign SWR1326 was at this time in contact with Zurich apron north and was taxiing on taxiway ECHO to the holding point for runway 16. The aircraft was approximately 700 m before the holding point for runway 16, when at 11:41:14 UTC the crew reported to the ADC air traffic control officer as follows: *"Hello swiss one three two six, ready when reaching".* The crew immediately received clearance from the ATCO to taxi to the take-off position on runway 16.

Just a few seconds later a third Airbus A320 aircraft reported on the Zurich ground (GRO) frequency in order to cross runway 28 on taxiway ECHO. The GRO air traffic control officer received clearance to cross from the ADC controller, whereupon the GRO air traffic control officer activated the runway blocking and gave the Airbus crew clearance to cross runway 28. As a result of the activation of the runway blocking, runway 28 was shown in red on all screens at the workstations in the tower (cf. chapter 1.9.3).

At 11:42:07 UTC the GRO air traffic control officer was called by a private business jet aircraft, registered as D-AJJK, whose callsign he did not, however, understand.

On the basis of the changed take-off sequence, at 11:42:19 UTC the ADC air traffic control officer gave the crew of SWR 1326 take-off clearance as follows: *"Swiss one three two six, wind zero two zero degrees seven knots, runway one six cleared for take off".* At this time, SWR 1326 was still on taxiway ECHO, approximately 50 m before the beginning of runway 16, and confirmed the take-off clearance immediately.

While the take-off clearance was being issued to SWR 1326 the crew of SWR 202W were taxiing to the take-off position on runway 28. As they did so, they had to process the final points of the corresponding checklist (cf. chapter 1.5.2). According to their statement they had not noticed the take-off clearance to SWR 1326 on runway 16; the take-off clearance is clearly audible on the CVR.

After the third Airbus had crossed runway 28, the GRO air traffic control officer de-activated the runway blocking on runway 28 at 11:43:01 UTC and the runway, until then shown illuminated in red on the screens, was again displayed in black. This indicated to the ADC air traffic control officer that runway 28 was once more available to him. Immediately afterwards, at 11:43:05 UTC, he gave the crew of SWR 202W holding on runway 28 the following take-off clearance: *"Swiss two zero two whiskey, wind zero one zero degrees seven knots, runway two eight, cleared for take off."* The crew immediately confirmed take-off clearance and initiated their take-off roll at 11:43:12 UTC. When this take-off clearance was issued by the ATCO, the electronic flight strip for SWR 202W was in second position on the TACO[2] screen above the green dividing line which visually separates aircraft

[1] ATMM Zurich, APP, section 3, 5.14 - Tower stipulates the following: *"IFR separation between departures RWY 16 and approaches RWY 14, departures direction east: When a departure has started take-off roll on RWY 16, no arrival shall be between 8 NM final and threshold 14".*

[2] TACO: Abbreviation for tower and approach coordination. For details cf. chapter 1.10

before take-off from those which have already taken off. Below it and in the first position before the green dividing line, the flight strip for SWR 1326 was still in place.

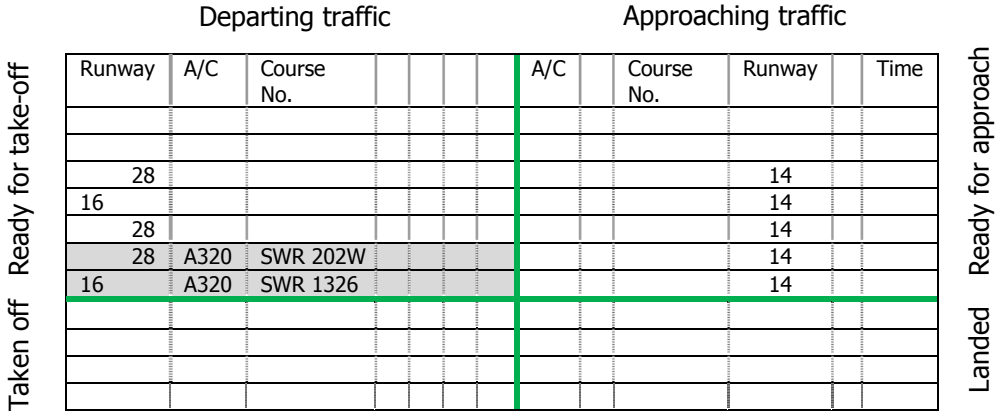


Figure 1: Simplified schematic presentation of the TACO screen at the time of the take-off clearance to SWR 202W.

Whilst the take-off clearance was being issued to SWR 202W, SWR 1326 on runway 16, was already on its take-off roll, and according to the recordings of the digital flight data recorder (DFDR) its speed was a few knots. It had started its take-off roll at 11:43:00 UTC, after it had briefly stopped after taxiing to the take-off position, in order to carry out a so-called standing take-off. This was due to the fact that two engines of different configurtions were installed (cf. chapter 1.5.3). According to the statement of the crew, they had not noticed the take-off clearance given to SWR 202W on runway 28.

At 11:43:20 UTC the crew of D-AJJK made the second call to the GRO air traffic control officer. The ADC air traffic control officer, who had noticed this call, wanted to assist his colleague. He therefore informed the GRO air traffic control officer that it concerned D-AJJK, which was requesting a change of stand on the apron.

At 11:43:40 UTC, a stage 2 alert was triggered by the runway incursion monitoring and conflict alert sub-system (RIMCAS). The blue labels of the two aircraft, SWR 1326 and SWR 202W, on the SAMAX screens changed their colour to red and the acoustic "RIMCAS" alarm sounded (cf. Annex 1). According to the SAMAX recordings, aircraft SWR 1326 was rolling at a speed of 143 kt and aircraft SWR 202W was rolling at 89 kt.

According to his statement, the ADC air traffic control officer was surprised by the alert and believed in the first instant that it was a *"false alarm with a vehicle"*. In addition, he stated that SWR 1326 was no longer present in his mental plan at this point in time. He checked whether a vehicle was close to the runways or whether a landing aircraft was on runway 16. He then realized the two aircraft which were simultaneously on their take-off rolls on runway 16 and runway 28. At 11:43:49 UTC he gave the crew of SWR 202W the order: *"Swiss two zero two whiskey, stop immediately!"* The crew did not respond to this order, since two seconds before they had seen the aircraft taking off from runway 16 and had immediately initiated an aborted take-off (cf. figure 2 and chapter 1. 5.4). When the abort was initiated, SWR 202W was rolling at a speed of 135 kt and SWR 1326, which was lifting off, had a speed of 162 kt. SWR 202W was approximately 550 m before the intersection of runways 16/28.

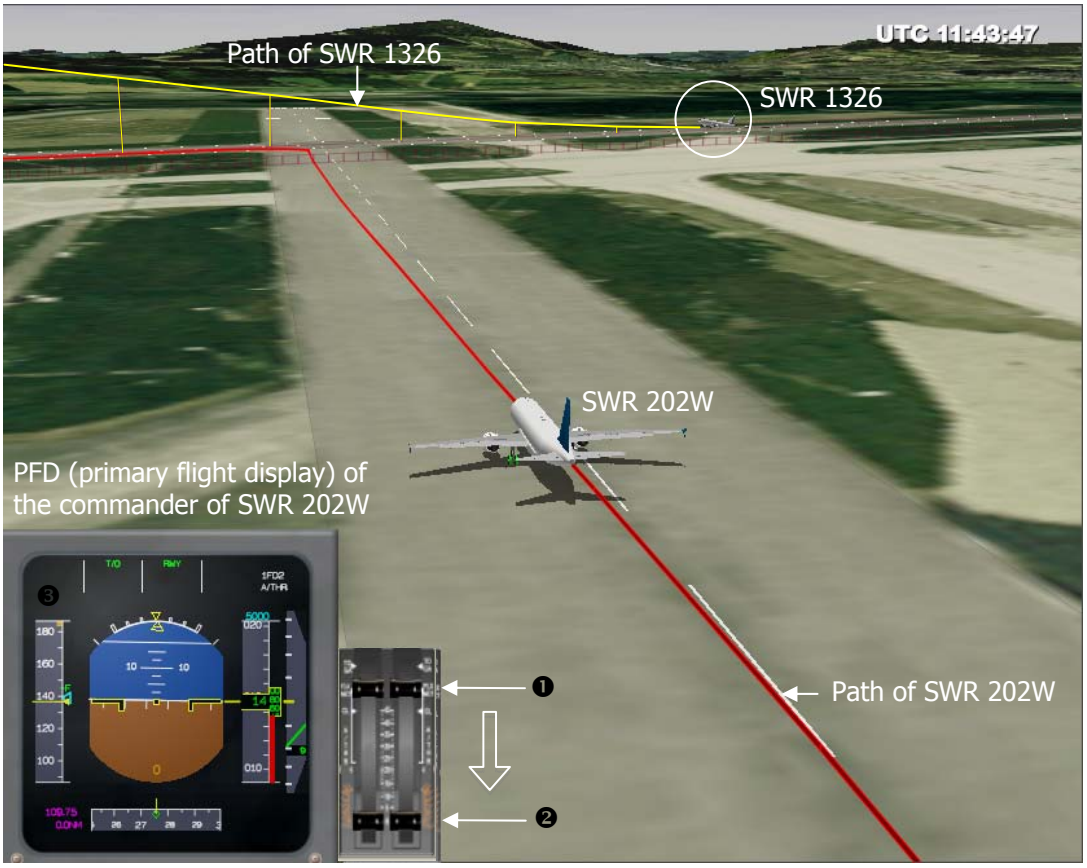


Figure 2: Take-off roll of the two aircraft reconstructed from the flight recorders. Line of sight along runway 28. Time 11:43:47 UTC, when the crew of SWR 202W noticed SWR 1326 and initiated the aborted take-off.

❶ Throttles in take-off position
❷ 1 second later: throttles in idle position
❸ Speed indicator

Figure 3: View from the cockpit of SWR 202W at the same time (11:43:47 UTC). The picture was taken in the tower simulator (TOSIM).

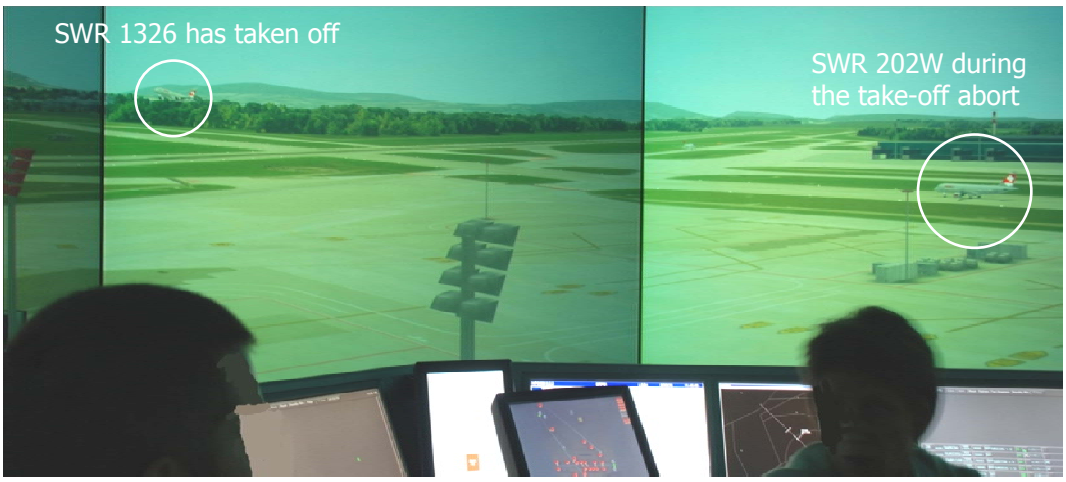


Figure 4: View from the tower, from the ADC workstation, shortly after the aborted take-off of SWR 202W. The picture was taken in the tower simulator (TOSIM).

Figure 5: At the same time: View from the cockpit of SWR 202W after the aborted take-off was initiated. The picture was taken in the tower simulator (TOSIM).

At 11:44:00 UTC the ADC air traffic control officer cleared the take-off message for SWR 1326 on his TACO screen by clicking on his mouse. SWR 1326 had lifted off from the runway shortly before.

SWR 202W came to a standstill in the safety area of runway 16 at 11:44:03 UTC[3]. After a short assessment of the situation, the crew decided to taxi to a stand to the south, via runway 16 and taxiway ECHO. After vacating runway 16, because of their hot brakes, the crew requested that the fire brigade be kept in a state of readiness. This led to alarm 21 being triggered in the control tower.

After a detailed technical inspection of the aircraft by a licensed maintenance company, the aircraft took off approximately two hours later on the planned flight, with a different crew.

The crew of SWR 1326 had not noticed the serious incident during their take-off roll. They continued with their take-off and the flight to their destination. They were informed of the serious incident by the ATCO during the climb.

[3] The recording of the Swiss airport movement area control system (SAMAX) and the statement of the SWR 202W copilot allow the conclusion that the nose of aircraft HB-IJW jutted out onto runway 16 and was therefore partly on the runway 16/28 intersection. The visualisation of the flight recorder data allows the conclusion that the aircraft came to a standstill immediately before runway 16.

The GRO air traffic control officer, who was sitting directly beside the workstation of the ADC controller, was conducting radio conversations on his frequency with the crew of a business aircraft shortly before and at the time of the serious incident.

The ADC air traffic control officer was replaced shortly after the serious incident by another air traffic control officer.

1.1.4 Location of the serious incident

Position	Zurich airport (cf. chapter 1.7)
Date and time	15 March 2011, 11:43 UTC
Lighting conditions	Daylight

1.2 Personnel information

1.2.1 Crew of SWR 1326

1.2.1.1 Commander

1.2.1.1.1 General

Person	Swiss citizen, born 1963
Licence	Air transport pilot licence aeroplane – ATPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the Federal Office of Civil Aviation (FOCA) on 13 February 1996, valid till 14 February 2016.
Ratings	A320 PIC, valid till 6 February 2012 Language proficiency: English level 4, valid till 2 January 2014
Instrument flying rating	Night flying NIT(A) Instrument flight aircraft IR(A) Category III instrument approaches (IR Category III), valid till 6 February 2012
Last proficiency check	Proficiency check on 3 February 2011
Medical fitness certificate	Class 1 & 2, without restrictions Class 1, valid till 29 April 2011
Last medical examination	22 April 2010

1.2.1.1.2 Flying experience

Total	11 722 hours
on the type involved in the incident	4051 hours
of which as commander	1401 hours
during the last 90 days	147 hours

1.2.1.1.3 Crew times

Start of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 15:30 UTC 15 March 2011, 10:25 UTC

End of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 20:06 UTC
Flight duty times in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 4:36 hours
Rest times in the 48 hours before the serious incident	from 13 to 14 March: off duty from 14 to 15 March: 14:19 hours
Flight duty time at the time of the serious incident	1:18 hours

1.2.1.2 Copilot

1.2.1.2.1 General

Person	Swiss citizen, born 1978
Licence	Commercial pilot licence aeroplane - CPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the Federal Office of Civil Aviation (FOCA) on 12 August 2008, valid till 28 January 2016.
Ratings	A320 COPI, valid till 16 September 2011 Language proficiency: English level 5, valid till 19 January 2017
Instrument flying rating	Night flying NIT(A) Instrument flight aircraft IR(A) Category III instrument approaches (IR category III), valid till 16 September 2011
Last proficiency check	Proficiency check on 16 January 2011
Medical fitness certificate	Class 1 & 2 Restriction: VDL (shall wear corrective lenses and carry a spare set of spectacles) valid till 4 October 2011
Last medical examination	16 September 2010

1.2.1.2.2 Flying experience

Total	2150 hours
on the type involved in the incident	2026 hours
during the last 90 days	199 hours

1.2.1.2.3 Crew times

Start of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 15:30 UTC 15 March 2011, 10:25 UTC
End of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 20:06 UTC
Flight duty times in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, 4:36 hours

Rest times in the 48 hours before the serious incident	from 13 to 14 March: off duty from 14 to 15 March: 14:19 hours
Flight duty time at the time of the serious incident	1:18 hours

1.2.2 Crew of SWR 202W

1.2.2.1 Commander

1.2.2.1.1 General

Person	Swiss citizen, born 1967
Licence	Air 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 April 1995, valid till 9 June 2015.
Ratings	A320 PIC, valid till 30 June 2011 Language proficiency: English level 4, valid till 30 June 2013
Instrument flying rating	Night flying NIT(A) Instrument flight aircraft IR(A) Category III instrument approaches (IR category III), valid till 30 June 2011
Last proficiency check	Proficiency check on 6 November 2010
Medical fitness certificate	Class 1 & 2 Restriction: VDL (shall wear corrective lenses and carry a spare set of spectacles) valid till 26 June 2011
Last medical examination	10 June 2010

1.2.2.1.2 Flying experience

Total	12,100 hours
on the type involved in the incident	5966 hours
of which as commander	2070 hours
during the last 90 days	177 hours

1.2.2.1.3 Crew times

Start of duty in the 48 hours before the serious incident	13 March 2011, 13:00 UTC 14 March 2011, 14:09 UTC 15 March 2011, 10:25 UTC
End of duty in the 48 hours before the serious incident	13 March 2011, 20:21 UTC 14 March 2011, 15:29 UTC
Flight duty times in the 48 hours before the serious incident	13 March 2011, 07:21 hours 14 March 2011, 01:20 hours
Rest times in the 48 hours before the	from 13 to 14 March: 19:08 hours

serious incident	from 14 to 15 March: 18:56 hours
Flight duty time at the time of the serious incident	01:18 hours

1.2.2.2 Copilot

1.2.2.2.1 General

Person	Swiss citizen, born 1977
Licence	Air transport pilot licence aeroplane – ATPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the Federal Office of Civil Aviation (FOCA) on 11 November 2008, valid till 30 December 2015.
Ratings	A320 COPI, valid till 11 May 2011 Language proficiency: English level 4, valid till 4 March 2014
Instrument flying rating	Night flying NIT(A) Instrument flight aircraft IR(A) Category III instrument approaches (IR category III), valid till 11 May 2011
Last proficiency check	Proficiency check on 13 September 2010
Medical fitness certificate	Class 1 & 2, without restrictions Class 1, valid till 23 May 2011
Last medical examination	17 May 2010

1.2.2.2.2 Flying experience

Total	2624 hours
on the type involved in the incident	2624 hours
during the last 90 days	208 hours

1.2.2.2.3 Crew times

Start of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, off duty 15 March 2011, 10:25 UTC
End of duty in the 48 hours before the serious incident	13 March 2011, off duty 14 March 2011, off duty
Flight duty times in the 48 hours before the serious incident	13 March 2011, 0 hours 14 March 2011, 0 hours
Rest times in the 48 hours before the serious incident	from 13 to 14 March: off duty from 14 to 15 March: off duty
Flight duty time at the time of the serious incident	1:18 hours

1.2.3 Air traffic control personnel

1.2.3.1 ADC air traffic control officer

1.2.3.1.1 General

Function	Aerodrome control (ADC)
Person	Swiss citizen, born 1982
Start of duty on the day of the incident	06:20 UTC
Licence	Air traffic controller licence based on European Community Directive 2006/23, first issued by the Federal Office of Civil Aviation (FOCA) on 30 June 2005
Relevant ratings	ADI (aerodrome instruments)
Medical fitness certificate	Class 3, restrictions: VDL (shall wear corrective lenses); from 18 May 2010, valid till 23 May 2012.

1.2.3.1.2 Additional information

An analysis of the documents on the selection and training of the air traffic control officer indicated that the latter was qualified by Skyguide as good to very good. After acquisition of the corresponding license and ratings, the legally prescribed performance checks take place within Skyguide. A classification of current performance, i.e. a differentiated qualification, is not undertaken.

Before the serious incident, the ADC air traffic control officer had never before handled survey flights at the ADC workstation.

The air traffic control officer was involved in a serious incident on intersecting runways 16 and 28 on 31 July 2008, in which he cleared an aircraft for take-off on runway 28 after he had previously cleared an aircraft approaching runway 16 to land. The order given immediately to the aircraft rolling on runway 28 to abort its take-off was able to remedy the situation.

The investigation by the Aircraft Accident Investigation Bureau came then to the following conclusion:

"Der schwere Vorfall ist darauf zurückzuführen, dass die ATC einem Flugzeug den Start auf Piste 28 bewilligte, während zuvor ein auf Piste 16 anfliegendes Flugzeug eine Landefreigabe erhalten hatte und im Begriffe war zu landen."

[The serious incident is attributable to the fact that ATC cleared an aircraft for take off from runway 28, while an aircraft approaching runway 16 had previously received landing clearance and was about to land.]

Following this serious incident, neither a debriefing with the air traffic control officer was carried out by Skyguide, nor were any other measures of any kind taken. A Critical Incident Stress Management (CISM) did not take place, because the ATCO declined it.

Clarifications with Skyguide showed that with regard to dealing with an air traffic control officer who has been involved in an accident or a serious incident, the only procedure which exists is for the supervisor to decide whether the employee concerned can continue working without supervision immediately after the incident.

Other procedures, which for example should clarify whether the employee needs to be retrained or whether further measures are necessary, did not exist at the time of the serious incident.

The Skyguide air navigation services company has a so-called "competence in doubt" procedure, which is applied in the case of insufficient qualification of ATCOs in day-to-day operations or during the periodic competency checks. This procedure is explicitly not applied in the case of serious incidents or accidents.

After the serious incident on 15 March 2011, Skyguide's management decided to no longer deploy the air traffic control officer concerned at the workstations in the aerodrome control centre until all the results of the investigation had been analysed and Skyguide's procedures for serious incidents had been further refined.

1.2.3.2 GRO air traffic control officer

1.2.3.2.1 General

Function	Ground Control (GRO)
Person	Danish citizen, born 1958
Start of duty on the day of the incident	05:40 UTC
Licence	Air traffic controller licence based on European Community Directive 2006/23, first issued by the Federal Office of Civil Aviation (FOCA) on 15 January 1993.
Relevant ratings	ADI (aerodrome instruments)
Medical fitness certificate	Class 3, restrictions: VML (shall wear multifocal lenses), valid from 15 November 2010, valid till 27 November 2011.

1.3 Aircraft information

1.3.1 SWR 1326

Registration	HB-IJH
Aircraft type	Airbus A320-214
Characteristics	Twin-jet short-haul and medium-haul aircraft
Manufacturer	Airbus S.A.S., Toulouse, France
Year of manufacture	1996
Engines	LH: CFM56-5B4/2P (DAC) RH: CFM56-5B4/P (SAC)
Owner	NBB Owl Co. Ltd., 8034 Zurich, Switzerland
Operator	Swiss International Airlines
Maximum permissible take-off and landing mass	73 500 kg 64 500 kg
Take-off mass	The actual take-off mass for flight SWR 1326 was 72 200 kg and the corresponding speed V_1[4] was 147 kt
Crew / passengers	Flight SWR 1326: 2 cockpit, 6 cabin, 127 pax

[4] V_1 is the maximum speed at which, in the case of an aborted take-off, the aircraft can still be brought to a standstill on the runway. Once speed V_1 is reached, a take-off is continued (cf. chapter 1.5).

1.3.2 SWR 202W

Registration	HB-IJW
Aircraft type	Airbus A320-214
Characteristics	Twin-jet short-haul and medium-haul aircraft
Manufacturer	Airbus S.A.S., Toulouse, France
Year of manufacture	2004
Engines	LH: CFM56-5B4/P (SAC) RH: CFM56-5B4/P (SAC)
Owner	International Lease Finance Corp., Los Angeles, USA
Operator	Swiss International Airlines
Maximum permissible take-off and landing mass	73 500 kg 64 500 kg
Take-off mass	The take-off mass for flight SWR 202W was 64 500 kg and the corresponding speed V_1 was 135 kt
Crew / passengers	Flight SWR 202W: 2 cockpit, 5 cabin, 120 pax

1.4 Meteorological information

1.4.1 General

The information in sections 1.4.2 to 1.4.6 was provided by MeteoSwiss.

1.4.2 General meteorological situation

[Translated from German]: An extended low pressure area centred over the Pyrenees was bringing southerly winds over the Alpine region and therefore generating a Föhn wind situation. On the south side of the Alps, humidity was trapped, whilst the northern side of the Alps remained relieved. The opposing pressures over the Alps again increased during the day, as did the Föhn airstream.

1.4.3 Weather at the time of the serious incident

On the basis of the listed information, it is possible to conclude that the weather conditions in the area of the serious incident were as follows:

Cloud	*1/8 at 11 000 ft AMSL, 6/8 at 30 000 ft AMSL*
Weather	-
Visibility	*Around 18 km*
Wind	*North wind at 6 kt*
Temperature/dewpoint	*13°C / 04°C*
Atmospheric pressure	*QNH LSZH 1011 hPa, QNH LSZA 1018 hPa, LSGG 1009 hPa*
Hazards	*None detectable*

1.4.4 Astronomical information

Position of the sun	Azimuth: *183°*	Elevation: *40°*
Lighting conditions	Daylight	

1.4.5 Meteorological aerodrome reports

At the time of the serious incident the following meteorological aerodrome report (METAR) was valid:

LSZH 151120Z 02006KT 340V060 CAVOK 11/04 Q1011 NOSIG=

In clear text, this means:

On 15 March 2011, shortly before the 11:20 UTC issue time of the aerodrome weather report, the following weather conditions were observed at aerodrome LSZH:

Wind	From 20 degrees at 6 kt, varying in direction from 340 degrees to 060 degrees.
Meteorological visibility	Visibility over 10 km
Cloud	No cloud below 8000 ft AGL
Temperature	11 °C
Dewpoint	04 °C
Atmospheric pressure	1011 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere

1.4.5.1 ATIS reports by Zurich airport

On 15 March 2011 from 11:20 UTC the following departure ATIS (automatic terminal information service) was broadcast by Zurich airport:

15.03.2011 11:44:40 DEP ATIS ZURICH
INFO WHISKEY RWY: DEP RW 28
MET REPORT LSZH 1120Z 15.03.2011
020 DEGREES 6 KT VARYING BTN 340 DEG AND 060 DEG
CAVOK
+11/+4
QNH 1011 ONE ONE
NOSIG
TWY ECHO 8 CLSD,
INCREASED BIRD ACTIVITY AT AND AROUND AD

1.4.5.2 Forecasts

At the time of the serious incident, the following terminal aerodrome forecast (TAF) applied:

LSZH 150825Z 1509/1615 VRB03KT 7000 NSC TX19/1514Z TN03/1606Z TX15/1614Z BECMG 1509/1512 CAVOK BECMG 1509/1512 04006KT BECMG 1611/1615 9999 BKN080=

In clear text, this means: On 15 March 2011 at 08:25 UTC, the following weather conditions were forecast for LSZH airport between 09:00 UTC on 15 March and 15:00 UTC on 16 March:

Wind	variable at 3 kt
Meteorological visibility	7 km
Trend	Within the next 2 hours no significant changes are expected regarding wind, visibility, weather or cloud
Temperature forecast	The forecast maximum temperature on 15 March at 14:00 UTC was 19° The forecast minimum temperature on 16 March at 06:00 UTC was 3° and the maximum temperature at 14:00 UTC was 15°
Conditional forecast	On 15 March between 09:00 UTC and 12:00 UTC, a uniform or irregular transition to a meteorological visibility of more than 10 km and no cloud below 8000 ft ASGL was expected to take place. On 15 March between 09:00 UTC and 12:00 UTC a uniform or irregular transition to a wind from 040 degrees at 6 kt was expected to take place. On 16 March a uniform or irregular transition to a meteorological visibility of more than 10 km was expected to take place between 11:00 UTC and 15:00 UTC, with cloud cover of 5/8 to 7/8 at 8000 ft AGL.

1.5 Take-off procedures

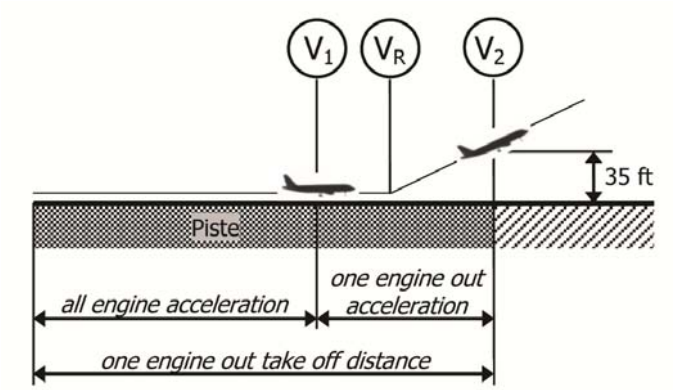
1.5.1 General

The following details do not explicitly refer to the aircraft involved in the serious incident, but are of a general nature.

The take-off distance (runway length) needed for a specific take-off mass (aircraft mass) depends on the elevation of the aerodrome, the outside temperature, the atmospheric pressure, the wind and the runway surface (dry, wet or contaminated). It is the longest of the following three distances:

- the one engine out take-off distance. This is the distance which is needed in order to attain a height of 35 ft at the end of the runway if one engine fails at a speed of V_1 (figure 6).
- the accelerate stop distance. This is the sum of the distance which is necessary to accelerate to a speed of V_1 and the distance needed to bring the aircraft to a standstill on the runway in the event of an aborted take-off at V_1 using the brakes (figure 7).
- 115% of the all engine take-off distance. This is the distance which is needed, allowing a reserve of 15%, at normal acceleration, in order to attain a height of 35 ft at the end of the runway (figure 8).

The following graphics (figures 6 to 8) provide a corresponding overview:



V_1 = decision speed. If an engine fails at this speed, the aircraft is able either to continue the take-off with a safe climb or abort the take-off and come to a standstill on the runway.

V_R = rotation speed. Rotation is initiated to take off.

V_2 = minimum safety take off speed. This speed guarantees a safe climb with one engine failed at V_1. It is 20% higher than the stall speed.

Figure 6: *One engine out take off distance*

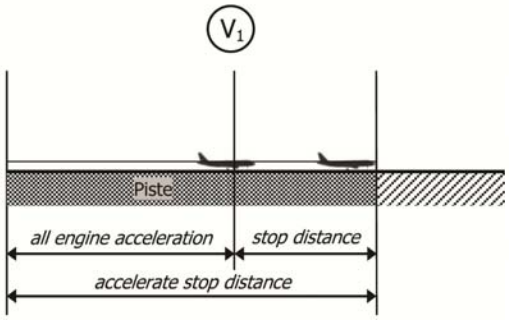


Figure 7: accelerate stop distance

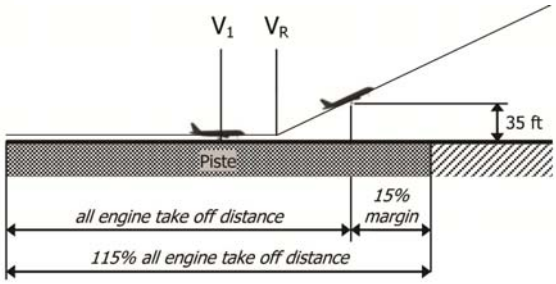


Figure 8: 115% all engine take-off distance

If the calculations by the crew before take-off indicate that the runway length needed for the current take-off mass is shorter than that currently available, the aircraft would come to a standstill before the end of the runway, in the event of an aborted take-off at V_1. Likewise, the crew, in the event of an aborted take-off after reaching V_1 - for whatever reason - would still be able to bring the aircraft to a standstill on the runway.

In the serious incident currently under investigation, the actual runway length of runway 28 and runway 16 was greater for both aircraft than required for their respective take-off masses.

1.5.2 Operating procedures for taxiing and take-off roll

In the operator's operational manual B (OM B), the SOP (standard operating procedures) are provided in section 2. In principle, taxiing is carried out by the commander. Control of the aircraft by the copilot is permitted only in exceptional cases and is described in section 2.04.10 *"Ground operation"* of the OM B as follows, among other things: *"For limited periods (e.g. during PA) the controls may be given to the Copilot. Handover of the controls should only be done in a straight line or after bringing the aircraft to a stop."*

Among other things, OM B, section 2.04.20 *"Flight checklist"* also mentions that before line up on the runway the following three points of the take-off check list must be processed, as described as follows in the *expanded flight checklist* (OM B 2.04.30):

BEFORE LINE UP

5. b/P ECAM MEMO- CHECKED

PREDICTIVE WINDSHEAR (if installed)

- Switch to AUTO.

TCAS

- Set TCAS to TA / RA.

BRK FAN

- Check brake fan OFF.

Check for additional MEMO items and judge necessity of

6. b/P Pack 1 and 2 - OFF

- Check that both flow control valves are closed green.

7. b/P Cabin - READY

Check that "CABIN READY" (if installed) is displayed in green on T.O. MEMO list.

READY FOR DEPARTURE

These three points must be processed by both pilots. Among other things, this is stated in the OM B 2.04.10 under flight checklist as follows:

"Checklists which need dialog between PIC and Copilot [marked in the checklist with "b/P"] *or which are not part of daily routine operation (e.g. DE-ICING) have to be executed as classic DO-Checklist (read item then execute, verify that the item has been executed)."*

In addition, before and after line up, the following two mandatory points must be executed, as laid down as follows in the OM B 2.04.10 under take-off and initial climb :

"GENERAL

- *(…)*
- *Before entering the runway:*
  - *Check the respective approach area and check FOB*[5]
- *When lined up and before setting take-off thrust, both pilots shall cross check headings and runway markings (identification of runway)*
- *(…)"*

According to the OM B section 2.04.10 *"take-off and initial climb"* a distinction is made between the following two types of *take-off*:

*"**ROLLING TAKE OFF***

- *The rolling-take off may be started upon entering the runway. Thrust should be increased as soon as the aircraft is lined up in order to satisfy the assumptions for the take-off performance calculation. Any acceleration out of a turn in combination of high thrust and braking should be avoided.*

STANDING TAKE-OFF

- *A standing take-off shall be performed under any of the following conditions:*
- *Visibility/RVR at or close to take-off minimum*
- *Contaminated runway*

[5] FOB – fuel on board, actual amount of fuel in all fuel tanks of an aircraft

- *The aircraft shall be lined up and brought to a stop. Release the brakes immediately before advancing the thrust levers.*

Note: *On aircraft equipped with engine intermix the take-off must be performed according to OM B 2.14.20."*

Moreover, the OM B Chapter 2.04.10 *"task sharing during take-off and initial climb"* specifies how the work is to be divided between PIC and copilot, depending on whether the take-off is carried out by the PIC or the copilot (cf. Annex 2). It should be pointed out that an aborted take-off is initiated in any case by the PIC. Among other things, the corresponding procedure is regulated in the OM B Chapter 2.04.10 *"rejected take-off"* as follows:

"GENERAL

- *The seats of both pilots must be adjusted so as to allow full brake pedal deflection with the rudder in either extreme position*
- *When the ABS is technically available it shall be used for rejecting the take-off*
- *The call out "STOP" by the PIC also means "my controls"*
- *After rejected take-off with high speed and high gross weight (high energy stop), rising brake temperatures may activate the fuse plugs and deflate the tires. The threat of landing gear fire may not be totally excluded. Therefore it is recommended to proceed to an isolated or non crowded area, considering the local airport facilities and the actual situation.*

Note: the performance calculations are based upon the assumption that in case of a rejected take-off the first action (e.g. THRUST LEVERS IDLE) is initiated at V_1."

1.5.3 Take-off roll of SWR 1326 on runway 16

On aircraft HB-IJH, two engines of different configurtions were installed.

Among other things, in the OM B section 2.14.20 *"special operation engine intermix"* the following is stated with regard to take-off procedure with two engines of different configurtions:

"TAKE-OFF PROCEDURE (ENGINE INTERMIX TYPE 1, DAC[6] WITH SAC[7], SAC/TI[8])

- *Progressively adjust engine thrust in two steps:*
  - *Step 1: idle to 50% N1.*
  - *Brakes released when the 50% N1 is stabilized on both engines*
  - *Step 2: Both engines N1 to takeoff thrust*
  - *This procedure enables a significant slower acceleration from ground idle to N1=50% for the double annular combuster*
- *Other standard operative procedures apply for takeoff."*

In the present serious incident, the crew carried out a standing take-off. The take-off was carried out by the copilot (cf. Annex 2).

1.5.4 Take-off roll and aborted take-off of SWR 202W on runway 28

The take-off was carried out by the commander. Just before the speed V_1 of 135 kt was reached, the commander realised that SWR 1326 was closing from the right. At the same time as his callout at 11:43:47 UTC: *"Was isch das?"*

[6] DAC – dual annular combuster

[7] SAC – single annular combuster

[8] TI – Tech Insertion, engines with a new technology that mainly reduces fuel consumption and NO_x emission

[What's that?] he initiated an aborted take-off. The recordings in the DFDR show that taking the power lever back to idle, application of the brakes and activation of reverse thrust took place within two seconds (cf. Annex 3).

1.6 Communications

1.6.1 General

Radio communications between the crews and the air traffic control officer concerned took place without any technical restrictions up to the time of the serious incident.

1.6.2 Coordination procedures for runway crossings

Taxi control of aircraft is the responsibility, depending on the area of competency, of either apron north, apron south, aerodrome control or ground. Therefore, these movements in particular usually require multiple frequency changes. Aircraft landing on runway 14, for example, will be handed over by the ADC air traffic control officer to apron north. The latter controls the aircraft until it is short of runway 28, where it is again handed over to the ADC air traffic control officer for the runway crossing.

Aircraft taxiing to the start of runway 16, which come from the tarmac south of runway 28, are handed over by apron south to the GRO air traffic control officer to cross runway 28. In this case, the GRO air traffic control officer requests authorisation to cross the runway from the ADC air traffic control officer. If the ADC air traffic control officer grants this, he clears the crew of the relevant aircraft to cross the runway and activates the runway 28 blocking, whereupon this is shown in "red" on the SAMAX screen, the INCH information screen and the TACO screen on all workstations in the control tower. When the aircraft has crossed the runway, he hands over the aircraft to apron north and cancels the runway blocking, whereupon the runway is again displayed in black on the screens and is again available to the ADC air traffic control officer.

1.7 Aerodrome information

1.7.1 General

Zurich airport is located in north-east Switzerland. 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 1416 ft AMSL and the reference temperature is 24.0 °C.

The runways at Zurich Airport have the following dimensions:

Runway	Dimensions	Elevation of runway thresholds
16/34	3700 x 60 m	1390/1388 ft AMSL
14/32	3300 x 60 m	1402/1402 ft AMSL
10/28	2500 x 60 m	1391/1416 ft AMSL

Zurich Airport is characterised by a system of three runways; two of these runways (16 and 28) cross at the airport reference point. The landing paths of two other runways (16 and 14) intersect approximately 850 metres north-west of the threshold of runway 14.

1.7.2 Survey flights to check navigation equipment

So that the instrument landing systems (ILS) of airports can be certificated worldwide, they must be surveyed periodically using specially equipped survey aircraft. At Zurich airport such survey flights take place at least twice a year, in each case over a period of two weeks. In the process, up to 25 approaches on the respective runway are carried out daily for approximately three hours.

The air traffic control officers were in each case informed of these survey flights in advance in writing. The exact programmes of the approaches were available at the respective workstations, although changes might be made at short notice. The supervisor and ground controller supported the ADC air traffic control officer with coordination.

The ATCOs in Zurich control tower were informed by letter on 1 September 2010 (information: *"Handling of Nav Checker[9] at LSZH"*) by Skyguide, among other things as follows:

"RWY 14, VMC: 12:30 to 13:45 LT

- *Only flights north of airport (arc-flights, circle-flights, approaches RWY 14 with break offs latest ½ RWY length) first approach over entire RWY*
- *No GATO 14/16 separation in regard of Nav Checker required.*

(…)

Flight rules, separation: within class "D" airspace (CTR) in VMC conditions, traffic info only is necessary.

If the Nav Checker operates as VFR flight, there is no wake separation required, only cautionary info. If a special separation is needed, it will be stated in the program or requested by the PiC."

On 15 March 2011 the Super King Air B350 survey aircraft with the ATC callsign FCK 211 had taken off from runway 28 four minutes before the serious incident and the approaches on ILS 14 were scheduled to begin approximately ten minutes later. The programme of survey flights envisaged that in the first 75 minutes the approaches were to be aborted before the threshold of runway 14.

The air traffic control officer who was working at the ADC workstation at the time of the serious incident had previously studied the programme of the upcoming survey flights at the GRO workstation and completed a number of coordination tasks. He stated that he was also busy with the written programme of the flights during the serious incident.

In 2003, Zurich Airport requested approval from the Federal Office of Civil Aviation to carry out survey flights outside normal hours of operation. The FOCA approved this request in 2005. In individual cases, survey flights were subsequently made at night. In December 2009, the Federal Administrative Court overturned this arrangement in appeal proceedings because of a lack of a legal basis. The Federal Court confirmed this decision in December 2010. Because of this, it was possible to fly survey flights only during regular operating times until the amendment of the Ordinance on Aviation Infrastructure [Verordnung über die Infrastruktur der Luftfahrt – VIL] on 1 April 2011.

[9] The term Nav Checker refers to the survey aircraft

1.8 Flight recorders

The recordings from the digital flight data recorders (DFDR) and the cockpit voice recorders (CVR) of the two aircraft involved were requested.

The recordings were complete and it was possible to analyse them. Only for the CVR from aircraft SWR 1326 was analysis not possible, as the aircraft continued its flight to the destination airport and the recordings of the take-off had therefore already been overwritten on the CVR.

1.9 RIMCAS collision warning system

1.9.1 General

Level I of the advanced surface movement guidance and control system (A-SMGCS) was introduced in Zurich on the basis of the Swiss airport movement area control system (SAMAX) already installed. Level II of the A-SMGCS includes a collision warning function (runway incursion monitoring and conflict alert sub-system - RIMCAS). It came into service on 31 May 2010. In a service order (SO) OZ 2010-034E, the personnel concerned were informed accordingly by Skyguide.

The RIMCAS warning system supports the air traffic control officers in their monitoring of the movements of aircraft and vehicles on the runway system at the airport. Skyguide noted in this context in its service order:

"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 acoustic) on actual or potential conflicts in a timely manner."

In the event of hazardous convergences, the warning system generates two different types of alerts. A stage 1 alert and a stage 2 alert. The two alerts were described by Skyguide in service order (SO) OZ 2010 034E 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 alert the ATCO that a critical situation is developing or exists which may require immediate attention/action. The ALARM alert is both visual and audio.*

It was noted that usually a stage 1 alert (information) precedes a stage 2 alert (alarm), but that there may also be situations - such as in the present serious incident - in which the system can directly issue a stage 2 alert (alarm).

1.9.2 Basis for calculations

To ensure that appropriate warnings can be generated, the system must be assigned certain parameters. It should be noted that at the time of the serious incident the system could not distinguish between aircraft and vehicles. The system only processed position reports from vehicles which were equipped accordingly. According to statements of some specialists, it will be possible in the future to distinguish between vehicles and aircraft.

The speed and the direction vector are determined from the current position in a one-second cycle, with the direction vector being continuously projected forward. Speeds must be higher than 12 metres per second (23:33 kt).

In order to recognize the problem of two aircraft crossing on two different runways, a circular area with a diameter of 400 metres was defined around the intersection of runways 16/28. If, on the basis of the calculated projections, two air-

craft simultaneously entered this "critical circular area", a stage 2 alert was triggered.

To avoid false alarms due to the constantly changing directional vectors as aircraft taxied onto the runway, the line-up area was excluded from alarm generation for a length of 250 m on runway 28 and 350 m on runway 16.

1.9.3 Presentation of traffic on the air traffic control officer's SAMAX screen

On the air traffic control officer's SAMAX screen (Annex 1) vehicles are shown with a circular symbol and the corresponding vehicle designation, e.g. "Gusti4", as follows: Gusti4 (white on a brown background).

Aircraft on the ground are shown with a yellow symbol and a coloured label (cf. Annex 1). If the aircraft is on the tarmac or a taxiway, the display (label) is as follows, for example: SWR 225G 16 (white on a light blue background, ATC callsign SWR 225G, scheduled runway for departure 16). Shortly before, or as the aircraft taxies onto the runway, the label colour changes to dark blue, e.g. SWR202W 000. Now the last three digits represent the speed calculated by the system in a one-second cycle. When the aircraft has lifted off, the label disappears.

Labels of landing aircraft are shown on the runway in dark green and on the tarmac or a taxiway in light green, e.g. DLH 4UV 017.

In the event of a stage 2 alert before a possible collision (cf. Annex 1) the callsigns with the corresponding speed information change to a red background, e.g. SWR 1326 138 and SWR 202W 088. In addition, an acoustic warning signal, in form of a synthetic voice is generated: *"RIMCAS".*

If the GRO air traffic control officer receives authorisation from the ADC air traffic control officer to cross runway 28 (chapter 1.6.2), the GRO clicks with his mouse at his workstation to activate the runway blocking. As a result, the colour of runway 28 on the SAMAX screen changes to red, with the white letters GRO.

The comparisons of the speed values recorded by the flight data recorders (DFDR) on the aircraft and the values displayed by RIMCAS indicate that the latter are subject to a delay of two to three seconds and are virtually identical in their progression (cf. Annex 4).

1.9.4 False alerts

On the ground there are several possible sources of interference, such as nearby buildings or topographical conditions, which may falsify the calculated position of aircraft and vehicles.

Skyguide notes in this context in service order OZ 2010-034E:

"The quality of the hazardous situation detection by RIMCAS is dependent on the quality of the surveillance data. As a result, RIMCAS may provide false alerts if the surveillance performance is not optimal."

The elimination of such false alerts is a constant process and the corresponding analyses indicate that since the introduction of the system it has been possible to greatly reduce the number of daily false alarms.

In this context it should be noted that on a daily basis the system also triggers so-called nuisance alarms. These alarms correspond to the design of the system; they stem from the fact that the system cannot be designed to cover every situation. Such alerts are actually unwarranted, but they have to be analysed by the air traffic control officer and then mentally blanked out. They therefore represent an additional burden for the air traffic control officer.

The investigation has shown that these nuisance alarms are described by many ATCOs as false alarms.

According to the RIMCAS statistics, for example, on 15 March 2011, in the period between 05:00 UTC and 22:00 UTC, 25 stage 1 alerts and 19 stage 2 alerts were recorded. It should be noted that these statistics do not distinguish between genuine alarms and nuisance alarms. According to Skyguide statistics, on average 6.6 stage 2 alerts were generated per day in the period from January 2011 to March 2011. Overall, 19% were genuine alarms, 22% false alarms and 59% so-called nuisance alarms.

1.9.5 Application of the system

Among other things, Skyguide prescribes the following regarding general use:

"In normal visibility conditions, the ATCO [air traffic control officer] *shall cross-check RIMCAS alerts by visual observation.*

Note: SAMAX procedures apply. Permanent monitoring of ASD [A-SMGCS situation display] *is not mandatory, however when spotting the INFORMATION or being delivered the ALARM, the above procedure applies.*

In low visibility conditions, the ATCO shall use ASD and other equipment such as TDI/PRN to cross check RIMCAS alerts. In case of doubt and until the factual situation is established, the controller shall trust the RIMCAS indication and shall take the appropriate action if necessary (…)."

With regard to handling a stage 2 alert, Skyguide specifies the following in service order OZ 2010-034E:

"In case of ALARM alert, ATCO shall immediately assess the situation and, if necessary take appropriate action to resolve the hazardous situation.

Note 1: a Stage 2 alert (ALARM) does not necessarily mean that there is a hazardous situation; for example, a false alert.

Note 2: the action taken by the ATCO depends on the (traffic) situation and is left to his own best judgement."

Analysis of the data in the present serious incident indicates that the RIMCAS stage 2 alert was triggered at 11:43:40 UTC. The ATCO gave the crew of flight SWR 202W at 11:43:49 UTC the order to abort their take-off immediately. The crew had already initiated an aborted take-off, as they had noticed the aircraft taking off on runway 16 at 11:43:47 UTC.

1.9.6 Additional information

On 18 June 2010 an Airbus A340-600 on runway 16 and an ATR42 on runway 28 were simultaneously ready for take-off. The crew of the A340-600 received clearance for take-off, which they immediately acknowledged, and initiated their take-off roll. At the same time, the crew of the ATR42 acknowledged the take-off clearance which was not intended for them and started their take-off roll. The simultaneous take-off roll of the two aircraft was noticed and the air traffic control officer ordered the crew of the ATR42 to abort the take-off immediately. During the aborted take-off, a stage 2 warning was generated by the RIMCAS.

The investigation came to the conclusion that among other things the following factor contributed to the serious incident:

"Das Kollisionswarnsystem der Flugverkehrsleitung war wenig geeignet, um die sich anbahnende Konfliktsituation zu entschärfen."

[The collision warning system of the air traffic control was inappropriate for resolving the impending conflict.]

The air navigation services company Skyguide decided, among other things, to take the following measure after the serious incident:

[Transalted from German]: The incident was analysed as part of the current coordination and monitoring process of the SAMAX/RIMCAS system which was newly introduced at the end of May 2010. To improve the fine tuning of the alerts and to eliminate undesirable false alarms, the manufacturer will by summer of 2011 deliver new software which will make it possible for RIMCAS to distinguish between vehicles and aircraft on the runways. This will further reduce cases of late alerts or false alarms in the vicinity of the intersection of runways 16/28.

In the meantime, it turned out that the manufacturer could not deliver the new software until the end of 2011.

1.10 The TACO coordination system

1.10.1 General

The tower and approach coordination system (TACO) is a flight data processing system which displays the current flight plan data on a screen at every workstation in tower and approach. The key data of each current flight, such as altitude, runway, scheduled departure time, departure route or speed are displayed to the ATCO in the form of electronic flight strips. The ATCO can enter additional information such as take-off and landing times, heading, changes in altitude and airspeed in real time. TACO is tightly networked with other air traffic control systems and is, therefore, an important information resource for the air traffic control officer.

1.10.2 Application of the system

On the ADC air traffic control officer's TACO screen, arriving and departing IFR traffic is displayed in the form of electronic flight strips in such a way that departing traffic is visible on the left and approaching traffic on the right. A green dividing line separates aircraft which have taken off from those which are still on the ground waiting to take off, and approaching aircraft from those which have already landed.

By clicking on individual strips, the take-off or landing sequence can be changed at any time and adapted to the current situation. Clicking on a specific box on the strip triggers a landing or take-off message, whereupon the corresponding strip switches from above the green dividing line to the position below the green dividing line. This means that the ATCO at all times has an overview of which aircraft are on the ground and which are in the air.

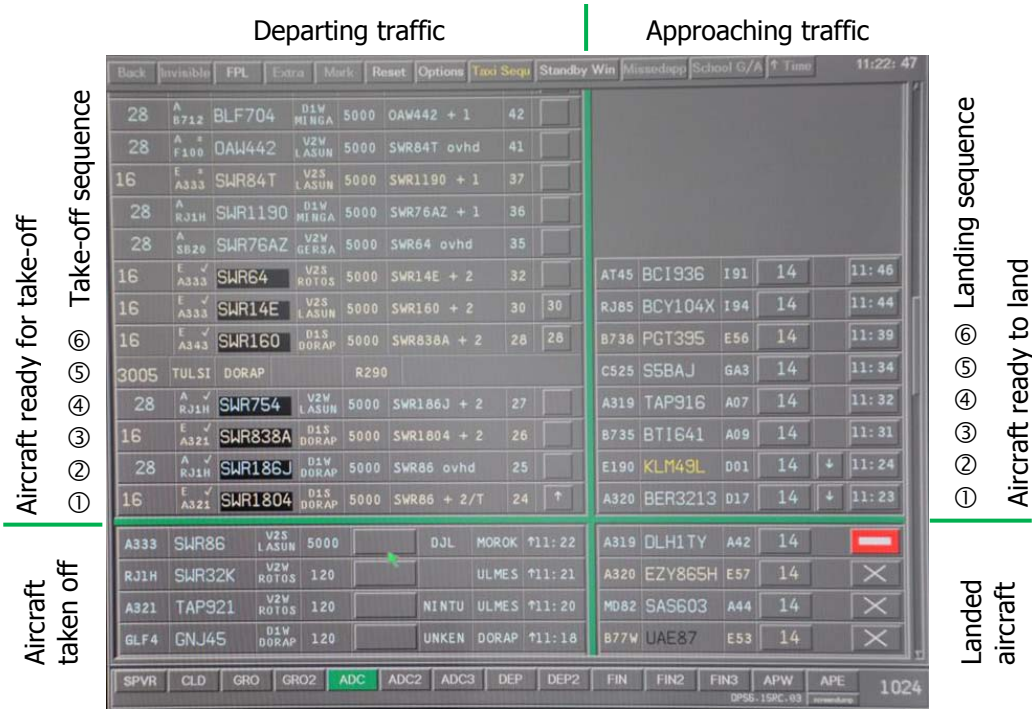


Figure 9: Typical display on a TACO screen. The information on the illustrated screen does not correspond to the display at the time of the serious incident.

1.11 Workstations and equipment in the control tower

1.11.1 ADC workstation

The following image shows the equipment at the ADC workstation in the Zurich control tower at the time of serious incident.

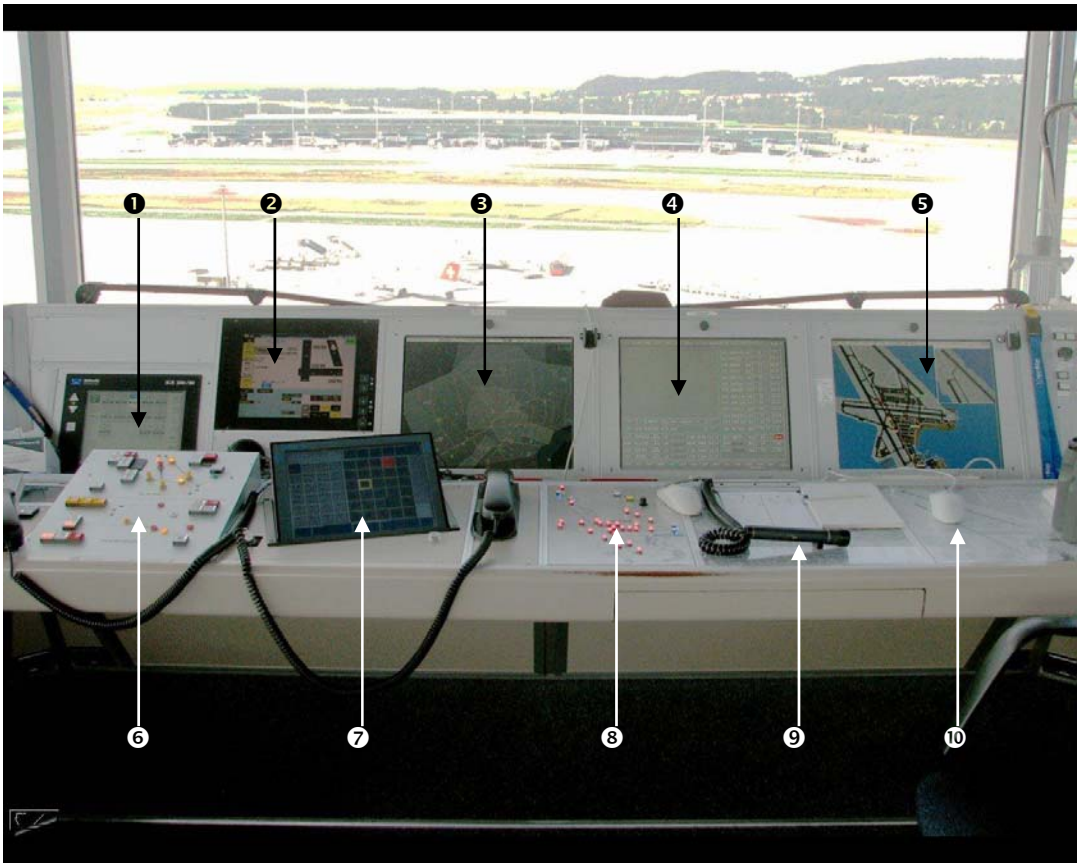


Figure 10: ADC air traffic control officer's workstation.

No.	Equipment / Display colour	Function / Application
❶	Radio control	Entering frequencies used
❷	INCH grey; red when runway is closed	(Information system Switzerland) Display of weather, runway condition, time and wind
❸	PRN Vigie	*(poste radar de nuit)* Radar picture of air situation within a circumference of approximately 50 km
❹	TACO grey, red and orange strips for closed runways	(Tower and approach coordination system) Electronic display of all flight plans
❺	SAMAX diff. colours such as green, blue, red, orange, brown	(Swiss airport movement area control system) Ground radar with integrated RIMCAS
❻	FLUKO red, white, yellow	(Flight coordination Kloten / Dübendorf) Coordination with Dübendorf military air traffic control
❼	Telephone	Coordination with various units, such as approach, apron, final etc.
❽	stopbar panel red	Cancel stopbar lights for intersecting runways
❾	Microphone	for radiocommunication
❿	Computer mouse	Several computer mice for inputs into the different systems.

In addition - although not visible in the above image - the airport lighting is controlled from a horizontal touch screen.

1.11.2 Other workstations

In the control tower, in addition to the aerodrome control (ADC) workstation, there are the ground control (GRO), clearance delivery (CLD) and supervisor (SPVR) workstations. Among other things, the GRO air traffic control officer also has the task of supporting the other air traffic control officers in the control tower when necessary and, for example, assisting with the monitoring of the airspace. However, particularly during periods of high volumes of traffic, every ATCO in the control tower is fully occupied with his own tasks.

1.11.3 Ground radar screen

On the ground radar screen (Swiss airport movement area control system - SAMAX), the current traffic situation on the runways, taxiways and the apron are displayed. In order not to unnecessarily impede the view to the outside, the rectangular screen was positioned at an angle.

Since the runway system of Zurich airport with the two long runways of 14 and 16 is geographically more or less aligned in a north-south direction, too few details are displayed when the entire runway system is displayed in full on the screen.

For this reason a form of presentation is usually selected in which the northern part of the runway system is displayed in a separate window (inset) on the screen. Both the main image and the inset overlap slightly.

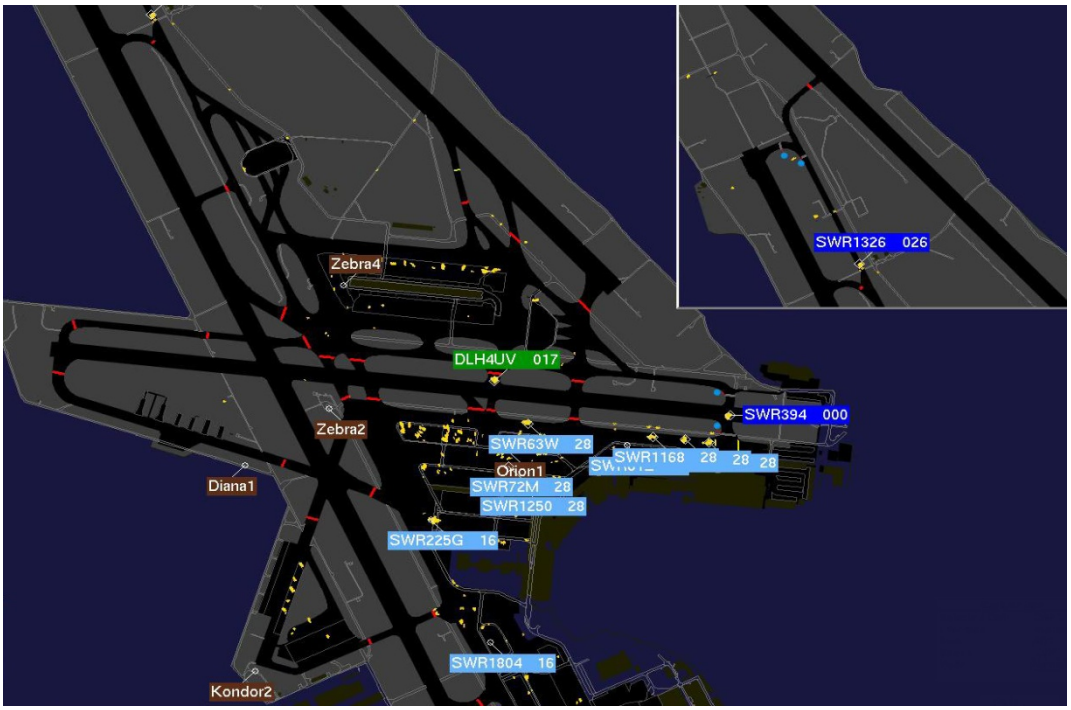


Figure 11: SAMAX ground radar screen. The northern part of the runway system is shown in a separate box (inset) on the screen.

1.12 Additional information

1.12.1 General

The investigation showed that in this incident as also in previous serious incidents, the high complexity of operation at Zurich-Kloten airport played a role. For this reason, an attempt was made to draw a comparison with airports in Europe which also feature complex operating systems and which are similar in terms of their geographical location close to densely populated city centres. In particular,

the following five airports were compared with regard to noise regulations, arrival and departure procedures, operating concepts for intersecting runways, VFR traffic and special flights:

Name	ICAO abbreviation	Number of runways	Number of intersecting runways	Aircraft movements 2010
Amsterdam	EHAM	6	2	402 374
Hamburg	EDDH	2	2	157 210
Copenhagen	EKCH	3	2	approx. 260 000
Vienna	LOWW	2	0[10]	246 146
Zurich	LSZH	3	2	268 765

Table 1: European airports: a comparison

1.12.2 Approach and departure procedures

Within the framework of a comparative study, data on all arrival and departure procedures (standard instrument departures - SID) available at the time of the serious incident was requested. These were presented on a map on which arrival procedures were coloured blue and departure procedures coloured yellow. In addition, the urban areas in the immediate vicinity of the respective airport were shaded red (cf. Annexes 5 to 9).

1.12.2.1 Intersection points between approach and departure procedures

The individual airports were studied with regard to lateral intersection points between departure and arrival procedures; any possible vertical separation of the flight paths was deliberately left out.

The following criteria were applied to determine the number of intersecting points of flight paths:

- Approaches: for each runway direction only the respective so-called final approach segment including the missed approach procedure was considered. Here the choice was restricted to the best available approach procedure for each runway direction, i.e. almost without exception an instrument landing system (ILS). In only a few cases was this an approach solely by means of a localiser or a VOR radial.
- Departures: all SID for each runway direction were considered. The beginning of the SID was equated with the start of the runway.
- Intersections of the flight paths of intersecting runways were not counted; nor were intersection points which were the result of converging runways immediately (within one kilometre) after the end of the runway.
- Identical sections of two routes were counted only once up to the first common point; accordingly, the initial, common climb of SID or missed approach procedures on one and the same runway were not counted as an intersection.
- Intersections between landings in one runway direction and SID in the opposite direction were not surveyed; however, intersections between departures and landings in one runway direction in the sense of a single runway concept were included.

The number of lateral intersection points of flight paths between arrival and departure procedures collected in this way is contained in table 2.

[10] The two runways do not have a common intersection; however, the operating concept takes into account the fact that the two runways cannot be operated independently.

1.12.2.2 Intersection points within the same departure procedure

The number of lateral intersections within the same departure procedure was counted; i.e. this category includes only those SID which featured a heading change of more than 180°.

The number of intersections within the same departure procedure is also included in Table 2.

ICAO abbreviation	SID	Intersection points between arrivals and departures	Intersection points within SID
EHAM	82	197	0
EDDH	32	52	0
EKCH	44	56	0
LOWW	58	92	0
LSZH	53[11]	206	27

Table 2: Lateral intersection points between approach and departure procedures

1.12.3 Simultaneous use of two intersecting runways for departures

1.12.3.1 Operating concepts

When comparing airports with intersecting runways, it is striking that Zurich airport is operated nearly every day for long periods of time with a concept which provides for take-offs from intersecting runways.

ICAO abbreviation	Departure traffic from intersecting runways as % of annual operating time
EHAM	1
EDDH	1
EKCH	3
LOWW	Unknown
LSZH	73

Table 3: Operating times for take-offs on intersecting runways

In 2008, Flughafen Zürich AG conducted a safety survey; in the hazard library, the runway 16/28 intersection was featured as one of 31 top hazards at Zurich airport. Up to the completion of this investigation, there was no information on practical measures to improve the situation.

1.12.3.2 Procedure for giving take-off clearance

In the context of the present serious incident, it was also determined which procedural regulations existed in Skyguide for the simultaneous use of runways 16 and 28 for departure traffic. Of particularly interest were the criteria according to which air traffic control officers could clear an aircraft on runway 28 for take off when shortly beforehand another aircraft had been cleared for take off on runway 16. In this respect, it was found that there are several sections in the ATM Manual Switzerland dealing with departing aircraft, take-off clearances, wake turbulence and the like. Furthermore, the ATM Manual Zurich contains regulations which include runway utilisation concepts, noise abatement measures and other aspects of air traffic control. However, there is no detailed description of the op-

[11] Two departure procedures envisaged exclusively for propeller aircraft were not taken into consideration.

erating concept which provides for the simultaneous use of runways 16 and 28 for departures and which is most frequently applied as outlined above. In particular, clear and unambiguous criteria according to which a take-off clearance may be given are lacking.

As a justification for the absence of such a procedure description, the Skyguide air navigation services company explained: *"Wir glauben, dass in einem dynamisch-interaktiven System nicht alles schriftlich fixiert werden kann und soll, weil nicht jede erdenkbare Situation vorhersehbar ist."* [We believe that in a dynamic and interactive system not everything can or should be set out in writing, because not every imaginable situation is predictable.] It is also argued that many air traffic control activities were not written down but had evolved and become established over the years.

The detailed procedures for departures on intersecting runways were not noted in the documents because the ICAO requirements (Doc 4444) were interpreted directly. In addition, Skyguide noted that during the training of air traffic control officers, departures on intersecting runways would be intensively practised and the subject would be discussed with air traffic control officers participating in refresher courses.

If one compares this situation with Cologne-Bonn airport, for example, which also has an operating concept where intersecting runways can also be used simultaneously for departures, one finds that in the "Betriebsanweisung Flugverkehrskontrolle" [Operation instructions for air traffic control] the following procedure is laid down for giving a take-off clearance:

"Ein startendes Luftfahrzeug ist von einem anderen Luftfahrzeug, das eine kreuzende Piste benutzt, zu staffeln, indem sichergestellt wird, dass es den Startlauf nicht beginnt, bevor eine der nachfolgenden Bedingungen erfüllt ist:

- *(…) das andere Luftfahrzeug hat abgehoben und eine Kurve eingeleitet, die eine Staffelungsunterschreitung ausschliesst oder*
- *Hat die Pistenkreuzung überquert“*

[An aircraft which is taking off must be separated from another aircraft which is using an intersecting runway, by ensuring that it does not start its take-off roll before one of the following conditions is met:

- (…) the other aircraft has lifted off and initiated a turn which excludes a violation of separation or
- has crossed the runway intersection]

1.12.4 Operating concepts and statistical data

From all five airports, enquiries were made or key data requested on the following aspects relating to operating concepts and statistical data:

- Annual number of movements by fixed-wing aircraft and helicopters
- Annual number of runway crossings
- Annual number of runway incursions
- Runway operating concepts and general conditions
- Statistical distribution of runways for arrival and departure procedures
- Airport activity (coordination effort, number of frequency changes, etc.)
- Activity within the TMA (VFR traffic, special flights and coordination effort for special operational areas for gliding, military, parachute jumps, etc.)

In the daytime the "North" operating concept is applied most frequently; it specifies runways 28 and 16 as the main take-off directions; at the same time, arrivals are primarily routed onto runway 14 and occasionally onto runway 16. According to the statistical data on Zurich airport, departures in the year 2010 (cf. Annex 10) it is apparent that more than 75% of departure traffic is routed onto the runway 16 and runway 28 departure routes (marked in yellow) to waypoints VEBIT or DEGES (cf. figure 12).

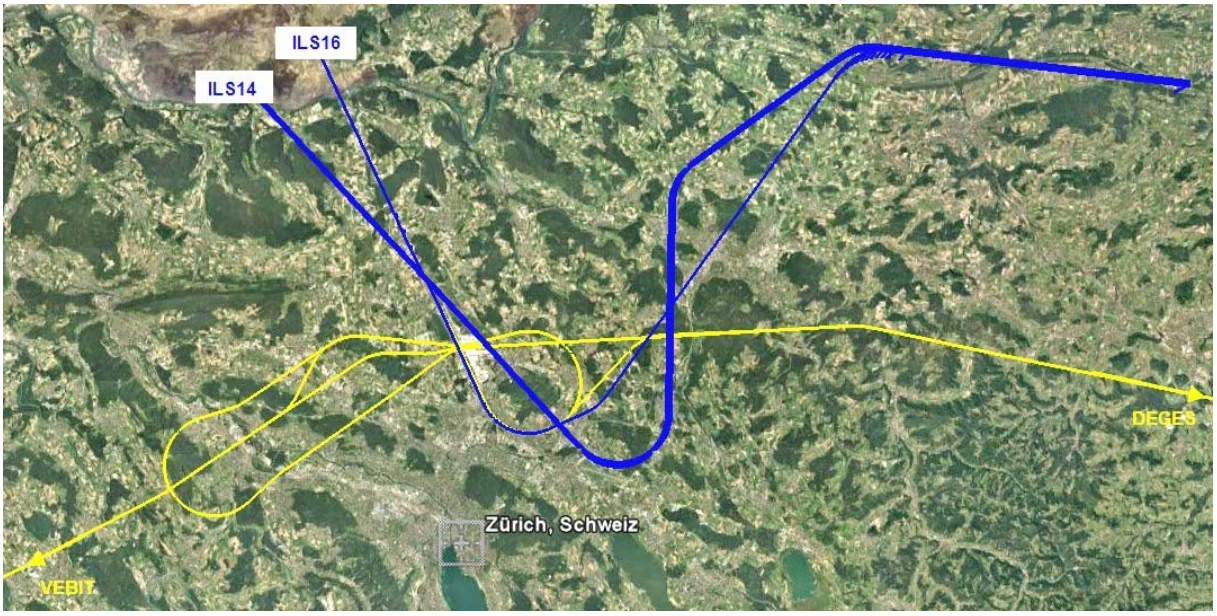


Figure 12: "North" operating concept, Zurich airport, with most-used standard instrument departures (SID)

In the case of the "Bise" operating concept, departures are made from runways 10 and 16, likewise most often to the same waypoints; in the same way, arrivals are simultaneously routed onto runway 14. In 2010 approximately 3% of departure traffic was handled on runway 10.

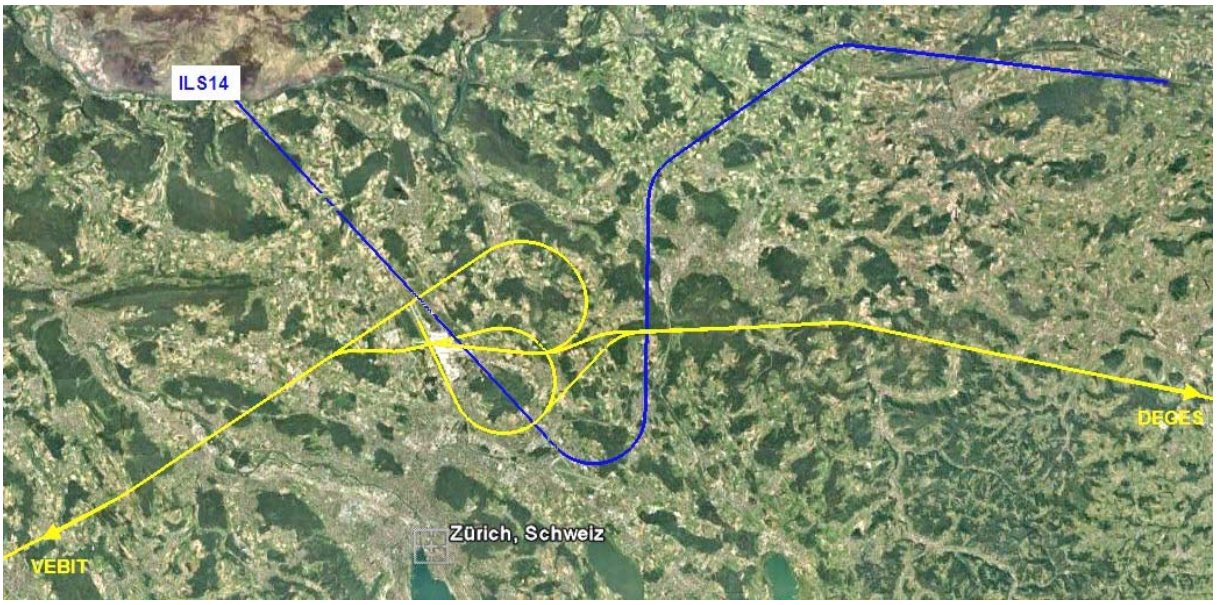


Figure 13: "Bise" operating concept at Zurich airport with the most-used standard SID

Since at the airports questioned only a small part of the data requested for comparison is collated, a meaningful comparison of Zurich airport with these airports could only be made, regarding departure traffic on intersecting runways.

2 Analysis

2.1 Technical aspects

2.1.1 General

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

2.1.2 RIMCAS collision warning system

When the stage 2 alert (alarm) was triggered at 11:43:40 UTC, the accelerating SWR 1326 on runway 16, according to the RIMCAS recording, was rolling at a speed of 143 kt and SWR 202W on runway 28 was rolling at 89 kt.

The serious incident shows that a RIMCAS stage 2 alert, for an impending conflict with the two aircraft taking off at the same time from intersecting runways, was triggered too late.

In this context it should be noted that the RIMCAS was not introduced primarily to provide warnings of two aircraft taking off at the same time on intersecting runways. Rather, the intention, as the system designation implies, was to warn of collisions between vehicles and aircraft on the ground.

2.2 Human and operational aspects

2.2.1 Peculiarities and risks of an aborted take-off

Once an aircraft has started its take-off roll, the risks associated with an aborted take-off increase. The procedures for the operation of modern commercial jet aircraft therefore attempt to weigh the importance of a technical or operational problem against the risks involved in aborting a take-off. Thus, for example, some warnings of system failures are suppressed in the cockpit during take-off and most operators envisage an aborted take-off above a certain speed - typically 80 to 100 kt - only in a few emergency situations. From an air traffic control perspective, this means that a command to abort take-off should only be given to an aircraft which is taking off and which is already rolling faster than 80 to 100 kt if a continuation of the take-off is expected to be associated with a major risk. Such endangerment may occur, for example, in the case of a significant risk of collision or unexpected obstacles on the runway.

Since the point in time at which an aircraft on take-off has reached the critical speed at which an aborted take-off is still possible with reasonable risk varies according to the aircraft type, take-off configuration and environmental factors, an assessment of the situation by a third party, such as an air traffic control officer, is generally difficult.

2.2.2 Flight crews

2.2.2.1 Crew of SWR 1326

The crew of SWR 1326 acknowledged the clearance intended for them, to taxi to the take-off position on runway 16, and the take-off clearance given to them one minute later. At this time, the crew were still taxiing to the take-off position. Owing to the engine configuration of their aircraft, the crew had to perform a standing take-off, which naturally led to a few seconds delay. After pushing the throttle levers forward, the crew were concentrating on the take-off roll; the copilot was primarily focusing on control of the aircraft and the commander had to monitor all the parameters displayed in the cockpit.

The fact that the crew did not realise during the take-off roll that the ATCO was also giving take-off clearance to the crew of SWR 202W on runway 28 can be explained by the fact that in this phase concentration is on controlling and monitoring the aircraft, and perception in such a case is unconsciously concentrated on one's own callsign. If the call is for a different aircraft, it can happen that the subsequent message is blanked out.

At the moment when the commander of SWR 202W caught sight of SWR 1326, the latter was already lifting off. At this stage, the commander of SWR 1326 was having to look in the direction of flight and was not able to detect the aircraft taking off, coming from the left on runway 28.

2.2.2.2 Crew of SWR 202W

The crew of SWR 202W, with their aircraft, were in the line-up on runway 28, when the ATCO gave SWR 1326 the take-off clearance on runway 16. In this phase, the crew had to work through the final points on the checklist and carry out additional by heart items which are prescribed during the line-up. As these points are processed, verbal communication takes place between the two pilots and this also explains why they did not perceive the ATCO's take-off clearance intended for SWR 1326. For the crew of SWR 202W, as for all crews, it is a fact that in phases of high concentration, perception is focused on the own callsign and a message with a different callsign can be blanked out.

Immediately before decision speed V_1 was reached, the commander of SWR 202W caught sight of SWR 1326 coming from the right on runway 16; which, according to his statement, was already lifting off. His reaction was very quick; within 1 to 2 seconds he had decided on an aborted take-off and initiated it (cf. Annex 3).

The fact that both pilots of SWR 202W in this phase did not consciously perceive the ATCO's order to abort the take-off is easily explained by the fact that they had already initiated the aborted take-off; a radio message in these two seconds is not relevant for the pilots' decision-making and for the initiation of the aborted take-off. In addition, both pilots stated that the noise level in the cockpit was very high during the aborted take-off.

In summary, it can be concluded that the crew acted responsively and efficiently and carefully implemented the procedures laid down for such a case.

2.2.3 Air traffic control

2.2.3.1 Actions and procedures

According to the statement of the ADC air traffic control officer concerned, there was a high volume of traffic of high complexity at the time of the serious incident. He justified this assessment mainly with reference to the impending survey flights. The GRO air traffic control officer assessed the volume of traffic as high with normal complexity.

Analysis of the radio and radar recordings shows that it was an average working day which featured increased complexity compared to the normal situation, due to the scheduled survey flights. The volume of traffic was high but corresponded to the normal situation at this time of day.

The ADC air traffic control officer stated that he had not noticed the impending conflict because he had been studying the documentation for the survey flight which was soon to commence. The survey aircraft, which was to calibrate the runway 14 instrument landing system (ILS) for approximately three hours and to this end had to make around 25 approaches, had taken off from runway 28 at

11:39:50 UTC and was to commence the first ILS approach on runway 14 a few minutes after the serious incident.

The survey programme envisaged several different approaches and circuits, which places demands on the ATCO in terms of approach coordination. Such special flights increase complexity if there is a high volume of traffic and thus create an additional risk.

On the basis of the planned programme the survey flights would have affected take-off traffic only slightly until approximately 12:45 UTC. This is apparent from the provisions for survey flights, listed in chapter 1.7.2. The programme was designed so that the peak in departures occurring shortly after noon was not significantly hampered. Thus the air traffic control officer concerned did not have to take into consideration take-offs from runway 32, and the demanding separation procedure for go-arounds on runway 14 and take-offs on runway 16 (GATO 14/16) was not applied. Furthermore, both the survey aircraft and the other aircraft flying in Class D airspace under visual flight rules only had to be given traffic information; this did not significantly increase complexity for the air traffic control officer at the time of the serious incident.

The air traffic control officer had already been dealing with the programme of survey flights during his work at the GRO workstation. He was now dealing with the programme of these flights once again, in a phase with a high volume of traffic and an operating concept which is in itself demanding because of the intersecting runways. This forward-looking commitment is possibly attributable to the fact that the air traffic control officer had never before handled survey flights at the ADC workstation, that the coordination of such flights is generally demanding and that he therefore wished to be especially well prepared. He therefore turned to something which seemed important to him, but which in objective terms was not of a high priority. This meant that his primary task, actual air traffic control, was no longer being given the attention which is essential for safe operation.

In the present case, this diverting of attention, not adapted to the situation, created an essential precondition for the genesis of the serious incident.

The ADC air traffic control officer had cleared SWR 1326 for take off when the aircraft was still on the taxiway. This is not unusual, but it does mean that the beginning of the aircraft's take-off roll does not take place immediately after the take-off clearance. In the meantime, the ADC air traffic control officer had released runway 28 for the GRO air traffic control officer, so that the latter could give clearance to another aircraft to cross runway 28. As the aircraft had crossed the runway, the GRO air traffic control officer cancelled the blocking on runway 28; this meant that the runway, previously shown in red on all screens, was now displayed again in black. This may have been a trigger for the ADC air traffic control officer to give the take-off clearance to SWR 202W which was waiting on runway 28. As the air traffic control officer himself said, SWR 1326 was no longer present in his mental image. This explains why he was no longer checking runway 16 and so also did not realise that SWR 1326 had not yet passed the runway intersection.

On the TACO screen it could be seen at this point in time that SWR 1326 still had the status of an aircraft on the ground when the ATCO gave SWR 202W take-off clearance. The departure strip for SWR 202W was still in second place above the departure strip for SWR 1326. The take-off message of SWR 1326 was triggered by the ADC air traffic control officer clicking with his mouse on his TACO screen at 11:44:00 UTC, shortly after SWR 1326 had lifted off and 55 seconds after the ATCO had given SWR 202W clearance for take off. From this it can be concluded that the ATCO was not aware of the TACO screen when he gave SWR 202W the clearance to take off.

The GRO air traffic control officer was sitting next to the ADC air traffic control officer and was not aware of the two take-off clearances which had been given. At this time he was conducting radio communication on his radio frequency with the crew of a business jet aircraft.

2.2.3.2 The ADC air traffic control officer's personality factors

The ADC air traffic control officer had been involved in another serious incident on intersecting runways 16 and 28 on 31 July 2008, during which he cleared an aircraft for take-off on runway 28 after he had previously cleared an aircraft approaching runway 16 to land. Even given the resulting possibility of comparison, the search for a pattern of behaviour characteristic of this ATCO did not produce any result. It was impossible to detect any uniformity in the form of a conjunction or reciprocal effect of quite specific a) personality-related and b) external circumstances which triggered these incidents.

On the other hand, it is possible to give a list of factors that might have contributed to the conduct of the ADC air traffic control officer on 15 March 2011:

- Situational factors (time and immediate temporal context of the serious incident):
  - Additional demands on attention due to the survey flights.
  - The time - approximately 90 minutes before the end of duty: the combination of fatigue and thinking ahead can affect the ability to concentrate.
  - Questioning of the ADC air traffic control officer revealed that there were no problems in his private life and hence no psychological distress at the relevant point in time.
- Factors further back in time:
  - The fear that the serious incident of 31 July 2008 had recurred. This did not contribute in a causative manner to the serious incident under investigation, but according to his statement it was a delaying factor in trouble-shooting after the sounding of the RIMCAS stage 2 alert.
  - In addition, it is generally true that recalling a serious incident can divert part of one's attention.
- Personality-specific factors (individual long-term characteristics of the air traffic control officer):
  - A distinct readiness to assist and willingness to cooperate.

    This manifests itself in the form of voluntary assistance while working as ADC air traffic control officer, but also when being questioned about the serious incident on 15 March 2011: he has a very evident concern to support the analysis with the aid of self-reflective and self-critical considerations.
  - A tendency to inappropriate prioritisation.

    This probably manifests itself mainly as the reverse of his readiness to help and willingness to cooperate. The spontaneous assistance of the ADC air traffic control officer to the GRO air traffic control officer within the timeframe of the serious incident concerning the call from business aircraft D-AJJK may have contributed to the fact that SWR 1326 had disappeared from his consciousness.

    According to the ADC air traffic control officer's statement, some of his attention was absorbed by his preoccupation with the programme of survey flights, which also had an adverse effect on an appropriate setting of priorities.

These factors, individually or cumulatively, may have contributed to the ADC air traffic control officer forgetting about SWR 1326. However, the fact that there is no actual explanation of why he forgot about it again is an additional burden for the air traffic control officer, quite apart from the immediate consequences.

2.2.3.3 Handling of RIMCAS alerts

According to Skyguide statistics (cf. chapter 1.9.4) only one in five alarms was a “genuine alarm”, which meant that such “genuine alarms” were not given the importance they deserved. This fact is confirmed by the ATCO’s statement that he was surprised by the RIMCAS alert and initially thought of a *"false alarm with a vehicle"*.

The procedures applied by ATCOs for reasons of traffic efficiency fairly often trigger system-generated nuisance alarms. These are taken into account by the ATCOs. However, this does also result in sensitivity to alarms being restricted.

The current situation with genuine, false and nuisance alarms makes it more difficult for air traffic control officers to assess the situation and therefore creates a hazard from the viewpoint of aviation safety.

2.2.3.4 The ADC air traffic control officer's workstation

In addition to outside visibility, the ADC air traffic control officer has at his disposal five screens, of different sizes and colours, as well as other equipment such as radio, lighting controls, video monitors and computer operating devices (mouse, keyboard). The operation and monitoring of this equipment, plus the wealth of information which the ATCO has to process, requires continuous scanning. On the other hand, the ATCO often has very little time to look outside and to carry out 360° scanning of the airspace. Also, most of the screens differ in construction, and the systems require different types of operation - and this requires additional effort. Likewise, the large number of different colours which partly draw attention to hazards can cause visual saturation. Viewed from the viewpoint of ergonomics, this approach to dealing with safety-related information is not optimal.

Special mention should be made in this regard of the presentation of the runway system on the ground radar screen (SAMAX), as it was in operation at the time of the serious incident. This rectangular screen displayed the traffic situation on the ground and was positioned at an angle (cf. figure 11, section 1.11.2). In order to display the entire runway system coherently on this screen, a magnification ratio showing insufficient detail would have had to be chosen. Therefore, a setting was usually used in which the northern part of the runway system was shown in a separate window (inset). Such a display is ergonomically unfavourable, since it makes it more difficult for the air traffic control officer to take in the entire runway system at a glance. In the present case, this was especially significant at 11:43:05 UTC (cf. Annex 1), when both aircraft were at the beginning of runways 16 and 28, SWR 1326 had begun its take-off roll and SWR 202W received take-off clearance. Since at Zurich airport 73% of the departing traffic takes off from the intersecting runways which are in simultaneous operation, a comparable situation is common and the ergonomically poor display is therefore of particular importance.

2.2.3.5 Aerodrome control centre working concept

The GRO air traffic control officer has the task, among others, of supporting the ADC air traffic control officer. Consequently, with regard to the ADC air traffic control officer the GRO air traffic control officer has a supporting, but not a moni-

toring function. However, he may no longer be able to guarantee this support in every case if there is a high volume of traffic, because he is fully occupied by his own tasks. Apart from the fact that the support of the ADC air traffic control officer is no longer available precisely when it is needed most, this constitutes a systemic problem of the working concept of the aerodrome control centre at Zurich Airport. The basic working concept assigns a specific area of responsibility to each air traffic control officer, though no reciprocal monitoring is provided for. Therefore, error-free working of the individual is assumed, which, as is well known, is not realistic.

On the basis of this finding, for example a crew of two persons has become commonplace in the operation of complex aircraft. The use of two pilots is not justified by the average workload, which could be handled without any problems by a single person. Rather, a method of working is implemented which ensures that the two pilots appropriately monitor each other's activities, and errors can be detected and corrected at an early stage. This significantly reduces the effects of errors.

The working concept of the aerodrome control centre at Zurich airport does not feature a comparable safety net which would ensure early detection of errors by an individual air traffic control officer by means of mutual monitoring.

The cited systemic interconnections are one reason why at European airports which are comparable to Zurich two or more ADC air traffic control officers are deployed to monitor the runway system and the airspace. In the Frankfurt aerodrome control centre, for example, a second full-time air traffic control officer is provided to support the ATCO who is controlling the traffic. Both ATCOs devote themselves to the same traffic activities. Experience shows that this extra ATCO can constitute a valuable safety net.

2.2.4 Complexity of operation at Zurich airport

Preliminary mention should be made of the fact that at the time of the investigation there was no internationally recognised standard relating to the complexity of an airport. The desired comparison between the five European airports by means of a comparison of flight path intersections between arrival, departure and go-around procedures, as well as typical statistical parameters, addresses only partial aspects and makes no claim to be exhaustive. Nevertheless, the following statements can be made:

- With regard to lateral points of intersection between arrival, departure and go-around procedures, Zurich scores the highest. Such intersections do not constitute a threat *per se*, but they do increase the scanning effort required by the air traffic control officer concerned.
- Because the runway 16 departure route takes a left turn shortly after take-off and thus crosses the path of the runway 14 missed approach procedure, on 30 August 2003 there was a convergence of two commercial aircraft which involved a high risk of collision. For this reason, the Aircraft Accident Investigation Bureau issued Safety Recommendation no. 369, which proposed that air traffic control should apply a procedure which also guarantees adequate separation in this situation. The implementation of this safety recommendation by the FOCA and Skyguide led to a scheme which requires chronological coordination between take-offs on runway 16 and landings on runway 14. This gives the air traffic control officer only a short window of time in which a take-off on runway 16 is possible at all. The implementation of this safety recommendation is an example of how a non-systemic fix of a safety deficit may generate new safety problems - in this case increased complexity for the air traffic control officer.

- Zurich airport is operated by far the most frequently in accordance with a concept which includes departures from two intersecting runways which are in use simultaneously. Such a concept is clearly more demanding than the operation of parallel runways and includes a potential for conflict when two aircraft are in take-off position at the same time and take-off clearance is given to one of these aircraft.
- It is striking that within the air navigation services company Skyguide there are no clear and unambiguous procedures according to which take-off clearances are given for precisely this concept with departures from intersecting runways, which is frequently applied and which is demanding. The argument put forward by Skyguide, i.e. that it is not possible or appropriate to define such procedures, is not convincing - other air navigation services companies working with comparable operating concepts have actually had such procedures established for a long time. It should be stressed that from the point of view of aviation safety it is not a simple matter to call into existence regulations which in and of themselves may still not guarantee safety. Reasonable and simple criteria applied in day-to-day operation help to structure workflows and may constitute for those applying them a kind of "mental traffic light function", which helps to avoid errors in their work. The principle implemented by the air navigation services company, i.e. that not all activities in air traffic control can be enshrined in procedures, applies to many complex systems and is not in dispute. In the present case, however, especially in the light of the discussion of complexity aspects, the question must at least be posed as to whether this principle has been taken a step too far. This has possibly led to a situation in which the lack of unambiguous procedures has made the situation for the air traffic control officer more complex than would have been necessary on the basis of the operating concept alone.
- Looking at the management of arrival and departure routes, it is striking that at Zurich airport, unlike the airports which were compared, the flight paths are substantially more concentrated and that an early separation e.g. of departure routes is not undertaken (cf. Annexes 5 to 9). This visual impression is supported by the large number of lateral intersections within the same departure routes. As a result of this management of arrival and departure routes, unlike at the other comparable airports, this means that aircraft hardly fly over the urban area close to the airport at all. In particular the departure routes near the airport are in turn rerouted in such a way that aircraft gain altitude a short distance from the airport and pass over it again in order to concentrate the noise in the vicinity of the airport, as far as possible. In 2010 this traffic which was rerouted in the vicinity of the airport constituted more than one third of all take-off movements (cf. Annex 10). However, the resulting benefits in terms of noise pollution in the wider environs are obtained through greater complexity for air traffic control. As several serious incidents in recent years show, this greater complexity constitutes a potential hazard.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- Both aircraft were licensed for IFR operation.
- The investigation found no evidence of pre-existing technical problems, neither ground-side nor aircraft-side, which might have caused or influenced the serious incident.

3.1.2 Crews

- The pilots were in possession of the necessary licences for the flight.
- There are no indications of any of the pilots suffering health problems during the serious incident.
- The crew of SWR 1326 acknowledged the clearance they received to taxi to the take-off position and also the clearance for take-off from runway 16.
- The crew of SWR 1326 did not see the aircraft taking off from runway 28.
- The crew of SWR 202W acknowledged the clearance for take off from runway 28.
- After the commander of SWR 202W detected the aircraft approaching from the right on runway 16, he immediately initiated an aborted take-off.

3.1.3 Air traffic control personnel

- The air traffic control officers were in possession of the licences necessary to exercise their activities.
- There are no indications of any of the air traffic control officers suffering health problems during the serious incident.
- The ADC air traffic control officer was involved in a serious incident on the intersecting runways 16 and 28 on 31 July 2008, in which he cleared an aircraft on runway 28 for take-off after he had previously cleared an aircraft approaching runway 16 to land.
- Following the serious incident on 31 July 2008, neither a debriefing with the air traffic control officer was carried out by Skyguide, nor were any other measures taken.

3.1.4 History of the serious incident

- Aircraft SWR 202W was ready for take-off behind other aircraft short of runway 28 when at 11:37:38 UTC the crew received the following clearance: *"Hello swiss two zero two whiskey, tower, behind company airbus, line up runway two eight behind."*
- Aircraft SWR 1326 was on taxiway ECHO, approximately 50 m short of the start of runway 16 when the crew received clearance for take off from runway 16 at 11:42:19 UTC.
- At this time SWR 202W was lining-up on runway 28 and the crew were processing the corresponding points in the checklist.
- The crew of SWR 1326 carried out a standing take-off and initiated this at 11:42:50 UTC.

- From 11:42:15 UTC to 11:43:01 UTC, the GRO air traffic control officer used runway 28 for a crossing operation, blocking this runway in the system for the ADC air traffic control officer.
- The crew of SWR 202W received clearance for take off from runway 28 at 11:43:05 UTC. They acknowledged this clearance and started their take-off roll at 11:43:12 UTC.
- At this time the two electronic flight strips of SWR 1326 and SWR 202W were on the TACO screen in a position above the dividing line which separates aircraft on the ground from aircraft which have taken off.
- SWR 1326 was at this time already on its take-off roll on runway 16.
- At 11:43:40 UTC the RIMCAS (runway incursion monitoring and conflict alert sub-system) generated a stage 2 alert for the air traffic control officer and the acoustic alarm *"RIMCAS"* sounded.
- According to the RIMCAS, SWR 1326 was rolling at a speed of 143 kt at this time, and SWR 202W was rolling at 89 kt.
- At 11:43:47 UTC, the crew of SWR 202W noticed the aircraft taking off on runway 16 which was lifting off and immediately initiated an aborted take-off.
- At 11:43:49 UTC the ATCO gave SWR 202W the following order: *"Swiss two zero two whiskey, stop immediately!"*
- The crew did not reply to this command as they had already initiated an aborted take-off.
- Aircraft SWR 202W came to a standstill in the safety area of runway 16.
- The crew of SWR 1326 did not notice the aircraft taking off on runway 28 and continued their take-off and the flight to their destination.

3.1.5 General conditions

- At the time of the serious incident there was a high volume of traffic with an increased level of complexity.
- Frequency occupancy at the ADC workstation was high.
- At the time of the serious incident, survey flights were possible only during regular operating hours.
- At the time of the serious incident, the commencement of the survey flights was imminent.
- The weather had no influence on the serious incident.
- Zurich airport is operated for the most part according to a concept which includes departures from two intersecting runways which are in use simultaneously.
- In 2008, Flughafen Zürich AG conducted a safety survey; in the respective hazard library, the runway 16/28 intersection was featured as one of 31 top hazards at Zurich airport.

3.1.6 Organisational aspects

- With regard to dealing with an air traffic control officer who has been involved in an accident or a serious incident, the only procedure which exists within Skyguide is for the supervisor to decide whether the employee concerned can continue working without supervision immediately after the incident.

- The "competence in doubt" procedure was explicitly not applied at Skyguide in cases of serious incidents and accidents.
- A detailed description of the operating concept which provides for the simultaneous operation of runways 16 and 28 for departures doess not exist in the air traffic control company's procedures. In particular, clear and unambiguous criteria according to which a take-off clearance may be given are lacking.

3.2 Causes

The serious incident is attributable to the fact that the air traffic control officer concerned gave take-off clearance to an aircraft on runway 28 although another aircraft on runway 16, to which he had given take-off clearance shortly before, was still on its take-off roll. The result was that an inadvertent convergence of these aircraft occurred, involving a high risk of collision.

The following factors significantly contributed to the genesis of the serious incident:

- At a time with a very high volume of traffic at Zurich airport, survey flights were being carried out, which increased the complexity of operation for air traffic control.
- The air traffic control officer concerned was engaged on tasks which did not have a high priority at this time.
- The aerodrome control centre work concept allowed only inadequate mutual support in the case of a high volume of traffic and in general did not feature any monitoring for early detection and correction of errors.
- The air traffic control's collision warning system was inappropriate for resolving the impending conflict.

The genesis of the serious incident was favoured by the complex operation on two intersecting runways which is subject to a small error tolerance in the event of a high volume of traffic.

4 Safety recommendations and measures taken since the serious incident

According to the provisions of Annex 13 of the ICAO, all safety recommendations listed in this report are intended for the supervisory authority of the competent state, which has to 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, addresses implementation orders or recommendations to the FOCA.

[2] The FOCA informs DETEC periodically on the implementation of the orders or recommendations pronounced.

[3] DETEC informs the SAIB at least twice a year on the state of implementation by the FOCA."

On 17 May 2011, on the basis of Art. 18 para. 2 of the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents, the Aircraft Accident Investigation Bureau sent the Federal Office of Civil Aviation (FOCA) an interim report. In this interim report the following safety recommendations were issued at an early stage, so that work on improvement could begin without delay.

4.1 Safety recommendations

4.1.1 Safety deficit, RIMCAS

Although it should be noted that the RIMCAS warning system was not introduced primarily to provide a warning about two aircraft taking off at the same time on intersecting runways, if it were to be improved appropriately it would, however, be able to constitute an additional safety net.

When the stage 2 RIMCAS alert was triggered at 11:43:40 UTC, the accelerating SWR 1326 on runway 16 was rolling at 143 kt according to the RIMCAS recording and SWR 202W was rolling at 89 kt on runway 28.

The serious incident indicates that a RIMCAS stage 2 alert, for an impending conflict with two aircraft taking off at the same time from intersecting runways, was triggered too late.

In a previous serious incident it was evident that the system still has shortcomings in its function as a possible safety net: on 18 June 2010, an Airbus A340-600 on runway 16 and an ATR42 on runway 28 were simultaneously ready for take-off. The crew of the A340-600 received clearance for take-off, which they immediately acknowledged and initiated their take-off roll. At the same time, the crew of the ATR42 acknowledged the take-off clearance which was not intended for them and started their take-off roll. The simultaneous take-off roll of the two aircraft was noticed and the air traffic control officer ordered the crew of the ATR42 to abort take-off immediately. During the aborted take-off, a stage 2 alert was generated in the RIMCAS.

The investigation came to the conclusion that among other things the following factor contributed to the serious incident:

"Das Kollisionswarnsystem der Flugverkehrsleitung war wenig geeignet, um die sich anbahnende Konfliktsituation zu entschärfen."

[The collision warning system of the air traffic control was inappropriate for resolving the impending conflict.]

The air navigation services company Skyguide decided, among other things, to take the following measure after the serious incident:

[Transalted from German]: The incident was analysed as part of the current coordination and monitoring process of the SAMAX/RIMCAS system which was newly introduced at the end of May 2010. To improve the fine tuning of the alerts and to eliminate undesirable false alarms, the manufacturer will by summer of 2011 deliver new software which will make it possible for RIMCAS to distinguish between vehicles and aircraft on the runways. This will further reduce cases of late alerts or false alarms in the vicinity of the intersection of runways 16/28.

4.1.2 Safety Recommendation no. 429

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit der Flugsicherung Skyguide prüfen, inwiefern das Warnsystem RIMCAS für den Betrieb von sich kreuzenden Pisten verbessert werden kann und sicherstellen, dass diesbezügliche Verbesserungen beschleunigt umgesetzt werden."

[The Federal Office of Civil Aviation, together with the Skyguide air navigation services company, should examine the extent to which the RIMCAS warning system can be improved for the operation of intersecting runways and should ensure that such improvements are implemented rapidly.]

4.1.3 Safety deficit, survey flights

According to the statements of the ADC air traffic control officer concerned, at the time of the serious incident there was a high volume of traffic of high complexity; he justified this mainly with reference to the impending survey flights. The GRO air traffic control officer assessed the volume of traffic as high with normal complexity. The investigation concludes in its analysis that the volume of traffic can be described as high with slightly increased complexity.

The ADC air traffic control officer stated that he had not been aware of the impending conflict because he was busy with the documentation for the survey flight which was soon to commence. The survey aircraft, which was to calibrate the runway 14 instrument landing system (ILS) for approximately three hours and to this end had to make around 25 approaches, had taken off from runway 28 at 11:39:50 UTC and was to commence the first ILS approach on runway 14 a few minutes after the serious incident. The ADC air traffic control officer was already busy with the written programme at the GRO workstation.

In 2003, Zurich Airport requested approval from the Federal Office of Civil Aviation to carry out survey flights outside normal hours of operation. The FOCA approved this request in 2005. In individual cases, survey flights were subsequently made at night. In December 2009, the Federal Administrative Court overturned this arrangement in appeal proceedings because of a lack of a legal basis. The Federal Court confirmed this decision in December 2010. Because of this, it was possible to fly survey flights only during regular operating hours until the amendment of the Ordinance on Aviation Infrastructure [Verordnung über die Infrastruktur der Luftfahrt – VIL] on 1 April 2011.

The survey flights at Zurich Airport significantly increase the complexity of existing traffic and place high demands on the concentration and working capacity of an individual air traffic control officer. Within the framework of the investigation it was established that the ADC air traffic control officer had never before handled survey flights at the ADC workstation. There is no evidence that this operating procedure was practised systematically in the simulator.

4.1.4 Safety Recommendations nos. 430 - 432

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit der Flugsicherung Skyguide und mit dem Betreiber des Flughafens Zürich Massnahmen ergreifen, um sicherzustellen, dass periodisch notwendige Vermessungsflüge ausserhalb der Betriebszeiten des Flughafens oder während geeigneter Verkehrssituationen durchgeführt werden."

[The Federal Office of Civil Aviation, together with the Skyguide air navigation services company and the operator of Zurich airport, should take measures to ensure that periodically necessary survey flights are made outside the operating hours of the airport or during appropriate traffic situations.]

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit der Flugsicherung Skyguide prüfen, an welchen Arbeitsplätzen während Vermessungsflügen oder generell bei komplexen oder ausserordentlichen Verkehrssituationen zusätzliche Flugverkehrsleiter zur Bewältigung dieser Aufgaben eingesetzt werden müssen."

[The Federal Office of Civil Aviation, together with the Skyguide air navigation services company, should examine at which workstations additional air traffic control officers must be deployed during survey flights or generally in complex or exceptional traffic situations to carry out these tasks.]

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit der Flugsicherung Skyguide prüfen, inwiefern der Umgang mit Vermessungs- und anderen Spezialflügen im Simulator periodisch geübt werden sollte."

[The Federal Office of Civil Aviation, together with the Skyguide air navigation services company, should examine the extent to which the handling of survey flights and other special flights should be periodically practised in the simulator.]

4.1.5 Safety deficit, measures after a serious incident

The ADC air traffic control officer had previously been involved in a serious incident on intersecting runways 16 and 28 on 31 July 2008, in which he cleared an aircraft on runway 28 for take-off even though he had previously cleared an aircraft approaching runway 16 to land. The order given immediately to the aircraft rolling on runway 28 to abort its take-off was able to remedy the situation.

Following this serious incident, neither a debriefing with the air traffic control officer was carried out by Skyguide, nor were any other measures taken.

With regard to dealing with an air traffic control officer who has been involved in an accident or a serious incident, the internal Skyguide procedure merely states that the supervisor decides whether the employee concerned can continue working without supervision immediately after the incident. There are no other procedures to clarify whether retraining or other supportive measures are necessary.

As the investigation has shown, the ADC air traffic control officer's memory of the serious incident on 31 July 2008 was a delaying factor in attempting to remedy the serious incident of 15 March 2011. Come to terms with the first serious incident might possibly have meant that his reactions in the second case would not have been adversely affected by this incident.

4.1.6 Safety Recommendation no. 433

"Das Bundesamt für Zivilluftfahrt sollte von der Flugsicherung Skyguide Verfahren verlangen, die sicherstellen, dass an Unfällen oder schweren Vorfällen beteiligte Mitarbeiter überprüft und wenn nötig nachgeschult werden, so dass allfällige Fähigkeits- oder Leistungseinschränkungen zeitgerecht erkannt und behoben werden können."

[The Federal Office of Civil Aviation should demand air traffic control procedures from Skyguide air navigation services company which ensure that employees involved in accidents or serious incidents are appraised and if necessary retrained, so that any limitations in terms of capability or performance can be promptly detected and resolved.]

4.1.7 Systemic safety deficit

Since the year 2000, 12 comparable serious incidents have occurred on or in the immediate vicinity of Zurich airport, in relation to which a total 19 safety recommendations have been issued.

28 December 2000: AXX032 vs. SWR422

Brief description: during a go-around after an ILS approach on runway 14, the crew did not comply with the ADC air traffic control officer's order to stop their climb. This resulted in a dangerous convergence with an aircraft departing from runway 10.

Safety Recommendation no. 240

"Von der zuständigen Behörde sind in Anlehnung an die ICAO-Empfehlungen zweckmässige Regelungen zur Staffelung der Abflüge von den Anflügen festzulegen."

[Appropriate regulations are to be specified by the responsible authority for the separation of arrivals from departures, in accordance with ICAO recommendation.]

Status of implementation: cf. Report No. 1775, safety recommendations of the Aircraft Accident Investigation Bureau AAIB with comments by the Federal Office of Civil Aviation, dated 28 August 2003 (www.sust.admin.ch)

1 December 2001: TAP5327 vs. CRX3554

Brief description: The crew of TAP5327 taxied over the stopbar on taxiway ECHO to runway 28 and in the process converged dangerously with the shoulder of the runway, during which time aircraft CRX3554 was on its take-off roll on runway 28.

Safety recommendations:

Safety Recommendation no. 288

"Das Bundesamt für Zivilluftfahrt sollte überprüfen, ob die Rollwegbezeichnungen dahingehend geändert werden könnten, dass durchgehende Rollwege (d.h. Rollwege die Pisten kreuzen) unterschiedliche Bezeichnungen tragen. Zusätzlich sollte durch Schaffung von Freigabebegrenzpunkten vor den zu kreuzenden Pisten mehr systematische Sicherheit verwirklicht werden."

[The Federal Office of Civil Aviation should examine whether the taxiway designations could be changed in such a way that through taxiways (i.e. taxiways which cross runways) bear different names. In addition, more systematic safety should be achieved by creating clearance boundary points before the runways to be crossed.]

Safety Recommendation no. 289

"*Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass bei der Erteilung von Rollanweisungen, Sequenzfolgeinstruktionen und Verkehrshinweisen auf der gesamten manoeuvering area Formulierungen wie "… YOU ARE NUMBER TWO BEHIND…." oder "…FOLLOW BEHIND…." nicht angewendet werden."*

[The Federal Office of Civil Aviation should ensure that when taxiing instructions, sequencing instructions and traffic information are given, on the entire manoeuvring area formulations such as "..." "YOU ARE NUMBER TWO BEHIND…." or "..."FOLLOW BEHIND…." are not used.]

Safety Recommendation no. 290

"Das Bundesamt für Zivilluftfahrt sollte überprüfen, ob die Apron jedem zum Start rollenden Luftfahrzeug zusammen mit der Aufforderung zum Frequenzwechsel zu einer Leitstelle der Skyguide auch die Aufforderung: "HOLD SHORT OF RUNWAY…." wiederholen sollte."

[The Federal Office of Civil Aviation should examine whether Apron should repeat to every aircraft taxiing to take off the instruction "HOLD SHORT OF RUNWAY…." in addition to the request to change the frequency to a Skyguide control centre.]

Status of implementation: cf. Report No. 1880, safety recommendations of the Aircraft Accident Investigation Bureau AAIB with comments by the Federal Office of Civil Aviation, dated 9 February 2006 (www.sust.admin.ch)

23 November 2002: SWR195Z vs. TAR485 Time: 11:08 UTC

Brief description: A take-off clearance to aircraft TAR485 on runway 28 was given at the same time as aircraft SWR195Z was approaching on intersecting runway 16.

Safety recommendations:

Safety Recommendation no. 264

"Das Bundesamt für Zivilluftfahrt (BAZL) sollte veranlassen, dass grundsätzlich keine swingover Verfahren der beschriebenen Art angewendet werden."

[The Federal Office of Civil Aviation (FOCA) should ensure that in principle no swingover procedures of the described type are applied.]

Safety Recommendation no. 265

"Das Bundesamt für Zivilluftfahrt (BAZL) sollte veranlassen, dass die nächsten Ausbauschritte des swiss airport movement area control system (SAMAX) möglichst rasch realisiert werden. Insbesondere die umgehende Verwirklichung des runway incursion monitoring and conflict alert sub-system (RIMCAS) könnte zur Vermeidung ähnlicher Vorfälle einen wertvollen Beitrag leisten."

[The Federal Office of Civil Aviation (FOCA) should arrange for the next expansion of the Swiss airport movement area control system (SAMAX) to be implemented as quickly as possible. In particular, the immediate implementation of the runway incursion monitoring and conflict alert sub-system (RIMCAS) could make a valuable contribution to the prevention of similar incidents.]

Status of implementation: cf. Safety Project Directive SPD-2005-12C (http://www.caso-db.uvek.admin.ch/)

23 November 2002: SWR1168 vs. AFR1855 Time: 12:23 UTC

Brief description: During the take-off roll of aircraft SWR1168 on runway 28, aircraft AFR185 made an unauthorised crossing on taxiway ECHO.

Safety recommendations:

Safety Recommendation no. 266

"Das Bundesamt für Zivilluftfahrt sollte den Fluggesellschaften empfehlen, dass ihre Flugbesatzungen das take-off briefing in Zukunft wenn möglich vor Verlassen des Standplatzes durchführen. Dies würde die Piloten in die Lage versetzen, ihre ganze Aufmerksamkeit dem anschliessenden Rollverfahren zu widmen."

[The Federal Office of Civil Aviation should recommend to the operators that their flight crews should in future carry out the take-off briefing if possible before leaving the stand. This would enable the pilots to devote their full attention to the subsequent taxiing process.]

Safety Recommendation no. 267

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass die Realisierung des Projektes RIMCAS mit höchster Priorität vorangetrieben wird."

[The Federal Office of Civil Aviation should arrange for the implementation of the RIMCAS project to be expedited with the highest priority.]

Safety Recommendation no. 268

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass für die Funktion "Coordinator Apron Control" ein schriftliches Pflichtenheft erstellt wird."

[The Federal Office of Civil Aviation should arrange for a written specification to be produced for the "Coordinator Apron Control" function.]

Safety Recommendation no. 269

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass die Arbeitsplatzorganisation bei Apron Control so gestaltet wird, dass ein längeres Fernbleiben eines Vorfeldverkehrsleiter (VVL) von seinem Arbeitsplatz als "Coordinator Apron Control" nur nach einer entsprechenden Ablösung durch einen andern VVL erfolgen sollte."

[The Federal Office of Civil Aviation should arrange for the workstation organisation at Apron Control to be organized in such a way that prolonged absence of an apron controller from his workstation as "Coordinator Apron Control" should take place only after appropriate substitution by another apron controller.]

Safety Recommendation no. 270

"Das Bundesamt für Zivilluftfahrt sollte die Zweckmässigkeit der Rollwegbezeichnungen auf dem Flughafen Zürich überprüfen, insbesondere diejenigen im Vorfeldbereich (z.B. Rollweg ALPHA und ECHO). Pistenüberquerende Rollwege sollten nicht durchgehend die gleiche Bezeichnung tragen."

[The Federal Office of Civil Aviation should examine the appropriateness of the taxiway designations at Zurich airport, in particular those in the apron area (e.g. taxiways ALPHA and ECHO). Taxiways which cross runways should not bear the same name over their entire route.]

A comment for implementation of this safety recommendations is still pending.

21 March 2003: SWR754 vs. SAA275

Brief description: Simultaneous take-off roll of aircraft SAA275 and SWR754 on runway 16 and runway 28 respectively.

Safety Recommendation no. 271

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass Flugbesatzungen, denen gleichzeitig auf verschiedenen Pisten die Rollbewilligung in ihre Startposition erteilt wird, zusätzliche Begleitinformationen übermittelt werden wie z.B. Informationen betreffend Abflugsequenz. Dies würde zu einem erhöhten Situationsbewusstsein der Besatzungen führen."

[The Federal Office of Civil Aviation should arrange for flight crews who are simultaneously given taxi clearance to their take-off position on different runways

to be given additional accompanying information, such as, for example, information about the take-off sequence. This would lead to an increased situational awareness of crews.]

Status of implementation: cf. Safety Project Directive SPD-2005-12C (http://www.caso-db.uvek.admin.ch/)

30 August 2003: EZS932 vs. SWR1344

Brief description: The go-around of aircraft EZS932 after an approach on runway 14 led to a lateral and vertical violation of the minimum separation from commercial aircraft SWR1344, which was flying the assigned standard departure route on runway 16.

Safety Recommendation no. 369

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass die ATC für Verkehrssituationen wie die hier vorliegende, Verfahren anwendet, die unter allen Umständen, sowohl in IMC als auch in VMC, die notwendige Mindeststaffelung gewährleisten."

[The Federal Office for Civil Aviation should arrange that for traffic situations such as the one under consideration, ATC applies procedures which guarantee minimum separation under all circumstances, both in IMC and in VMC.]

Status of implementation: cf. implemented Safety Action for CD-2008-26C (http://www.caso-db.uvek.admin.ch/)

31 October 2004: UAE87 vs. SWR162C

Brief description: Because of turbulence, the crew of UAE 87 decided on a go-around shortly before touchdown on runway 14. Immediately beforehand, aircraft SWR162C had been given take-off clearance on runway 10. The order to SWR162C to abort its take-off prevented a convergence of the two aircraft on the extended runway centre line.

Safety Recommendation no. 392

"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass die FVL des Flughafens ZRH Betriebskonzepte entwickelt, aufgrund derer die vorgeschriebene Staffelung in IMC und in VMC zwischen durchstartenden und startenden Flugzeugen mit kreuzenden Flugwegen resp. ab kreuzenden Pisten gewährleistet ist."

[The Federal Office of Civil Aviation should arrange for air traffic control at ZRH airport to develop operating concepts on the basis of which the prescribed separation in IMC and VMC between aircraft going around and aircraft taking off with intersecting flight paths or from intersecting runways is guaranteed.]

Status of implementation: cf. implemented Safety Action for CD-2008-26C (http://www.caso-db.uvek.admin.ch/)

2 December 2004: BRT695 vs. SWR1499

Brief description: Take-off of aircraft BRT695 on runway 28 with simultaneous crossing of the same runway by aircraft SWR 1499 on taxiway JULIET.

Safety recommendation:

On 17 January 2005 the AAIB had provided the Federal Office of Civil Aviation with a safety recommendation within the framework of an interim report. In it, the AAIB recommended an immediate ban on the application of the non-standard coordination procedure (*wait/wait cancelled* via TACO, to speed up traffic han-

dling), which is neither documented nor instructed. The recommendation was implemented in the meantime.

24 October 2007: DLH1LA vs. RJA149

Brief description: The serious incident arose as a result of the inadvertent convergence of aircraft taking off from runway 10 and aircraft going around on runway 14, which involved a high risk of collision.

Safety recommendations:

Safety Recommendation no. 369

The Aircraft Accident Investigation Bureau did not issue a safety recommendation concerning the lack of procedural separation, but referred to safety recommendation No. 369 issued on 10 June 2005: *"Das Bundesamt für Zivilluftfahrt sollte veranlassen, dass die ATC für Verkehrssituationen wie die hier vorliegende, Verfahren anwendet, die unter allen Umständen, sowohl in IMC als auch in VMC, die notwendige Mindeststaffelung gewährleisten."* [The Federal Office for Civil Aviation should arrange that for traffic situations such as the one under consideration ATC applies procedures which guarantee minimum separation under all circumstances, both in IMC and in VMC.] Implementation of this safety recommendation would also eliminate the present safety deficit.

Status of implementation: cf. implemented Safety Action for CD-2008-26C (http://www.caso-db.uvek.admin.ch/)

Safety Recommendation no. 426

"Das BAZL sollte sicherstellen, dass bis zur Umsetzung der Sicherheitsempfehlung Nr. 369 die Flugverkehrsleiter ausreichend für den Umgang mit den gegenwärtigen Verfahren geschult werden."

[The FOCA should ensure that until safety recommendation No. 369 is implemented, air traffic control officers are adequately trained in applying the current procedures.]

A comment for implementation of this safety recommendation ist still pending.

31 July 2008: OLT212 vs. BER966Z

Brief description: The serious incident occurred because take-off clearance was given to an aircraft departing from runway 28 even though another aircraft was simultaneously approaching on runway 16 and had already been given clearance to land.

Safety Recommendation no. 411

"Das BAZL sollte veranlassen, dass die ATC Zürich mit geeigneten technischen Hilfsmitteln oder standardisierten betrieblichen Verfahren Konflikte von auf Piste landenden mit auf Piste 28 startenden Flugzeugen frühzeitig erkennen kann."

[The FOCA should arrange, by means of appropriate technical aids and/or standardised operational procedures, for ATC Zurich to enable early detection of conflicts between aircraft landing on runway 16 and aircraft taking off on runway 28.]

Status of implementation: cf. Safety Project Directive SPD-2005-12C (http://www.caso-db.uvek.admin.ch/)

18 June 2010: BCI937 vs. THA971

Brief description: Simultaneous take-off roll of aircraft THA971 and BCI937 on runway 16 and runway 28 respectively.

Safety recommendation no. 439:

"Das Bundesamt für Zivilluftfahrt sollte sicherstellen, dass in den in der Schweiz verwendeten Funkbetriebssystemen eine Doppelausstrahlung erkennbar ist."

[The Federal Office of Civil Aviation should ensure that for the radio operating systems used in Switzerland, a double broadcast is detectable.]

A comment for implementation of this safety recommendation ist still pending.

15 March 2011: SWR1326 vs. SWR202W

Brief description: Simultaneous take-off roll of two aircraft on runway 16 and runway 28.

The above serious incidents are summarised in Table 4 and classified according to their corresponding critical points of intersection (1 – 6).

Number	Description	Serious incidents
1	Intersection of runway 16 and runway 28	SWR195Z vs. TAR485
		OLT212 vs. BER966Z
		SWR754 vs. SAA275
		BCI937 vs. THA971
		SWR1326 vs. SWR202W
2	Intersection of runway 28 and taxiway E	TAP5327 vs. CRX3554
		SWR1168 vs. AFR1855
3	Intersection of runway 28 and taxiway J	BRT695 vs. SWR1499
4	Go-around on runway 14 and take-off on runway 10	UAE87 vs. SWR162C
5		DLH1LA vs. RJA149
6	Go-around on runway 14 and take-off on runway 16	EZS932 vs. SWR1344

Table 4: Serious incidents at Zurich airport classified according to critical intersections

The critical intersection points on the ground and in the vicinity of the airport are shown in figures 14 and 15 respectively.

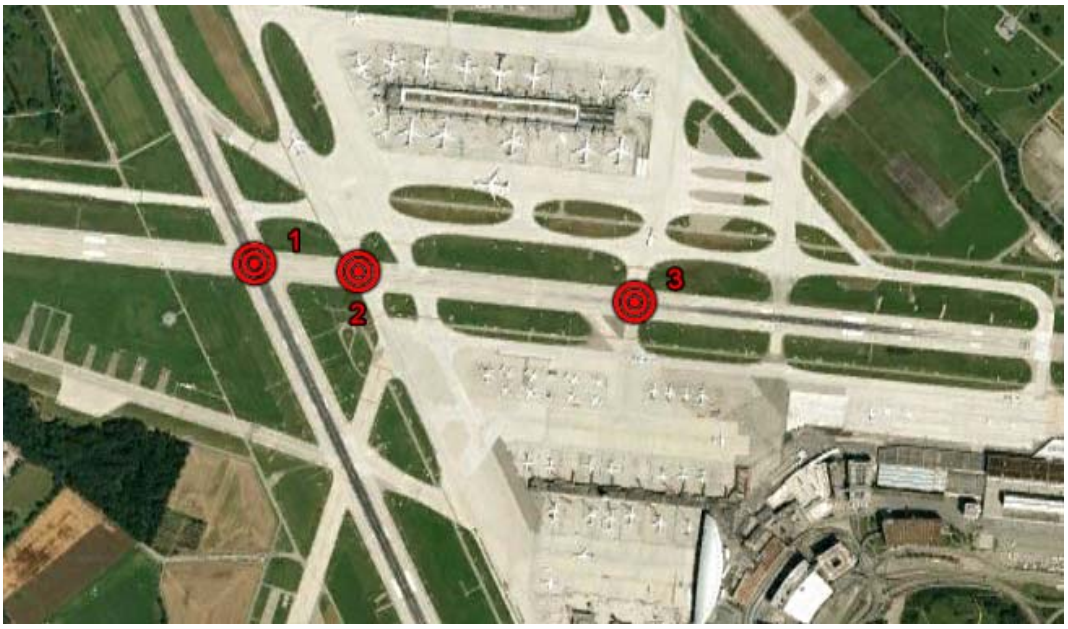


Figure 14: Critical intersection points on the ground

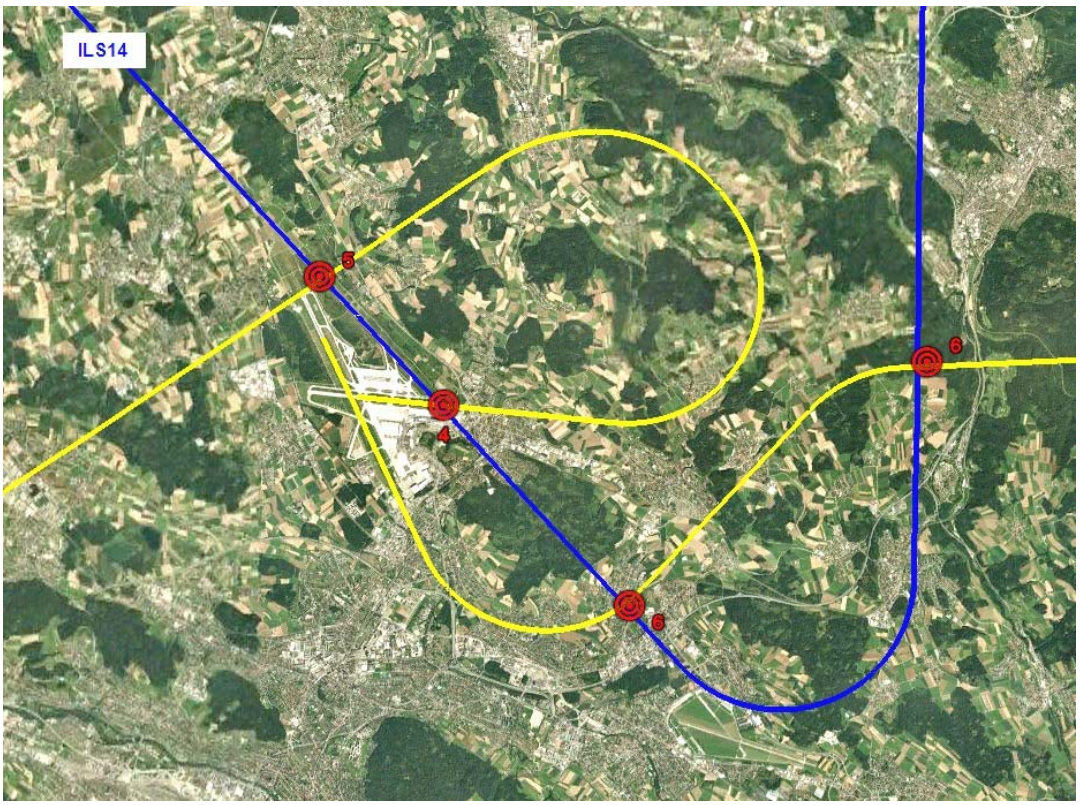


Figure 15: Critical intersection points in the vicinity of the airport

In summary, the impression is created that the previously implemented improvement in the operation of Zurich airport has been able to eliminate only selective risks. In the SAIB's view, the constant emergence of new problems suggests that the entire system of Zurich airport is currently being operated in a manner which involves further risks inherent in the system.

4.1.8 Safety recommendations nos. 434 – 435

"Das Bundesamt für Zivilluftfahrt sollte mit der Flugsicherung Skyguide, dem Betreiber des Flughafens Zürich und mit den Benutzern des Flughafens Zürich eine umfassende Analyse der Betriebsverfahren vornehmen und alle geeigneten Massnahmen treffen, welche die Komplexität und die systemischen Risiken verringern."

[The Federal Office of Civil Aviation, with the Skyguide air navigation services company, the operator of Zurich airport and users of Zurich airport, should carry out a comprehensive analysis of the operating procedures and take all appropriate measures to reduce complexity and the systemic risks.]

"Bis zur Umsetzung dieser Massnahmen, die sich aus einer solchen umfassenden Risikoanalyse ergeben, sollte wo nötig der Einsatz von zusätzlichem Personal oder von zusätzlichen bzw. verbesserten Sicherheitsnetzen angeordnet werden."

[Until these measures, which derive from such a comprehensive analysis have been implemented, where necessary the deployment of additional personnel or the use of additional or improved safety nets should be arranged.]

4.2 Measures taken since the serious incident

4.2.1 By the Federal Office of Civil Aviation

In its letter of 22 February 2012, the Federal Office of Civil Aviation (FOCA), among other things, gives its opinion on the safety recommendations [translated from German]:

Safety Recommendation no. 429

We are in agreement with the safety recommendation.

Measures taken:

Since March 2011 a total of 13 new releases have been implemented in the SAMAX/RIMCAS (Safety Net) system. The latest update followed on 15.12.11.

Safety Recommendation no. 430

We are basically in agreement with the safety recommendation. The FOCA would not be in agreement with a condition or an interpretation thereof to the effect that survey flights must be carried out outside operating hours by all means. The different degrees of utilisation of Zurich Airport make it possible to make survey flights in individual cases also during the day.

Measures taken:

On 1 April 2011 the revised article [Art. 39d Abs. 3 lit.B] of the Aviation Infrastructure Ordinance [Verordnung über die Infrastruktur der Luftfahrt – VIL] entered into force. This means that an adequate legal basis now exists to arrange for survey flights to take place on Geneva and Zurich airports temporarily at night (22:00 to 06:00), in so far as these cannot be arranged according to the rules during daytime operation. On this basis the FOCA issued a temporary authorisation for the year 2011; the authorisation for survey flights at night for March and August/September 2012 will be issued by the FOCA towards the end of February 2012.

Safety Recommendation no. 431

We are in agreement with the safety recommendation.

Measures taken:

The requested verification was carried out. The workload on the ADC during special flights (photo flights, etc.) was reduced by the restriction "only one special flight at a time". The measure has been in effect since the end of 2011; however, because of the small number of corresponding applications it will only begin to take effect in the 2012 summer season. "A reduction in the workload on the ADC during complex or exceptional traffic situations also is currently being examined in the context of the ‘ADC2 concept.

Safety Recommendation no. 432

We are in agreement with the safety recommendation.

Measures taken:

On the basis of the prioritisation of the necessary measures which was undertaken, the corresponding examination has not yet taken place. Immediate steps in connection with shifting survey flights to night-time had already been implemented (cf. SR no. 430).

Safety Recommendation no. 433

We are in agreement with the safety recommendation.

Measures taken:

(…). A finding was formulated, which requires Skyguide to draw up and introduce such a procedure for current operation also, as well for accidents or serious incidents. (…) The exact timing of the implementation is thus not yet clear.

Safety Recommendation no. 434

We are in agreement with the safety recommendation.

Measures taken:

(…). The results of this work (hazard listing, overall examination, risk definition) were available in autumn 2011.

(…)

The short-term measures should mostly be implemented by the end of 2012. Essentially these are the following:

- An additional air traffic control officer works in the tower for runway 14 (the so-called ADC2 concept; cf. Safety Recommendation no. 431)
- Moving survey flights to periods of reduced traffic (cf. Safety Recommendation no. 430)
- Consideration of special runway status lights
- Consideartion of the installation of an automated runway status display
- Update to warning system SAMAX/RIMCAS (cf. SR no. 429)
- Adapted slot system for helicopters in order to facilitate operation

In addition, the working group also dealt with medium- to long-term measures to improve the safety of the entire Zurich airport system. They are reflected in the currently ongoing work in connection with the strategic planning of aviation infrastructure [Sachplan Infrastruktur der Luftfahrt – SIL] for Zurich airport and will initially lead to further deconcentration of flight operations. (…)

Safety Recommendation no. 435

We are in agreement with the safety recommendation.

Measures taken:

See the details relating to Safety Recommendation 434.

4.2.2 By the Skyguide air traffic control company

In its letter dated 20 February 2012 Skyguide wrote that among other things it has taken the measures summarised below:

4.2.2.1 RIMCAS

Skyguide introduced improvements in the RIMCAS system, in collaboration with the software vendor, on 6 July 2011 and 14 December 2011. Among other things, the false alarms were reduced, and the parameters for take-offs on intersecting runways were modified (cf. also section 4.2.1: Measures taken in relation to Safety Recommendation no. 429.) A Skyguide memo dated 10 December 2011, states the following, among other things: "*To overcome the configuration limitations related to RWY intersection, a new SAMAX release will be implemented on 14f December 2011. With this major release the tool can be configured differently for aircraft/aircraft and aircraft/vehicle situations*."

4.2.2.2 Survey flights

Skyguide changed the procedures for survey flights as of 8 March 2012. Among other things, survey flights will now be carried out between 14:00 and 15:30 and between 22:15 and 02:00 LT. An additional air traffic control officer must be present in the control tower. No further special flights will be authorised during this period, and the acceptance rate for landing traffic will be lowered. (cf. section 4.2.1: Measures taken in relation to Safety Recommendation no. 430).

4.2.2.3 ADC air traffic control officer

After the serious incident on 15 March 2011, Skyguide's management decided to no longer deploy the air traffic control officer concerned at the workstations in the control tower until all the results of the investigation have been analysed and Skyguide's procedures for serious incidents have been further refined.

4.2.2.4 ADC frequency occupancy

With effect from 30 June 2011, Skyguide modified a number of radiotelephony procedures by means of an AIP amendment and an internal service order so that calls from pilots are shorter and therefore the occupancy of the tower frequency is reduced.

4.2.3 By the airport operator

In its letter of 10 February 2012, the responsible authority of Zurich airport stated the following [translated from German]:

(…) we have together with Skyguide and in accordance with Safety Recommendation no. 429 made various improvements to the RIMCAS warning system, by means of which the system has been optimised in that situations such as the one on 15 March 2011 can be detected promptly and an alert is triggered in good time. (…). Two workshops took place in early December 2011 under the aegis of Flughafen Zürich AG, with the participation of Skyguide, the air force, Swiss International Airlines with the FOCA and the CASO attending as an observer. In it, various short-term and medium- to long-term measures were identified, in particular to reduce the complexity of the overall system in Zurich and to mitigate other identified risks (cf. section 4.2.1: Measures taken in relation to Safety Recommendation no. 434). (…).

Payerne, 6 March 2012 Swiss Accident Investigation Board

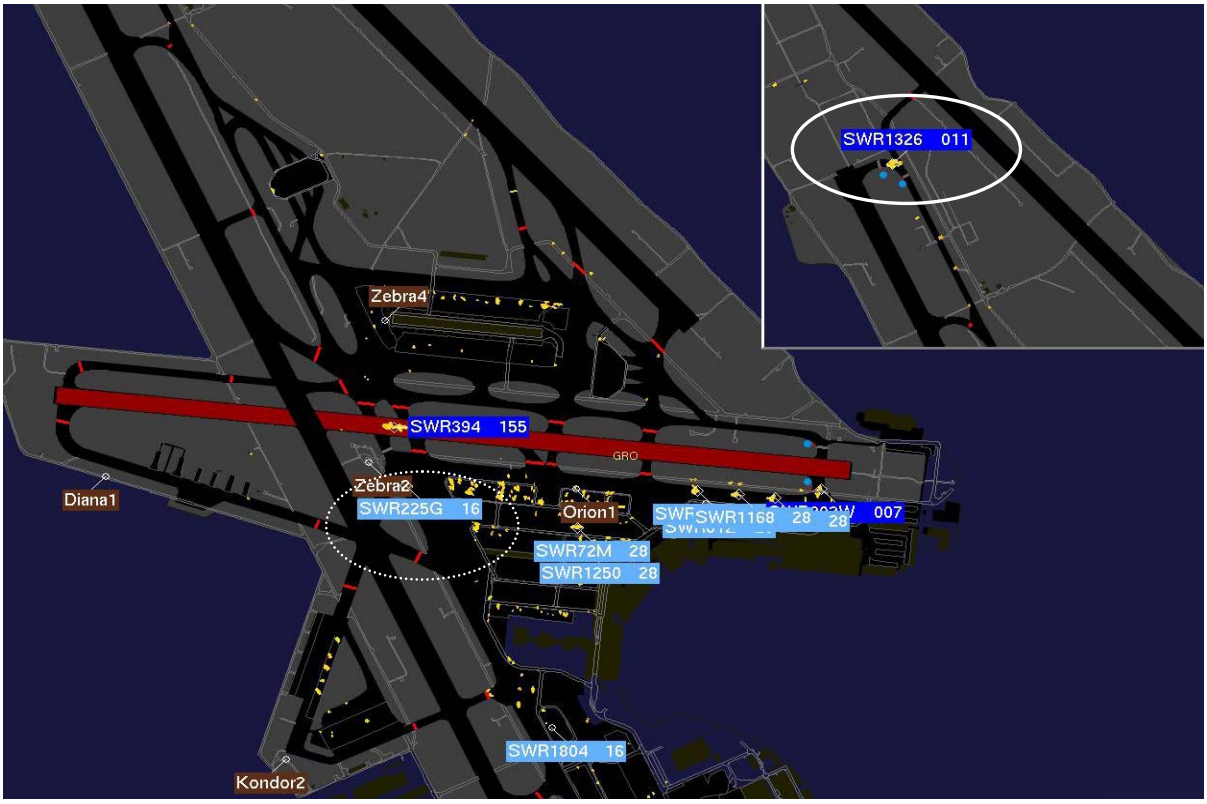
This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

Berne, 2 May 2012

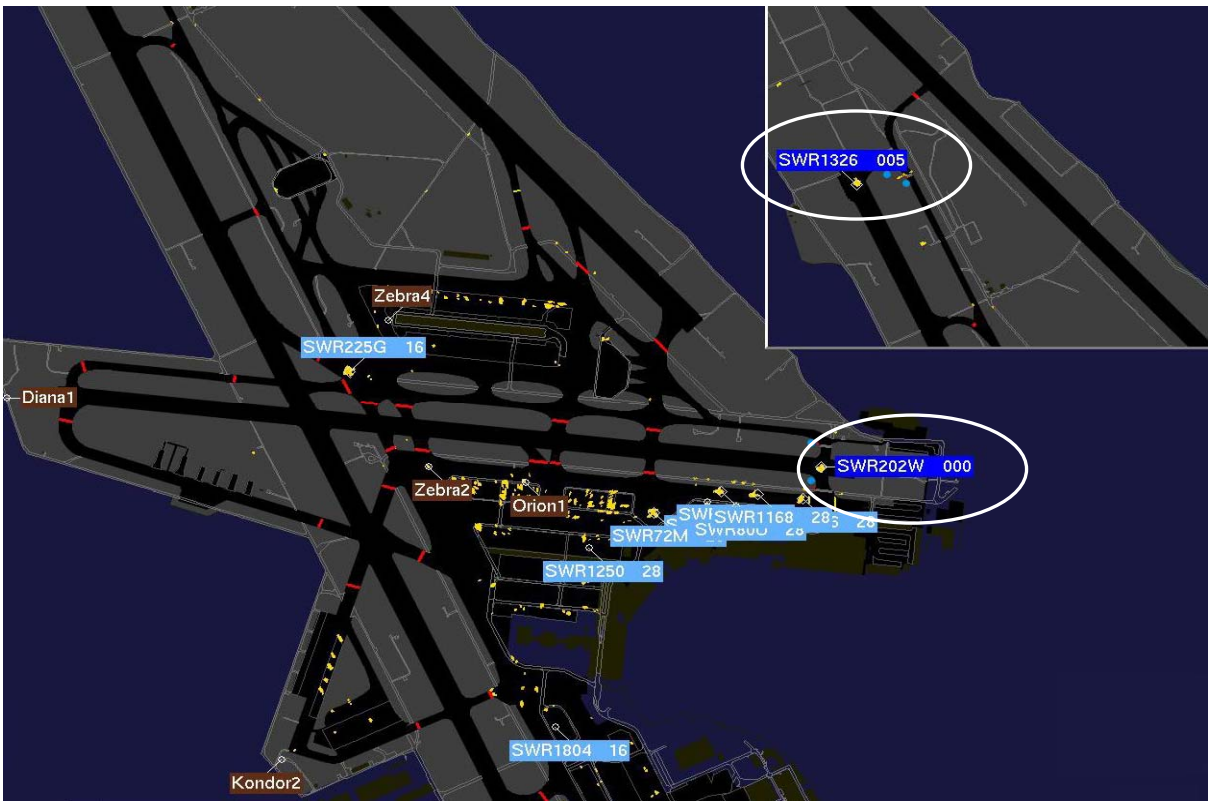
Annexes

Annex 1: RIMCAS recordings during take-off roll

11:41:17 UTC: SWR 1326 receives clearance to taxi to the take-off position on runway 16

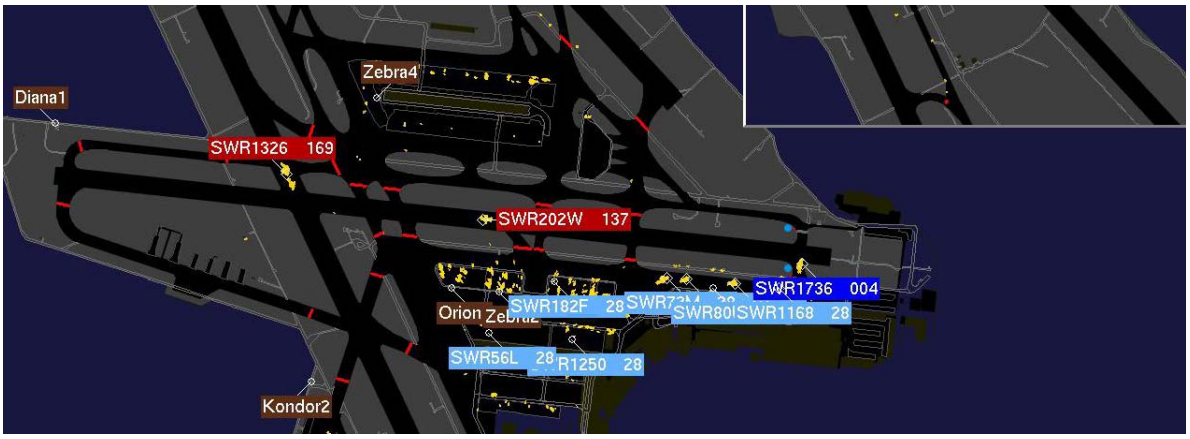


11:42:18 UTC: SWR 225G receives clearance to cross runway 28 (runway turns red).
11:42:19 UTC: SWR 1326 receives take-off clearance on runway 16



11:43:05 UTC: SWR 202W receives take-off clearance on runway 28, SWR 1326 starts its take-off roll

11:43:40 UTC: RIMCAS system generates a level 2 alert (aircraft markers turn red)



11:43:49 UTC: SWR 202W receives the instruction: *"Swiss two zero two Whiskey stop immediately."*

Annex 2: Division of labour on take-off

According to OM B section 2.04.10 (extract):

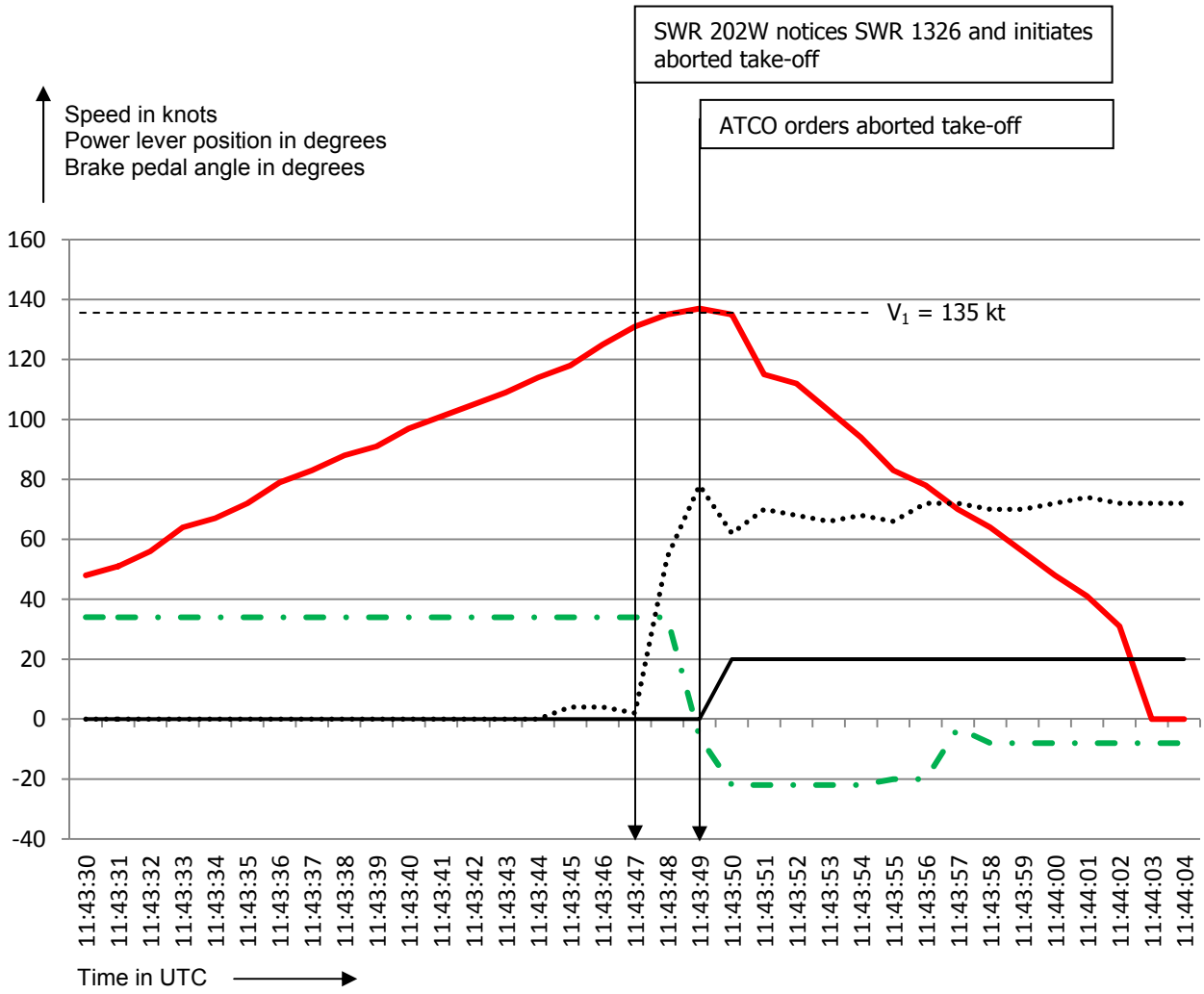
TASK SHARING DURING T/O AND INITIAL CLIMB

The **PIC** keeps his right hand on the thrust levers until V1 call out in order to be ready to reject the take-off, if necessary.

Flight phase, event	THE PIC SHALL	THE COPILOT SHALL
Cleared for take-off and upon lining up	– Call out **"TAKE-OFF"** – Advance thrust levers and check that both engines accelerate symmetrically to 50% N1	
Copilot take-off	– Order **"YOUR CONTROLS"** – Advance thrust levers to FLX or TOGA detent as appropriate	Confirm handover by calling **"MY CONTROLS"**
Thrust levers in FLX or TOGA detent	**Both pilots** check that	– FMA shows appropriate mode – ND shows correct T/O position

Flight phase, event	THE PF SHALL	THE PNF SHALL
Before 80 kt	– Hold side stick maintaining half forward deflection until 80 kt to restrict nose up effect at take-off thrust setting, releasing it progressively to reach neutral at 100 kt. (Notes 1, 2) – Verify on EW/D that take-off thrust is set and confirm **"CHECKED"**	– Check that take-off thrust is set, check EGT and call out **"TAKE-OFF THRUST SET"** – Monitor essential engine and flight instruments (e.g. N1, EGT, airspeed) and call out any anomalies – Be ready for immediate take-over by placing his hand close to side stick
At 100 kt	Cross check on PFD and confirm **"CHECKED"**	Call out **"ONE HUNDRED"** (Note 3)
At V1		Announce **"V1"**
At VR	Start smooth rotation with about 3-4 deg/sec towards 15° ANU. After lift off follow pitch bar. If FD not usable, climb with V2+10 (initially 15° ANU, maximum 18° ANU)	Call out **"ROTATE"**
When clear of ground and positive rate of climb is established	Order **"GEAR UP"**	Check positive rate, select gear up and monitor proper gear retraction
Above 100 ft RH: AP may be engaged	– Order **"ENGAGE AUTOPILOT 1 (OR 2)"** – Check FMA and confirm **"CHECKED"** – Check that NAV engages, if NAV is armed	Engage AP 1 (or 2), check on FMA and confirm **"AP 1 (or 2)"**

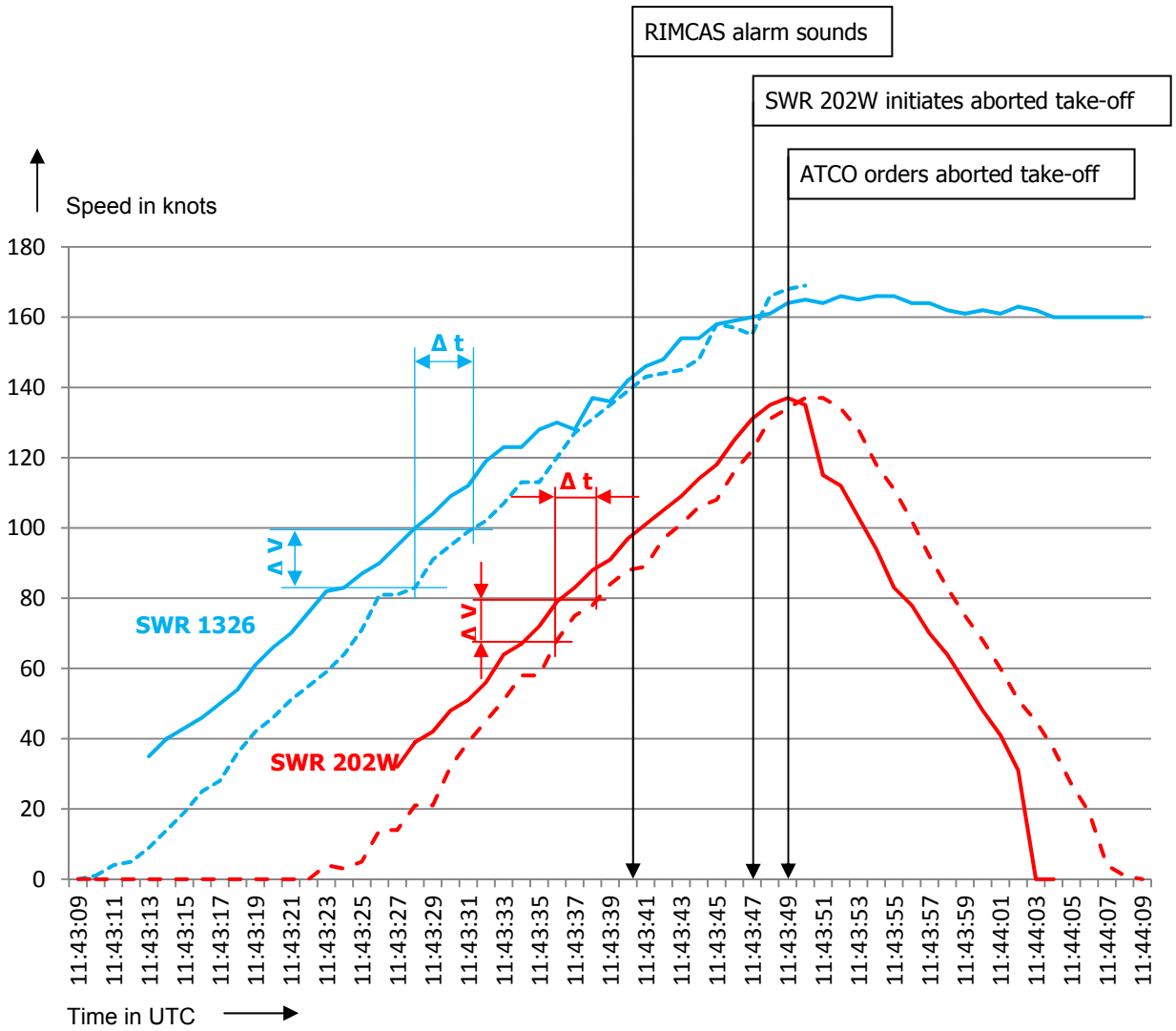
Annex 3: Take-off roll and aborted take-off, SWR 202W



Legend:

- Speed according to the FDR (flight data recorder)
- Power lever position (34°= take off power; <0° = idle / reverse)
- Brake pedal angle (maximum brake pressure at 50°)
- Reverse thrust flaps (0 = retracted; 20 = extended)

Annex 4: Speed plot of the two aircraft

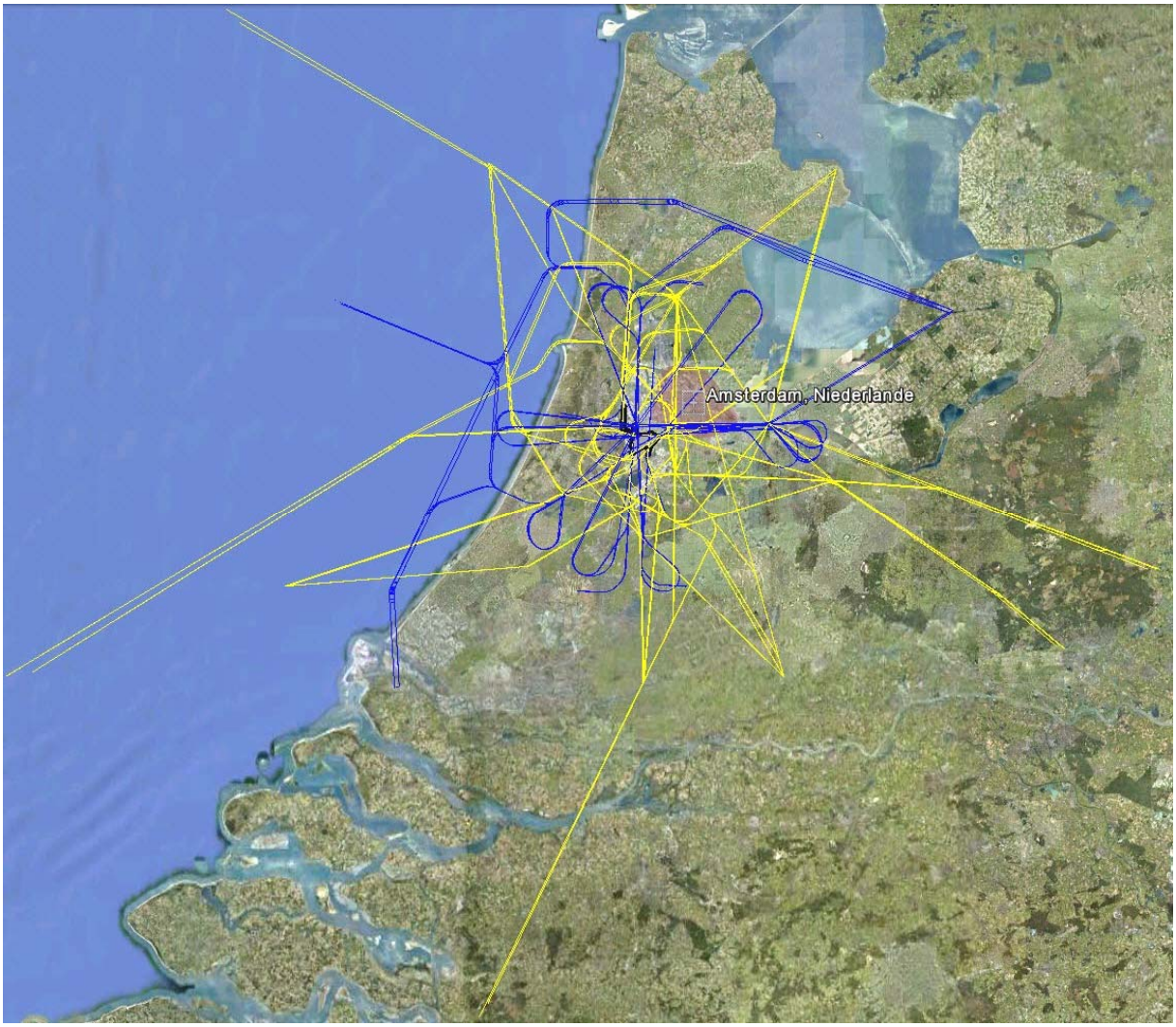


SWR 1326, Speed plot according to DFDR (digital flight data recorder)
SWR 1326, Speed plot according to RIMCAS recording
SWR 202W, Speed plot according to DFDR (digital flight data recorder)
SWR 202W, Speed plot according to RIMCAS recording

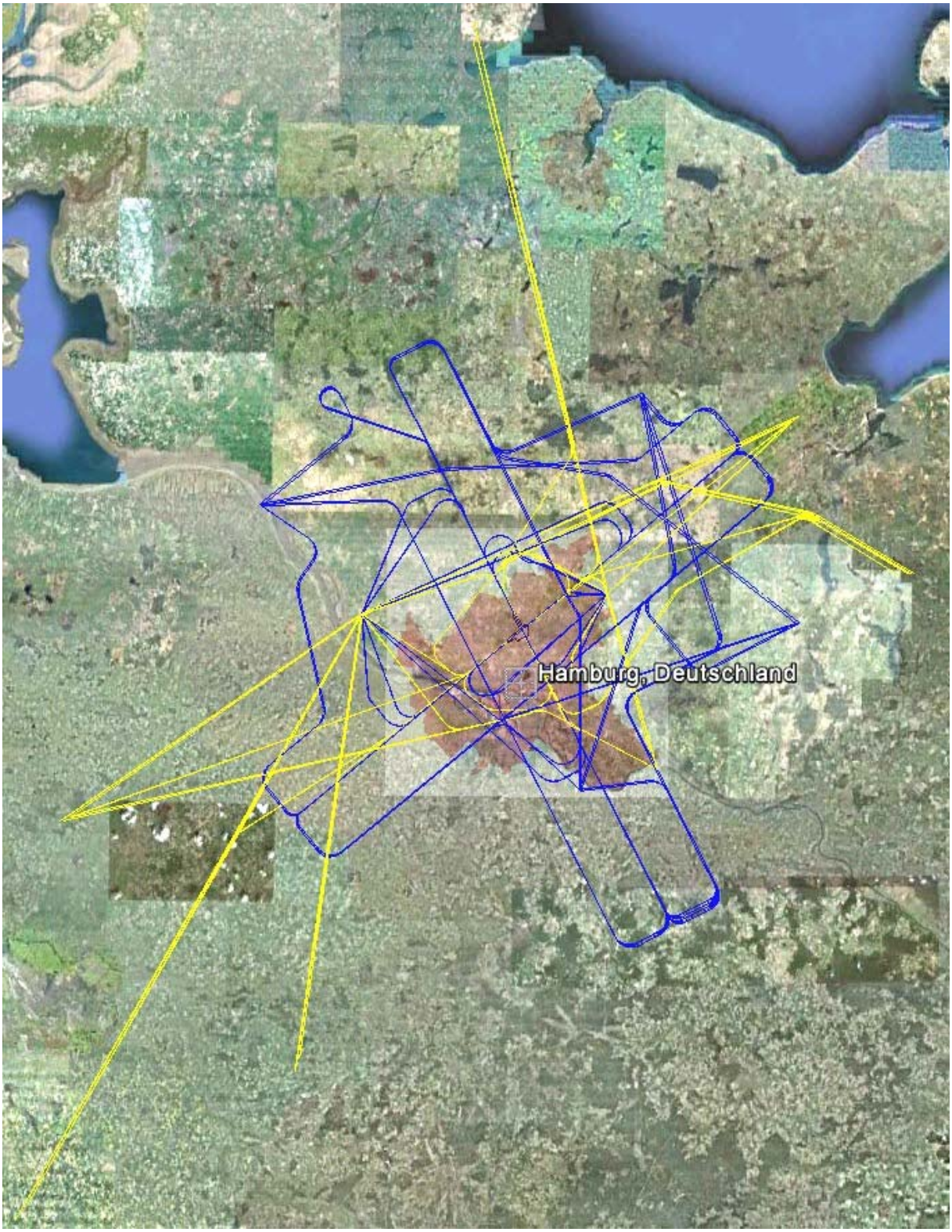
Example: SWR 1326 at 100 kt has a RIMCAS speed indication of 83 kt (100 kt is displayed 3 seconds later; ΔV = 17 kt, Δt = 3 seconds)

SWR 202W at 80 kt has a RIMCAS speed indication of 69 kt (80 kt not displayed until two and a half seconds later; ΔV = 11 kt, Δt = 2.5 seconds)

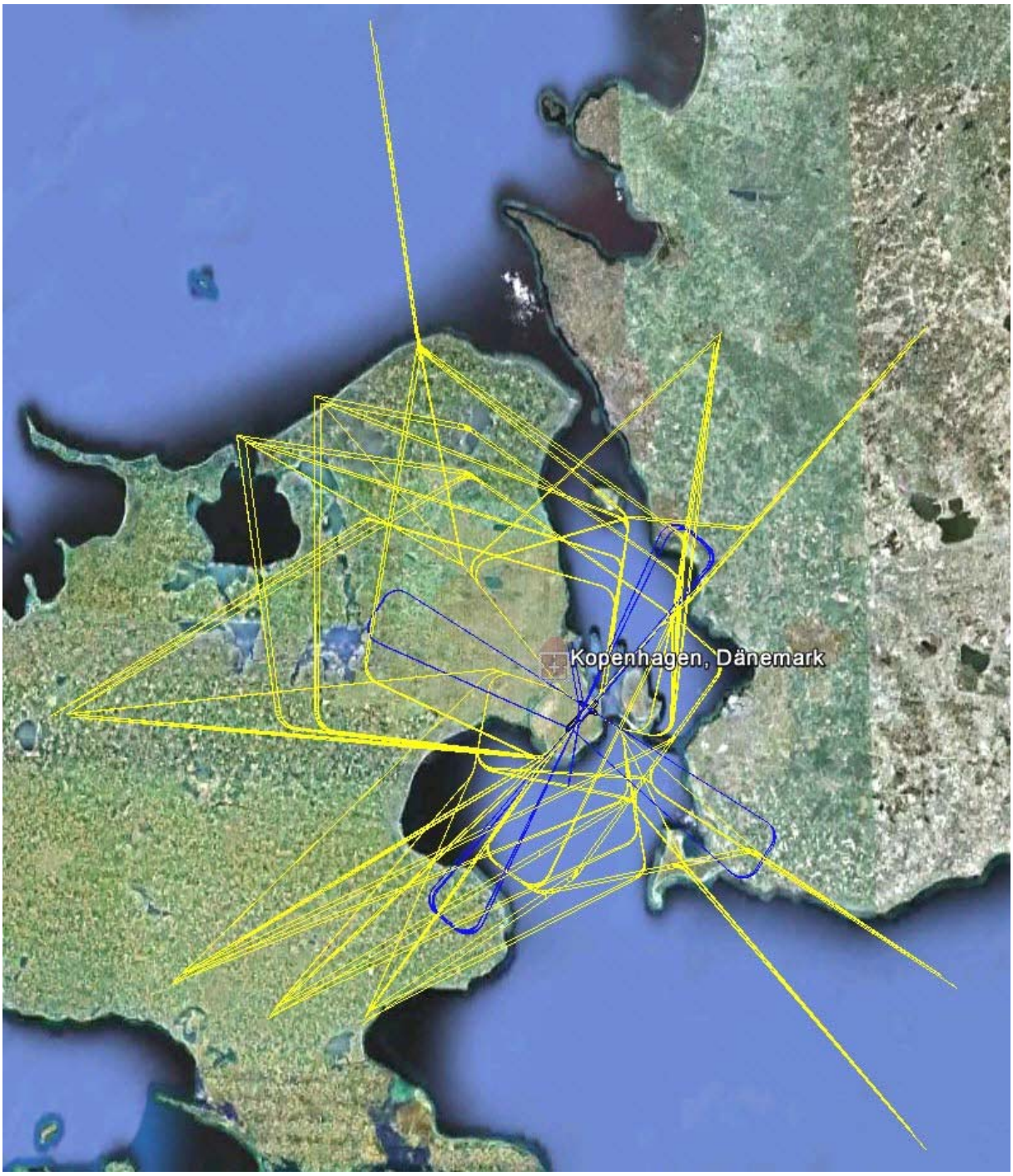
Annex 5: Arrival and departure procedures, Amsterdam (EHAM)



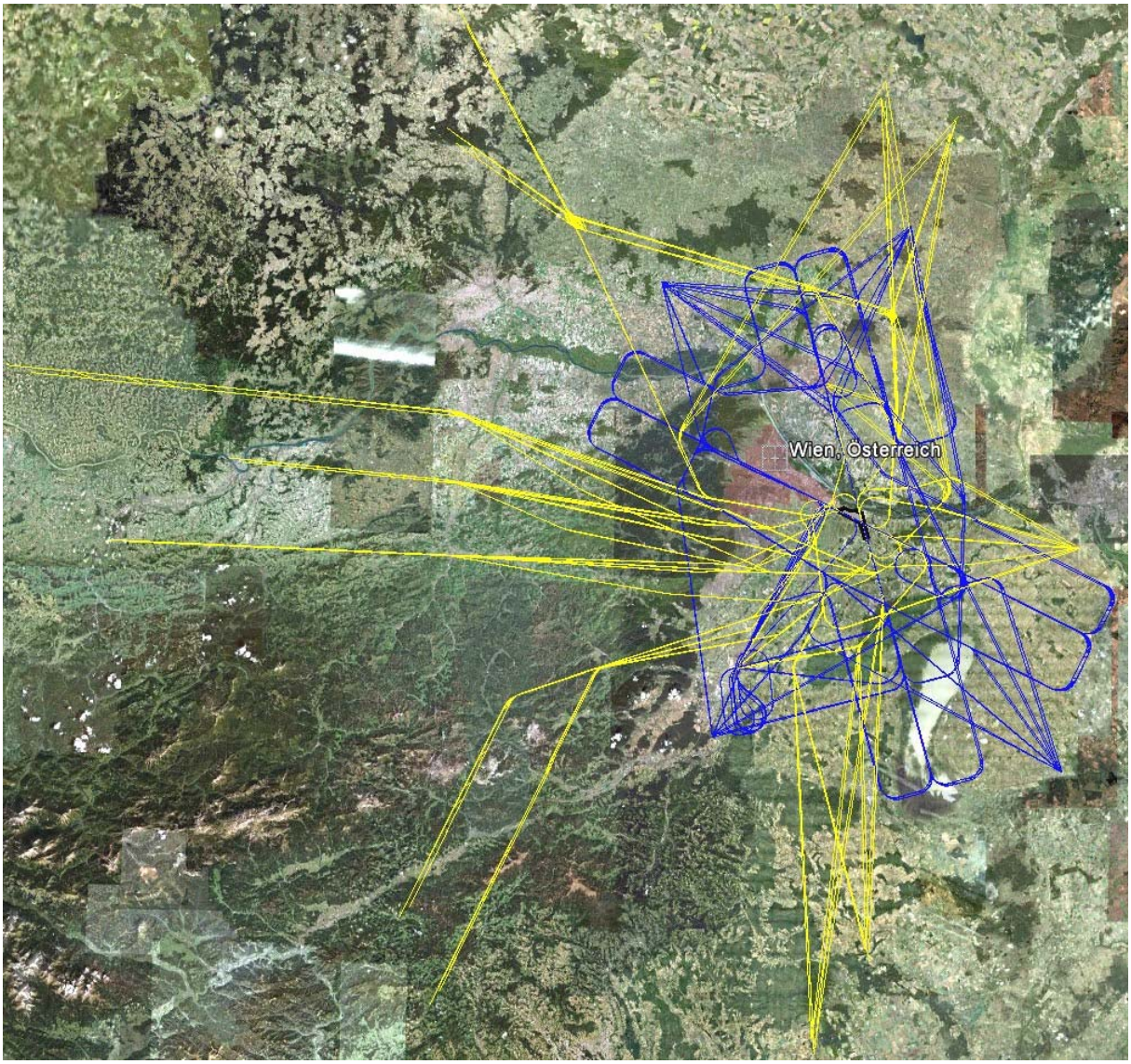
Annex 6: Arrival and departure procedures, Hamburg (EDDH)



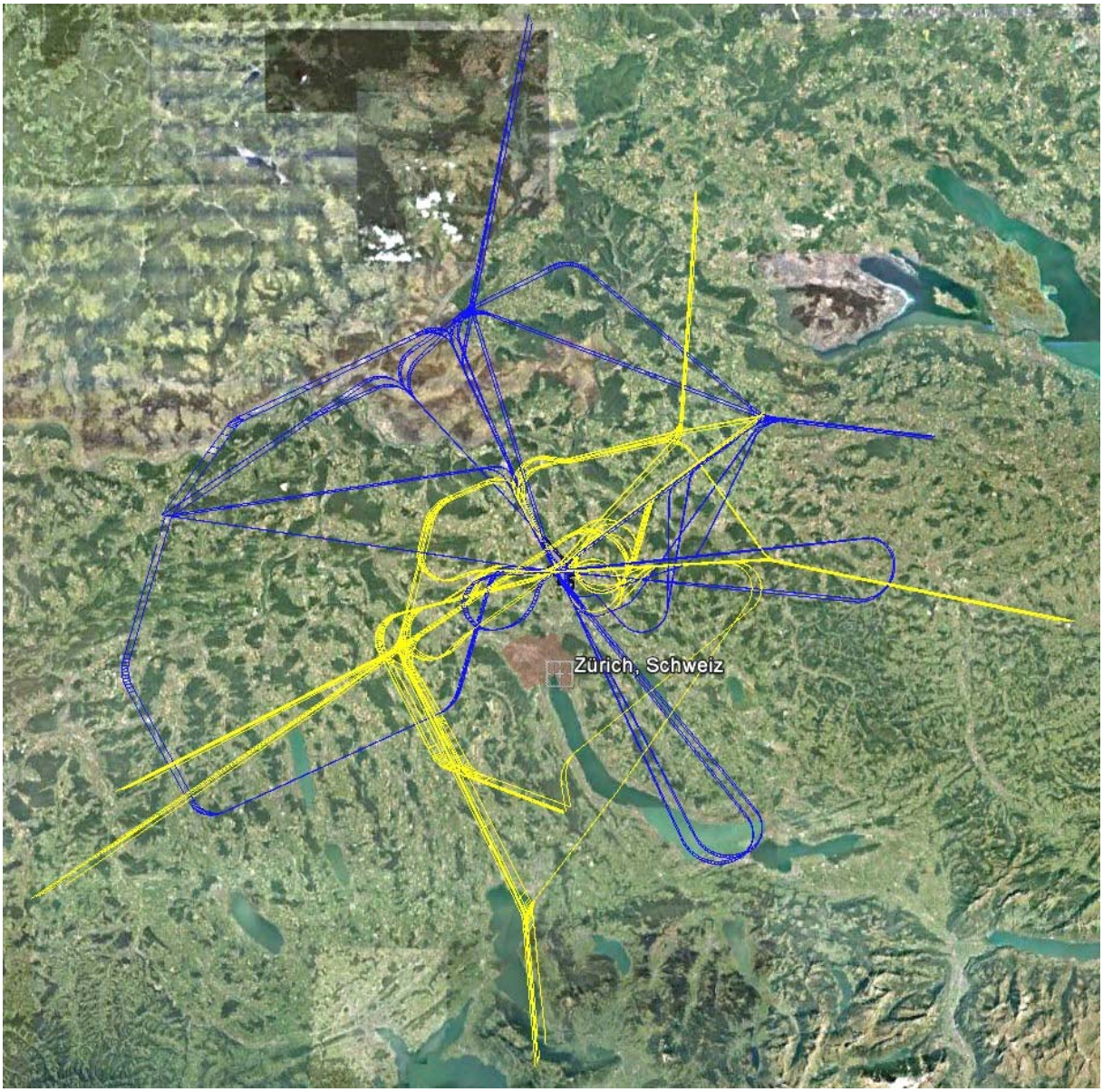
Annex 7: Arrival and departure procedures, Copenhagen (EKCH)



Annex 8: Arrival and departure procedures, Vienna (LOWW)



Annex 9: Arrival and departure procedures, Zurich (LSZH)



Annex 10: Statistical data on departure traffic from Zurich in 2010

Runway (# SIDs)	Designator[12]	Jet		Prop		131,612	per end of runway [%]	per total [%]
P-10 (10)	A1C	0		0		0		
	A1D	0		0		0		
	D1D	259	7.72%	160	56.74%	419	11.53%	0.32%
	D1E	1,447	43.16%	4	1.42%	1,451	39.92%	1.10%
	G1C	221	6.59%	21	7.45%	242	6.66%	0.18%
	G1E	0		0		0		
	V2E	1,405	41.90%	64	22.70%	1,469	40.41%	1.12%
	W2C[13]	0	0.00%	10	3.55%	10	0.28%	0.01%
	W2D	9	0.27%	4	1.42%	13	0.36%	0.01%
	Z1D	12	0.36%	19	6.74%	31	0.85%	0.02%
Total	10	3,353	100.00%	282	100.00%	3,635	100.00%	**2.76%**
P-28 (6)	A1V	4	0.01%	14	0.19%	18	0.02%	0.01%
	D1W	37,272	47.35%	4,002	55.18%	41,274	48.01%	31.36%
	G1W	1	0.00%	0		1	0.00%	0.00%
	V2W	41,123	52.24%	2,354	32.46%	43,477	50.57%	33.03%
	W2V	181	0.23%	443	6.11%	624	0.73%	0.47%
	Z1V	140	0.18%	439	6.05%	579	0.67%	0.44%
Total	6	78,721	100.00%	7,252	100.00%	85,973	100.00%	**65.32%**
P-14 (7)	A2A	0		0		0		
	D2A	0		0		0		
	D2B	0		0		0		
	G2B	0		0		0		
	V3B	1	100.00%	0		1		0.00%
	W3A	0		0		0		
	Z2A	0		0		0		
Total	7	1	100.00%	0		1		**0.00%**
P-32 (10)	A1M	1	0.01%	0		1	0.01%	0.00%
	D1N	5,783	38.27%	165	24.48%	5,948	37.68%	4.52%
	D2L	3,862	25.56%	247	36.65%	4,109	26.03%	3.12%
	G1N	0		0		0		
	S1N	0		0		0		
	S2L	0		0		0		
	V2N	5,440	36.00%	238	35.31%	5,678	35.97%	4.31%
	W2M	18	0.12%	8	1.19%	26	0.16%	0.02%
	Z1M	5	0.03%	16	2.37%	21	0.13%	0.02%

[12] The term designator stands for the shortened end point oft he SID connected with a characteristical number and a letter, e.g. "A1C" stands for SID "ALBIX 1C"

[13] W2C from runway 10: a prop SID (not registered in Annex 9)

	Z2L	1	0.01%	0		1	0.01%	0.00%
Total	10	15,110	100.00%	674	100.00%	15,784	100.00%	**11.99%**
P-16 (12)	A1R	0		0		0		
	D1R (V)	596	3.50%	20	62.50%	616	3.61%	0.47%
	D1S (V)	10,269	60.30%	3	9.38%	10,272	60.20%	7.80%
	G1S (V)	0		0		0		
	V2S (V)	6,160	36.17%	5	15.63%	6,165	36.13%	4.68%
	W2Q[14]	0		3	9.38%	3	0.02%	0.00%
	W2R	3	0.02%	0		3	0.02%	0.00%
	Z1R	2	0.01%	1	3.13%	3	0.02%	0.00%
Total	12	17,030	100.00%	32	100.00%	17,062	100.00%	**12.96%**
P-34 (10)	A1G	0		0		0		
	D1H	3,090	57.06%	4	57.14%	3,094	57.06%	2.35%
	D2F	557	10.29%	0		557	10.27%	0.42%
	G1H	0		0		0		
	S1H	0		0		0		
	S2F	0		0		0		
	V2H	1,766	32.61%	3	42.86%	1,769	32.63%	1.34%
	W2G	1	0.02%	0		1	0.02%	0.00%
	Z1G	0		0		0		
	Z2F	1	0.02%	0		1	0.02%	0.00%
Total	10	5,415	100.00%	7	100.00%	5,422	100.00%	**4.12%**
Misc.	Vxx[15]	9		3,726		3,735		**2.84%**
								100.00%

Annex 11: Departure routes with rerouted traffic in the vicinity of the airport

[14] W2Q from runway 16: a prop SID (not registered in Annex 9)

[15] Vxx: VFR departure procedure

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Swiss Accident Investigation Board SAIB

Aviation Division

Video clips relating to the serious incident involving SWR 1326 and SWR 202W

As part of the investigation into the serious incident, the data from the flight data recorders (FDR) of both aircraft was analysed. The data was converted using appropriate software in such a way that the sequence of the airprox can now be viewed in real time from different perspectives. To illustrate the serious incident and to complement the final report three video clips were produced:

Video clip 1: The aborted take-off roll of flight SWR 202W

This shows the take-off roll of flight SWR 202W on runway 28, as well as the take-off abort. Flight SWR 1326 can be seen at the top right of the image in video clip 1; it is beginning its take-off from runway 16 and lifts off in front of the SWR 202W which is braking.
The bottom right of the clip replicates the screen primarily used for flight guidance (primary flight display - PFD) and the thrust lever quadrant. On the PFD a number of the FDR parameters are shown (cf. figure 1)

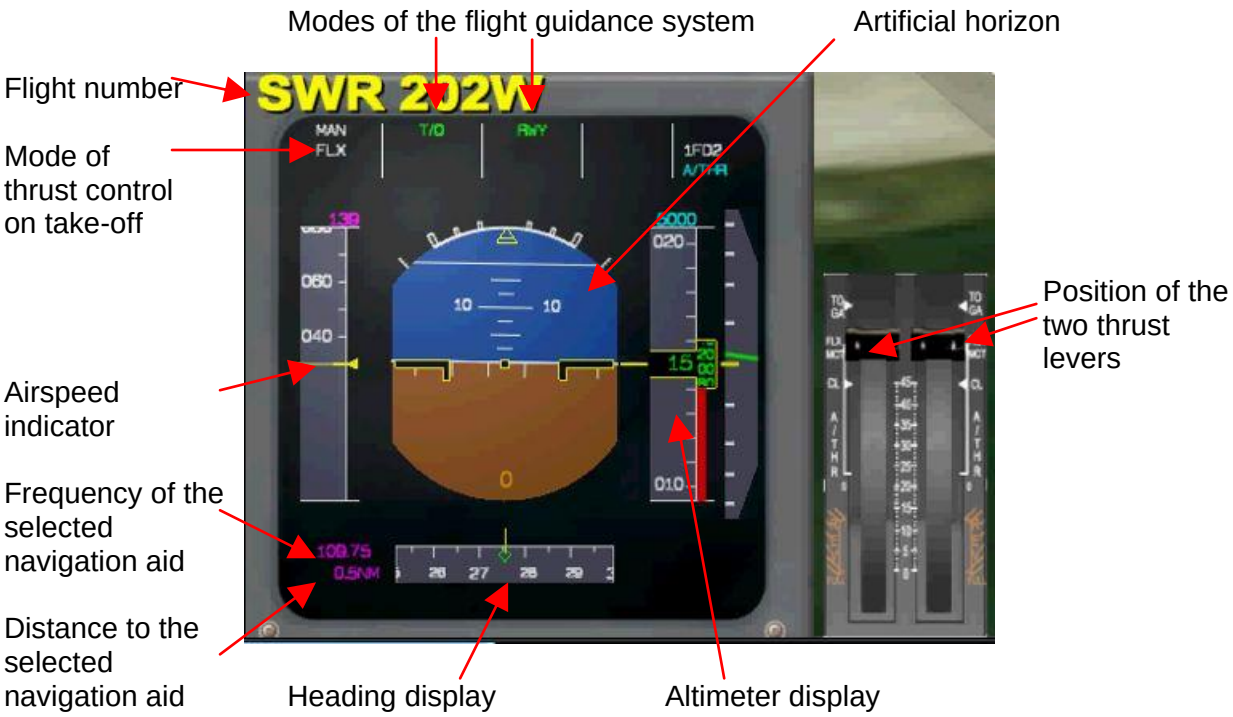


Figure 1: Detail of the primary flight display (PFD) shown in video clip 1 and 3 with a number of parameters.

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In addition the following information is superimposed:

- Time in coordinated universal time (UTC) (white)
- Transcription of the recordings from the cockpit of flight SWR 202W (yellow), ATC (light green) and from the cockpit of flight SWR 1326 (cyan).

This information is based on the cockpit voice recorder (CVR) of flight SWR 202W and the radio conversations between air traffic control and the two aircraft.

Video clip 2: Take-off and departure of flight SWR 1326

This shows the aircraft taxiing to the take-off position, the take-off and the initial climb of flight SWR 1326. Flight SWR 202W can be seen at the top left of the image in video clip 2.

The time and transcriptions of the conversations are also superimposed.

Video clip 3: The aborted take-off roll of flight SWR 202W with superimposed data of an additional aircraft

This shows the same sequence as video clip 1. However, an additional aircraft has been additionally superimposed; it is taking off at the same time as flight SWR 202W on runway 28, but does not abort its take-off and takes off normally. This representation is based on the FDR data from a comparable flight. This representation makes it possible to illustrate how the serious incident would have developed if the crew of flight SWR 202W had not aborted their take-off, but had instead continued it.

In addition, in this video clip the rolling distance completed by the aircraft and the respective flight path have been superimposed.

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