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Aircraft Accident Investigation Bureau AAIB

Final Report No. 2113 by the Aircraft Accident Investigation Bureau

concerning the serious incident - Airprox

involving the Airbus A340-600 aircraft, registration HS-TNA,

operated by Thai Airways International Ltd.

under radio callsign THA 971

and the Avions de Transport Régional ATR42 aircraft,

registration G-DRFC,

operated by Blue Islands Ltd.

under radio callsign BCI 937

on 18 June 2010

at Zurich airport

Aéropôle 1, Route de Morens, CH-1530 Payerne

General information on this report

This report contains the Aircraft Accident Investigation Bureau's (AAIB) 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 9th edition, applicable from 1 November 2001, 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 incident, Central European Summer Time (CEST) applied as local time (LT) in Switzerland. The relation between LT, CEST and UTC is:
LT = CEST = UTC + 2 hours.

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Final Report

Synopsis

Aircraft 1	
Owner	Thai International Public Companies Ltd., Thailand
Operator	Thai Airways International Ltd., Thailand
Manufacturer	Airbus S.A. S., Toulouse, France
Aircraft type	A340-600
Country of registration	Thailand
Registration	HS-TNA
Commercial flight number	TG 971
ATC callsign	THA 971
Radio callsign	Thai niner seven one
Flight rules	IFR
Type of operation	Scheduled flight
Departure point	Zurich (LSZH)
Destination point	Bangkok-Suvarnabhumi (VTBS)
Aircraft 2	
Owner	Healthspan Group, Guernsey
Operator	Blue Islands Ltd., United Kingdom
Manufacturer	Avions de Transport Régional, France
Aircraft type	ATR42-320
Country of registration	United Kingdom
Registration	G-DRFC
Commercial flight number	SI 937
ATC callsign	BCI 937
Radio callsign	Blue Island niner three seven
Departure point	Zurich (LSZH)
Destination point	Jersey (EGJJ)
Location	Zurich airport LSZH, runways 16 and 28 Swiss sovereign territory
Date and time	18 June 2010, 12:02 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 18 June 2010 at 12:02 UTC. The notification was received by the Aircraft Accident Investigation Bureau (AAIB) on the same day at approximately 15:00 UTC. After preliminary clarifications, which are usual with this type of serious incident, the investigation was opened on 22 June 2010.

The AAIB reported the serious incident to the investigating authorities of Thailand and the United Kingdom. The United Kingdom subsequently nominated an authorised representative.

The present investigation report is published by the Swiss AAIB.

Summary

On 18 June 2010 at 12:00:30 UTC, the Thai Airways International Airbus A340-600, ATC callsign THA 971, received clearance to taxi to the take-off position on runway 16. At 12:01:31 UTC the ATR42 aircraft of the Blue Islands airline, ATC callsign BCI 937, received clearance to taxi to the take-off position on runway 28. A British Airways aircraft, ATC callsign BAW 713, was ready to depart at holding position point BRAVO to the north of the threshold of runway 28. At 12:02:26 UTC the crew of THA 971 received clearance to take off from runway 16; they acknowledged it immediately and initiated the take-off roll. Almost simultaneously, the crew of BCI 937 initiated their take-off roll on runway 28. About 15 seconds later, at 12:02:47 UTC, the crew of BAW 713 informed aerodrome control that at that moment it was possible that two aircraft would take off simultaneously. At 12:02:50 UTC aerodrome control instructed the crew of BCI 937 to abort their take-off. The crew obeyed this instruction and vacated runway 28 on taxiway ALPHA 4. The crew of THA 971 continued their take-off and flight to their destination.

Causes

The serious incident is attributable to the fact that on runway 28 the crew of an aircraft initiated a take-off without a corresponding clearance; this led to a significant risk of collision with an aircraft taking off on runway 16.

The following factors contributed to the serious incident:

- The crew of the aircraft on runway 28 did not notice the readback of the take-off clearance by the crew of the aircraft on runway 16.
- The readback of the presumed take-off clearance by the crew of the aircraft on runway 28 was not audible to the air traffic controller because the chosen location of the receivers of the normal radio operation system favoured the suppression of this clearance.
- Air traffic control did not notice the aircraft beginning its take-off roll on runway 28.
- The air traffic control conflict alert system was inappropriate for defusing the impending conflict.

The occurrence of the serious incident was favoured by the complex operation on two intersecting runways, which has only a small error tolerance in the event of a high volume of traffic.

Safety recommendations

Within the framework of the investigation, one safety recommendation was made.

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 must decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, any establishment and any individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

Swiss legislation provides for the following regulation regarding implementation in the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents:

"Art. 32 Safety recommendations

The Federal Office shall inform the Bureau within six months of publication of the investigation report of the measures which are being taken on the basis of the safety recommendations in the investigation report or of the reasons why these measures are not being implemented."

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 radiotelephony traffic, various radar systems and the statements of crew members, air traffic controllers and technical experts were used.

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

In the Zurich tower (TWR) aerodrome control unit, the following workstations were occupied: aerodrome control (ADC), ground control (GRO), clearance delivery (CLD) and daily operation manager (DOM).

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

1.1.2 Pre-flight history

At the time of the serious incident, building work was in progress inside and outside the control tower. In the control tower cab, to the rear of the ADC and GRO workstations, conversion work was being performed on the manager's console. As a result of the notified and prevalent noise during work, the air traffic controller (ATCO) at the ADC workstation was working with a headset.

According to information from the ADC air traffic controller, there was a high volume of traffic of great complexity at the time of the serious incident.

The ADC workstation was equipped with an alert system which is designed to warn the ATCO of conflicts on the ground between aircraft and between aircraft and vehicles (cf. Section 1.9 and Annex 1).

1.1.3 History of the serious incident

At 11:52:31 UTC on 18 June 2010, the crew of the Avions de Transport Régional (ATR) 42 aircraft of the Blue Islands airline, ATC callsign BCI 937, contacted the air traffic controller (ATCO) at the ADC workstation. The ATCO informed the crew that she would call them back to communicate a take-off time. Two minutes later, at 11:54:37 UTC, on the same frequency, the crew of the Thai Airways International Airbus A340-600 aircraft, ATC callsign THA 971, reported that they were ready for take-off. They received the answer that they would be called back.

At 11:57:10 UTC the ATCO gave the crew of THA 971 the following clearance: *"Thai niner seven one, behind Cyprus Airbus line up runway one six."* The crew of THA 971 confirmed this clearance and about one minute later the ATCO informed the crew of BCI 937 that they could expect their take-off clearance in seven minutes. This communication was confirmed by the crew of BCI 937.

The THA 971 aircraft was at the runway 16 holding position when at 12:00:30 UTC the crew again received the following clearance: *"Thai niner seven one, line up runway one six".* They acknowledged this clearance and taxied to the take-off position on runway 16.

The ADC air traffic controller then conducted conversations with six other aircraft before she again returned to BCI 937, which had been in contact with her since 11:52:31 UTC. At 12:01:33 UTC, she cleared BCI 937 to taxi to the take-off position on runway 28. The crew acknowledged this clearance as follows: *"Blue Island nine three seven, line up runway two eight."*

At holding position point BRAVO, north of the threshold of runway 28, there was a British Airways aircraft, ATC callsign BAW 713.

The ADC air traffic controller originally kept the option open to allow BCI 937 to take-off before THA 971. Because of traffic arriving on runway 14 she refrained from doing so and at 12:02:26 UTC gave the crew of THA 971 clearance to take-off as follows: *"Thai nine seven one, wind two six zero degrees, seven knots, runway one six, cleared for take-off".* This take-off clearance was confirmed immediately by the crew of THA 971 as follows: *"Cleared for take off, runway one six, Thai nine seven one".* This radio message was recorded by the aerodrome control legal recording and was heard by the ADC air traffic controller and the GRO air traffic controller.

At the same time as the report from the crew of THA 971, the crew of BCI 937 on runway 28 reported "*We're cleared take off, Blue Island nine three seven",* because they were convinced that they had received take-off clearance. This radio message was neither recorded by the aerodrome control legal recording nor heard by the two air traffic controllers.

The crew of BAW 713, at holding position point BRAVO, who were monitoring the aerodrome control frequency, had realised that two aircraft were simultaneously in take-off positions on runways 16 and 28. In view of this fact, the crew discussed the risk of such a situation with intersecting runways. The following then occurred from their viewpoint: "*(...) ZRH Tower then gave the Thai A340 T/O clearance, which the Thai aircraft read back, at the same time we heard English voices read 'cleared for T/O'."* Immediately afterwards, the crew of BAW 713 observed that BCI 937 started to roll on runway 28. At 12:02:47 UTC they therefore informed aerodrome control: *"Ah, you may have two aircraft taking off at the moment".*

After the take-off clearance to THA 971 on runway 16, the ADC air traffic controller kept it in her field of view to be sure that the take-off had actually been initiated. This was necessary to guarantee the required separation from approaching traffic.

On the basis of the report from BAW 713 that two aircraft would possibly take off at the same time, the ATCO immediately looked at runway 28 and without delay gave the crew of BCI 937 the following instruction at 12:02:50 UTC: *"Blue Island nine three seven, hold position, Blue Island nine three seven, hold position, stop now."* The crew of BCI 937 reacted immediately and confirmed the instruction as follows: *"Stopping, stopping, Blue Island nine three seven".* At this time, BCI 937 had attained a speed of 54 kt and THA 971 a speed of 10 kt. The maximum speed of BCI 937 when the take-off was aborted was 74 kt.

While BCI 937 was braking, at a speed of 61 kt, a Stage 2 alert was generated on the RIMCAS (Runway Incursion Monitoring and Conflict Alert System) at the ADC workstation (cf. Annex 1). At this time, THA 971, during its take-off roll, had attained a speed of 71 kt.

The BCI 937 aircraft was able to vacate runway 28 via taxiway ALPHA 4, 950 metres after the threshold of runway 28.

The crew of THA 971 continued their take-off and the flight to their destination.

1.1.4 Location of the serious incident

Geographical position	Zurich airport (cf. chapter 1.7)
Date and time	18 June 2010, 12:02 UTC
Lighting conditions	Daylight

1.2 Personnel information

1.2.1 Crew of THA 971

1.2.1.1 Commander

Person	Thai citizen, born 1959
Licence	Air transport pilot licence aeroplane – issued by the Thai Department of Civil Aviation on 8 May 2007, valid from 17 May 2007 to 16 May 2012.
Ratings	Pilot in Command (PIC) for A340-500/600
Instrument flying rating	Automatically included in licence
Last proficiency check	5 May 2010
Medical fitness certificate	Class 1 Restrictions: corrective lenses for near vision are required on duty

1.2.1.1.1 Flying experience

Total	17 954 hours
on the type involved in the incident	1984 hours
during the last 90 days	235 hours

1.2.1.1.2 Duty times

Start of duty in the 48 hours before the serious incident	16 June 2010, 17:35 UTC 18 June 2010, 10:30 UTC
End of duty in the 48 hours before the serious incident	17 June 2010, 05:02 UTC
Flight duty times in the 48 hours before the serious incident	16/17 June 2010, 11:27 hours
Rest times in the 48 hours before the serious incident	from 17 to 18 June: 29:28 hours
Flight duty time at the time of the serious incident	01:32 hours

1.2.1.2 Copilot

Person	Thai citizen, born 1974

Licence	Air transport licence - aeroplane, issued by the Thai Department of Civil Aviation on 18 May 2007, valid from 31 May 2007 to 30 May 2012.
Ratings	Copilot for A340-500/600
Instrument flying rating	Automatically included in licence
Last proficiency check	5 May 2010
Medical fitness certificate	Class 1 Restrictions: corrective lenses for distant vision are required on duty
Last medical examination	28 April 2010

1.2.1.2.1 Flying experience

Total	10 458 hours
on the type involved in the incident	5383 hours
during the last 90 days	282 hours

1.2.1.2.2 Duty times

Start of duty in the 48 hours before the serious incident	16 June 2010, 17:35 UTC 18 June 2010, 10:30 UTC
End of duty in the 48 hours before the serious incident	17 June 2010, 05:02 UTC
Flight duty times in the 48 hours before the serious incident	16/17 June 2010, 11:27 hours
Rest times in the 48 hours before the serious incident	from 17 to 18 June: 29:28 hours
Flight duty time at the time of the serious incident	01:32 hours

1.2.2 Crew of BCI 937

1.2.2.1 Commander

Person	British citizen, born 1960
Licence	Air transport pilot licence aeroplane – ATPL(A)) according to joint aviation requirements (JAR) EASA, first issued by the UK Civil Aviation Authority on 25 September 2006, valid till 24 September 2011.
Ratings	ATR 42 300, ATR 42/72
Instrument flying rating	IR ATR 42/72, ATR 42/72
Last proficiency check	18 June 2009
Medical fitness certificate	Class 1 without restrictions
Last medical examination	7 April 2010

1.2.2.1.1 Flying experience

Total	4285 hours
on the type involved in the incident	501 hours
during the last 90 days	114 hours

1.2.2.1.2 Duty times

Start of duty in the 48 hours before the serious incident	16 June 2010, off duty 17 June 2010, 12:00 UTC 18 June 2010, 06:00 UTC
End of duty in the 48 hours before the serious incident	16 June 2010, off duty 17 June 2010, 18:40 UTC
Flight duty times in the 48 hours before the serious incident	16 June 2010, off duty 17 June 2010, 06:40 hours
Rest times in the 48 hours before the serious incident	from 17 to 18 June: 11:20 hours
Flight duty time at the time of the serious incident	06:02 hours

1.2.2.2 Copilot

Person	British citizen, born 1971
Licence	Commercial pilot licence aeroplane (CPL (A)) according to joint aviation requirements (JAR) EASA, first issued by the UK Civil Aviation Authority on 3 October 2007, valid till 2 October 2012.
Ratings	ATR 42/72
Instrument flying rating	IR ATR 42/72
Last proficiency check	19 May 2009
Medical fitness certificate	Class 1 without restrictions
Last medical examination	13 February 2010

1.2.2.2.1 Flying experience

Total	767 hours
on the type involved in the incident	449 hours
during the last 90 days	147 hours

1.2.2.2.2 Duty times

Start of duty in the 48 hours before the serious incident	16 June 2010, 12:00 UTC 17 June 2010, 12:00 UTC 18 June 2010, 06:00 UTC
End of duty in the 48 hours before the serious incident	16 June 2010, 18:40 UTC 17 June 2010, 18:40 UTC

Flight duty times in the 48 hours before the serious incident	16 June 2010, 06:40 hours 17 June 2010, 06:40 hours
Rest times in the 48 hours before the serious incident	from 16 to 17 June: 17:20 hours from 17 to 18 June: 17:20 hours
Flight duty time at the time of the serious incident	06:02 hours

1.2.3 Air traffic control personnel

1.2.3.1 Air traffic controller ADC

Function	Aerodrome control (ADC)
Person	Swiss citizen, born 1970
Start of duty on the day of the incident	11:10 UTC at the ADC workstation
Licence	Air traffic controller licence based on European Community Directive 2006/23, first issued by the Federal Office of Civil Aviation (FOCA) on 15 November 1996, valid till 20 February 2011
Relevant ratings	ADI aerodrome instruments
Medical fitness	Class 3, without restrictions; from 20 January 2010, valid till 21 February 2012

1.2.3.2 Air traffic controller GRO

Function	Ground control (GRO)
Person	Swiss citizen, born 1973
Start of duty on the day of the incident	11:30 UTC at the GRO workstation
Licence	Air traffic controller licence based on European Community Directive 2006/23, first issued by the Federal Office of Civil Aviation (FOCA) on 2 November 1995, valid till 24 April 2011
Relevant ratings	ADI aerodrome instruments
Medical fitness	Class 3, without restrictions; from 29 March 2010, valid till 24 April 2012

1.3 Aircraft information

1.3.1 THA 971

Registration	HS-TNA
Aircraft type	Airbus A340-600
Characteristics	Four-jet medium- and long-haul aircraft

	Manufacturer	Airbus S.A.S., Toulouse, France
	Year of manufacture	2005
	Owner	Thai International Public Companies Ltd., Thailand
	Operator	Thai Airways International Ltd., Thailand
	Relevant equipment	VHF communication: Three Rockwell Collins Type: VHF-920 (VDL Mode 2), PN 822-1250-020 Transmission power: 25 watt minimum

1.3.2 BCI 937

	Registration	G-DRFC
	Aircraft type	Avions de Transport Régional ATR42-320
	Characteristics	Twin-engined regional aircraft with turboprop propulsion, constructed as a high-wing aeroplane in entirely metal construction with retractable landing gear in nosewheel configuration
	Manufacturer	Avions de Transport Régional, France
	Year of manufacture	2009
	Owner	Healthspan Group, Guernsey
	Operator	Blue Islands Ltd., United Kingdom
	Relevant equipment	VHF communication: Two Collins 22C VHF 1: SN ZDH4V, PN 822-1113-021 VHF 2: SN ZDH4W, PN 822-1113-021 Transmission power: 16 watt minimum

1.4 Meteorological information

1.4.1 General

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

1.4.2 General meteorological situation

[Translated from German] *A low-pressure zone centred over southern Germany had brought an occlusion with active precipitation to German-speaking Switzerland. With the displacement of the depression towards the east, the precipitation abated shortly before the airprox.*

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 at the time and in the area of the serious incident were as follows:

Clouds	*2/8 at 2100 ft AMSL, 5/8 at 3100 ft AMSL, 7/8 at 5000 ft AMSL*
Weather	*-*
Visibility	*Around 12 km*
Wind	*South-west wind at 6 kt*

Temperature/dewpoint	*15 °C / 14 °C*
Atmospheric pressure:	*QNH LSZH 1013 hPa*
Hazards:	*None detectable*

1.4.4 Astronomical information

Position of the sun	Azimuth: *199°*	Elevation: *65°*
Lighting conditions	Daylight	

1.4.5 Aerodrome meteorological reports

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

LSZH 181150Z 23006KT 190V260 9999 FEW007 BKN017 BKN035 15/14 Q1013 RERA NOSIG=

In clear text, this means:

On 18 June 2010, shortly before the 11:50 UTC issue time of the aerodrome meteorological report, the following weather conditions were observed at airport LSZH:

Wind	From 230° at 6 kt, veering from 190° to 260°
Meteorological visibility	More than 10 km
Precipitation	Recent rain
Cloud	1-2/8 at 700 ft AAL
	5-7/8 at 1700 ft AAL
	5-7/8 at 3500 ft AAL
Temperature	15 °C
Dewpoint	14 °C
Atmospheric pressure:	1013 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Evolution forecast	It had been raining recently. In the two hours following the weather report, no significant change is expected.

1.4.6 Forecasts

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

LSZH 180825Z 1809/1915 23006KT 8000 RA FEW008 SCT012 BKN025 TX16/1815Z TN11/1906Z TX14/1910Z TEMPO 1809/1812 4000 RA BKN012 BECMG 1815/1818 NSW TEMPO 1906/1915 SHRA=

In clear text, this means: On 18 June 2010 at 08:25 UTC, the following weather conditions were forecast for LSZH airport between 09:00 UTC on 18 June 2010 and 15:00 UTC on 19 June 2010:

Wind	from 230 degrees at 6 kt

Meteorological visibility	8000 m
Precipitation	Rain
Cloud	1-2/8 at 1200 ft AAL 5-7/8 at 2500 ft AAL 8/8 with cloud base at 2200 ft AAL
Temperature forecast	Maximum temperature at 18:15 UTC 16°C Maximum temperature at 19:06 UTC 11°C Maximum temperature at 19:10 UTC 14°C
Provisional forecast	On 18 June 2010 between 09:00 UTC and 12:00 UTC visibility of 4 km, rain and 5-7/8 cloud expected; in individual cases less than one hour, overall less than 1½ hours. Between 15:00 UTC und 18:00 UTC a transition to non-significant weather takes place. On 19 June 2010, between 06:00 UTC and 15:00 UTC, rain showers expected. In individual cases less than one hour. Overall less than 4½ hours.

1.5 Radiocommunications on the tower frequency

1.5.1 General

There are two separate operating systems for VHF radio traffic on the Zurich tower ATC frequencies. These comprise the so-called normal radio operation system and the emergency radio system.

1.5.2 The normal radio operation system

The system consists of two transmitter and receiver installations respectively. These installations are located at different sites (cf. Annex 3).

Only one of the two transmitters is always in operation. The two receivers monitor the signal radiated by the transmitter and the system switches automatically to the second transmitter if certain criteria are not met on the receiver side, i.e. if the squelch[1] does not open in both receivers.

When an aircraft-side transmitter is active, what is termed best signal selection (BSS) is performed automatically on the receiver side. This is initiated by a squelch and is based on the fact that the receiver is selected under the application of the following three methods: adaptive signal to noise ratio, calculation of the articulation index and fast calculation of voice level[2].

This signal is transmitted on the one hand to the air traffic controller's workstation and is also recorded (legal recording). The signal for the recording is taken directly from the air traffic controllers workstation and as backup also on the BSS output. The recorded signal is identical to that which the ATCO hears.

[1] The squelch is an electronic circuit which serves to suppress receiver noise in the headset or speaker. If there is a signal of a few µvolts at the receiver's antenna input, suppression is cancelled (squelch opens).

[2] The BSS analyses the useful signal in the 400 Hz to 4 KHz range.

At the time of the serious incident, automatic mode was selected. At the ATCO's workstation there is the option to select receiver 1 or 2 manually if necessary.

1.5.3 The emergency radio system

The emergency radio system works completely independent of the normal operational system. At the time of the serious incident, the emergency radio system consisted of one transmitting and one receiving antenna respectively, which was located on the control tower (cf. Annex 3).

The emergency radio system is in permanent operation and at the time of the serious incident was set to the Zurich tower frequency of 118.100 MHz. In the normal case, the ATCO adjusts the volume control for the emergency radio system to the minimum level, so that the intelligibility of radio messages on the normal operational radio system is not compromised.

The signals on the emergency radio system are recorded independently of the operational radio system.

1.6 Communication

Radio communications between the crews and the air traffic controller concerned took place normally up to the time of the serious incident. The recordings of radio communications via the normal operational radio system indicate that during the readback of the take-off clearance by the crew of THA 971 the first part of the message is heard to be somewhat muted. In contrast, the second part of the message: *"(...) thai nine seven one"*, is clear and distinctly audible.

At the same time as the report from the crew of THA 971, the crew of BCI 937 on runway 28 reported: *"We're cleared take off, Blue Island nine three seven".* In the recording of the emergency radio system, this message is heard indistinctly. After this, the second part of the message from the crew of THA 971 can be heard clearly. These radio conversations on the emergency radio system were not audible at the air traffic controller's workstation as the corresponding volume control was set to the minimum level in accordance with established practice.

The crew of BAW 713, at holding position point BRAVO, who were also monitoring the 118.100 MHz frequency, realised that apart from the crew of THA 971, which confirmed the take-off clearance, a different voice, with a typical English accent, reported *"cleared for take-off"*.

The ADC and GRO air traffic controllers both testified that it is possible to hear clearly on the radio when two crews were transmitting simultaneously. Such a multiple transmission generally caused an easily audible superimposed whistling tone.

1.7 Aerodrome information

1.7.1 General

Zurich Airport is located in north-east Switzerland. The airport reference point (ARP) has coordinates N 47 27.5 / E 008 32.9 and an ELEV of 1384 ft. The reference elevation of the airport is 1416 ft AMSL and the reference temperature is specified as 24.0 °C.

The dimensions of Zurich airport runways are as follows:

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

Zurich airport is characterised by a system of three runways, two of which (16 and 28) intersect at the airport reference point. The approach corridors of two other runways (16 and 14) intersect approximately 850 metres north-west of the threshold of runway 14.

1.7.2 Construction work

At the time of the serious incident an extensive building programme was under way. Among other measures an elevator was erected on the north-east side outside of the control tower for this purpose. Viewed from the cab of the tower, this was in the field of view towards the threshold of runway 28. According to the ADC and GRO air traffic controllers' statements, the view towards runway 28 was obstructed by this elevator (cf. Annex 2). The two air traffic controllers also commented that as a result of this situation, or rather because of the builders and their work, there was a certain distraction in their field of view and the usual noise level in the control room was changing in a disturbing manner.

According to an agreement between skyguide and Zurich Airport (Flughafen Zürich AG) the air traffic controllers had the possibility to call on an especially installed telephone-hotline in case of interference caused by construction work. No use of this was made in the present case.

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. However, they had since been overwritten and were therefore no longer available to the investigation.

1.9 RIMCAS conflict alert system

1.9.1 General

Stage 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. Stage II of the A-SMGCS includes a conflict alert function (Runway Incursion Monitoring and Conflict Alert Subsystem - RIMCAS). It came into service on 31 May 2010. In a so called service order (SO) OZ 2010-034E, the personnel concerned were informed accordingly by skyguide.

The RIMCAS alert system supports the air traffic controllers in their monitoring of the movements of aircraft and vehicles on the runway system at the airport. Skyguide notes 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 audio) on actual or potential conflicts in a timely manner."

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

1.9.2 Basis of calculation

To ensure that appropriate alerts can be generated, the system must be assigned certain parameters. It should be noted that the system currently cannot yet distinguish between aircraft and vehicles. At the moment, the system only processes position reports from vehicles which are appropriately equipped. In the opinion of specialists, it will be possible to distinguish between vehicles and aircraft in the foreseeable future.

Every second, the speed and directional vector are determined from the current position by calculation. In the process, the directional vector is continuously projected forward. The speed must be higher than 12 metres per second (23.33 kt).

In order to recognise the problem of two aircraft crossing on two different runways, a circular area with a diameter of 400 metres was laid around the intersection of runways 16/28. If, on the basis of the calculated projections, two aircraft simultaneously enter this "critical circle" a Stage 2 alert is triggered.

In order to avoid false alarms due to the constantly changing directional vectors as aircraft taxi 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 Procedures with the system

For general use, among other things skyguide prescribes the following:

"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 (...)."

In service order OZ 2010-034E skyguide prescribes the following for dealing with a Stage 2 alert:

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

Note1: 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."

2 Analysis

2.1 Technical aspects

2.1.1 General

There are no indications of any pre-existing technical defects which may have caused or contributed to the serious incident.

2.1.2 Radio communications

There were problems with the sound recording of the radio communications using the normal operational radio system. During the readback of the take-off clearance by the crew of THA 971, the first part of the message is only weakened to hear. The second part of the message: *"(...) thai nine seven one"*, however, is clear and distinctly audible. The message *"We're cleared take off, Blue Island nine three seven",* by the crew of the BCI 937, however, was not recorded.

If it is assumed that because of the short and obstacle-free distance between THA 971 and the receiver at the "Sumpf" location (cf. Annex 3) the latter receiver had been selected by the system, the following factors may have contributed to the masking of the signal transmitted from BCI 937:

Because of the powerful transmitter of THA 971 (25 watts), in the ground-side receiver the gain was greatly reduced by the automatic gain control. It cannot be excluded that the signal emitted from BCI 937, which was in take-off position on runway 28, was further attenuated by reflection from buildings or holding aircraft at the antenna input of the receiver at the "Sumpf" location. However, it was still strong enough to adversely affect reception of the signal from THA 971.

If the crew of BCI 937 alone had transmitted, it is possible that the other ground-side receiver at the "Werkhof W14" location would have been selected.

In the recordings of the emergency radio system, the readback of the take-off clearance by the crew of BCI 937 can only be heard indistinctly. This radio conversation was not audible at the air traffic controller's workstation as the corresponding volume control was set to the minimum level in accordance with established practice. It should be noted in this context that the location of the emergency radio receiver was on the roof of the control tower (cf. Annex 3) and that different conditions therefore prevailed with regard to superimposition of signals.

At holding position point BRAVO, the crew of BAW 713, who were also monitoring the 118.100 MHz frequency, realised that apart from the crew of THA 971, who confirmed the take-off clearance, a different voice, with a typical English accent, also reported *"cleared for take-off"*. In this case, the situation was such that BAW 713 was located immediately next to BCI 937. THA 971, in contrast, was some distance away and also in the radio shadow of buildings. It therefore appears plausible that the crew of BAW 913 were able to hear the transmission from BCI 937.

The choice of the two receiver sites "Sumpf" and "Werkhof W14" appears appropriate in order to take into account the reduction in transmission quality caused by reflections or shadowing. The automatic selection of the receiver with the better signal to noise ratio (best signal selection), considerably improves transmission quality. However, this selection may lead to one transmitter being practically suppressed in the event of simultaneous transmissions from two transmitters.

The air traffic controllers questioned were of the unanimous opinion that they would recognise a multiple transmission due to a superimposed whistling tone. This opinion is based on experience with older aircraft-side transmission equipment, which in the event of dual transmission generally caused a superimposed whistling tone in the receiver in the audible frequency range. However, this is no longer the case with modern transmitters equipped with frequency synthesizers, because these transmit very precisely on the nominal carrier frequency[3]. However, this does cause a superimposed whistling tone which is below the audible range of human hearing.

Filters on the transmitter and receiver side are used to suppress low-frequency sounds in the cockpit, such as, for example, the rumble of the nose gear or low speech frequencies. However, a side-effect of such filters is that a superimposed tone below about 400 Hz is suppressed.

2.1.3 RIMCAS conflict alert system

The RIMCAS conflict alert system responded during the serious incident, after the crew of BCI 937 had already started to abort their take-off. When the Stage 2 RIMCAS alert was triggered at 12:03:01 UTC, the accelerating THA 971 on runway 16 indicated a speed of 71 kt and the decelerating BCI 937 on runway 28 indicated a speed of 61 kt (cf. Annex 1).

When the crew of BCI 937 started to abort their take-off, BCI 937 had a speed of 74 kt and THA 971 a speed of 34 kt. Even at this point the triggering of a RIMCAS alert would have been appropriate, since both aircraft were on a collision course at increasing speed. At this time, no Stage 2 alert had yet been generated, because only BCI 937, on the basis of the calculated projection, was in the "critical circle" (cf. chapter 1.9.2).

If BCI 937 had not aborted its take-off, the calculations indicate that, on the basis of the calculated projection, the Stage 2 RIMCAS alert would have been triggered at the same time, i.e. at 12:03:01 UTC (cf. Annex 1), when THA 971 entered the "critical circle area". This also applies even if BCI 937 had aborted its take-off on its own initiative at a later point in time, for whatever reason.

A reaction by the air traffic controller only after the triggering of the current RIMCAS Stage 2 alert would have been difficult. At this time, THA 971 had already a speed of 71 kt and BCI 937, which was still accelerating, would already have been in the critical speed range for aborting take-off.

In conclusion, it should be noted that in the configuration existing at the time of the serious incident, the RIMCAS system was not able to trigger an alert in good time when take-offs were taking place simultaneously on runways 16 and 28.

In connection with the possibility of being able to distinguish between aircraft and vehicles, the parameters for generating a RIMCAS Stage 2 alert for the situation: "simultaneous take-off on two intersecting runways" should be examined.

[3] At the current 8.33 KHz channel spacing, the nominal carrier frequency must be maintained very precisely.

2.2 Human and operational aspects

2.2.1 Air traffic control

According to the statements of the ADC air traffic controller concerned, there was a high volume of traffic with a high level of complexity at the time of the serious incident. The recordings of the radio conversations at this time confirm this statement.

In order to take account of the approaching traffic on runway 14, the ATCO did not make use of her option to allow BCI 937 to take off before THA 971. This decision was appropriate to the situation and was in line with both the usual procedures and the requirements of efficient traffic management. The fact that after the take-off clearance to THA 971 on runway 16 the ATCO kept the aircraft in view to ensure that the take-off was also initiated promptly because of the approaching traffic is understandable.

According to her statement, during this process the air traffic controller was paying no attention to BCI 937, which was in take-off position on runway 28. The fact that THA 971 acknowledged the take-off clearance and that she heard nothing from BCI 937 may have strengthened her conviction that there would be no take-off on runway 28.

It should be noted, however, that in the case of intersecting runways with one aircraft in each of the respective take-off positions, the potential for conflict may arise if one of these aircraft is given a take-off clearance.

At the time of the serious incident there was a volume of traffic which corresponded to a normal working situation during the peak hours at Zurich airport.

In the present case, an error occurred in this situation, when the crew of BCI 937 initiated a take-off without clearance. This error meant that air traffic control could no longer safely handle the risks inherent in the system.

According to the ADC and GRO air traffic controllers' statements, the view towards runway 28 was obstructed by the elevator on the north side of the control tower. The two air traffic controllers also commented that as a result of this situation, or rather because of the builders and their work, there was a certain distraction in their field of view and the usual noise level in the control room was changing in a disturbing manner.

Investigations in the control tower cab showed that despite the construction work in front of the control tower, visibility of the entirety of runway 28 was ensured from the ADC workstation in both the sitting and the standing positions (cf. Annex 2). However, it cannot be excluded that as a result of this work a certain distraction occurred in the air traffic controller's field of vision which might have made it more difficult to see BCI 937 approaching from the ATCO's peripheral field of vision.

However it has to be kept in mind that according to an agreement between skyguide and Zurich Airport (Flughafen Zürich AG) the air traffic controllers had the possibility to call on an especially installed telephone-hotline in case of interference caused by construction work. The two air traffic controllers ADC and GRO made no use of this possibility. Thus let to the conclusion that a possible interference was judged by them as an acceptable working environment.

The reaction of the air traffic controller to the report from BAW 713: *"Ah, you may have two aircraft taking off at the moment"* was immediate and resolved the situation.

2.2.2 Crews

The crew of THA 971 acknowledged the take-off clearance which was intended for them. Because their radio conversation was longer than the simultaneous transmission from crew of BCI 937, they were unable to hear the latter and thus did not realise that another aircraft was about to initiate a take-off. From their viewpoint, the subsequent take-off was uneventful. They learned of the serious incident only after the investigation was opened.

The crew of BCI 937 was ready to take off from runway 28 with their aircraft and were awaiting take-off clearance. The crew did not realise that the take-off clearance to THA 971 was not intended for them. This is surprising, since the take-off clearance from the air traffic controller both included the radio callsign and named runway 16.

Owing to the fact that the crew of BCI 937 had been on the aerodrome control frequency since 11:52:31 UTC and received a message at 11:58:23 UTC to the effect that that they could expect a take-off clearance in seven minutes, they would still have been able to realise that in the meantime a different aircraft had received clearance to taxi onto runway 16 and was also waiting for a take-off clearance, especially as the clearance to taxi onto runway 16 was repeated at 12:00:30 UTC. Clearly the crew were not aware of this fact.

In the belief that they had received take-off clearance, the crew of BCI 937 acknowledged with *"We're cleared take off, Blue Island nine three seven",* and initiated their take-off on runway 28. Since this radio message was shorter than the message from THA 971, the end of the readback of the take-off clearance *"(...) thai nine seven one"* was clearly audible to the crew of BCI 937 after releasing the microphone button.

With that it would have been recognizable that their own report had been superimposed on another. Such a situation normally leads to a verification of the respective clearance. That the crew did not react to this circumstance, the conclusion can be drawn that they were already focused on take-off initiation.

The conflict situation caused by the simultaneous take-offs on two intersecting runways was recognised by the crew of BAW 713 and reported without delay to aerodrome control, which had not detected the impending danger. This behaviour shows that the flight crew had a very good overview of the situation. This may have been facilitated by careful monitoring of the radio traffic, the realisation that there had been a double transmission and an active intellectual engagement with the problem posed by intersecting runways.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- Both aircraft were licensed for IFR flight.
- The investigation found no evidence of pre-existing technical defect, neither ground-side nor aircraft-side, which might have caused or influenced the serious incident.
- The investigation concludes that the "Sumpf" receiver was selected automatically and that this led to the suppression of the message transmitted from BCI 937 at the workstation of the ADC air traffic controller.

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 THA 971 acknowledged the clearance they received to take off from runway 16.
- The crew of BCI 937 acknowledged a take-off clearance at the same time.

3.1.3 Air traffic control personnel

- The air traffic controllers were in possession of the licences necessary to exercise their activities.
- There are no indications of any of the air traffic controllers suffering health problems at the time of the serious incident.
- At the time of the serious incident, the ADC air traffic controller was working with a headset.

3.1.4 History of the serious incident

- The THA 971 aircraft was in the runway 16 holding point when at 12:00:30 UTC the crew received clearance to taxi to take-off position on runway 16.
- The BCI 937 aircraft was at the runway 28 holding point when at 12:01:33 UTC the crew received clearance to taxi to the take-off position on runway 28.
- At 12:02:26 UTC the crew of THA 971 received the following clearance: *"Thai nine seven one, wind two six zero degrees, seven knots, runway one six, cleared for take off."*
- The crew of THA 971 acknowledged this clearance immediately and initiated their take-off.
- The crew of BCI 937 acknowledged the take-off clearance given to THA 971 with their own radio callsign and initiated their take-off.
- A British Airways aircraft, callsign BAW 713, was at holding position point BRAVO to the north of the threshold of runway 28.

- The crew of BAW 713 reported to the ADC air traffic controller at 12:02:47 UTC: *"Ah, you may have two aircraft taking off at the moment."*
- At 12:02:50 UTC the ADC air traffic controller instructed BCI 937: *"Blue Island nine three seven hold, hold position, Blue Island nine three seven, hold position, stop now."*
- The crew of BCI 937 aborted their take-off immediately.
- The crew of the THA 971 continued their take-off.

3.1.5 General conditions

- According to the ADC air traffic controller, there was a high volume of traffic with a high level of complexity.
- Owing to the construction work inside and outside the tower, the working conditions for the air traffic controllers in the tower were not in line with normal operations.
- The weather had no influence on the serious incident.
- In the configuration which applied at the time of the serious incident, the RIMCAS conflict alert system was not able to trigger an alert in good time when take-offs were taking place simultaneously on runways 16 and 28.

3.2 Causes

The serious incident is attributable to the fact that on runway 28 the crew of an aircraft initiated a take-off without a corresponding clearance; this led to a substantial risk of collision with an aircraft taking off on runway 16.

The following factors contributed to the serious incident:

- The crew of the aircraft on runway 28 did not notice the readback of the take-off clearance by the crew of the aircraft on runway 16.
- The readback of the supposed take-off clearance by the crew of the aircraft on runway 28 was not audible to the air traffic controller, because the chosen location of the receivers of the normal radio operation system favoured the suppression of this clearance.
- Air traffic control did not notice the beginning of the take-off roll of the aircraft on runway 28.
- The air traffic control conflict alert system was inappropriate for defusing the impending conflict.

The occurrence of the serious incident was favoured by the complex operation on two intersecting runways, which has only 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, any establishment and any individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

Swiss legislation provides for the following regulation regarding implementation in the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents:

"Art. 32 Safety recommendations

The Federal Office shall inform the Bureau within six months of publication of the investigation report of the measures which are being taken on the basis of the safety recommendations in the investigation report or of the reasons why these measures are not being implemented."

4.1 Safety recommendations

4.1.1 Safety deficit

On 18 June 2010 at 12:00:30 UTC, the Thai Airways International Airbus A340-600, ATC callsign THA 971, received clearance to taxi to the take-off position on runway 16. At 12:01:31 UTC the ATR42 aircraft of the Blue Islands airline, ATC callsign BCI 937, received clearance to taxi to the take-off position on runway 28. A British Airways aircraft, with the ATC callsign BAW 713, was ready to depart at holding position point BRAVO to the north of the threshold of runway 28. At 12:02:26 UTC the crew of THA 971 received clearance to take off from runway 16; they acknowledged it immediately and initiated their take-off. Almost simultaneously, the crew of BCI 937 initiated their take-off roll on runway 28. Approximately 15 seconds later, at 12:02:47 UTC, the crew of BAW 713 informed aerodrome control that two aircraft would be taking off simultaneously. At 12:02:50 UTC aerodrome control instructed the crew of BCI 937 to abort their take-off roll. The crew obeyed this instruction and vacated runway 28 on taxiway ALPHA 4. The crew of THA 971 continued their take-off and flight to their destination.

The recordings of the emergency frequency show that the crew of BCI 937 acknowledged a take-off clearance at the same time as the crew of THA 971. However, the acknowledgment by BCI 937 was not audible to the air traffic controller. The investigation concludes that because of the locations of the two aircraft, the locations of the two receivers and the automatic selection (best signal selection) of the "Sumpf" receiver, the report from BCI 731 was suppressed.

4.1.2 Safety Recommendation No.439

The Federal Office of Civil Aviation should ensure that double transmission is detectable on the radio operation systems used in Switzerland.

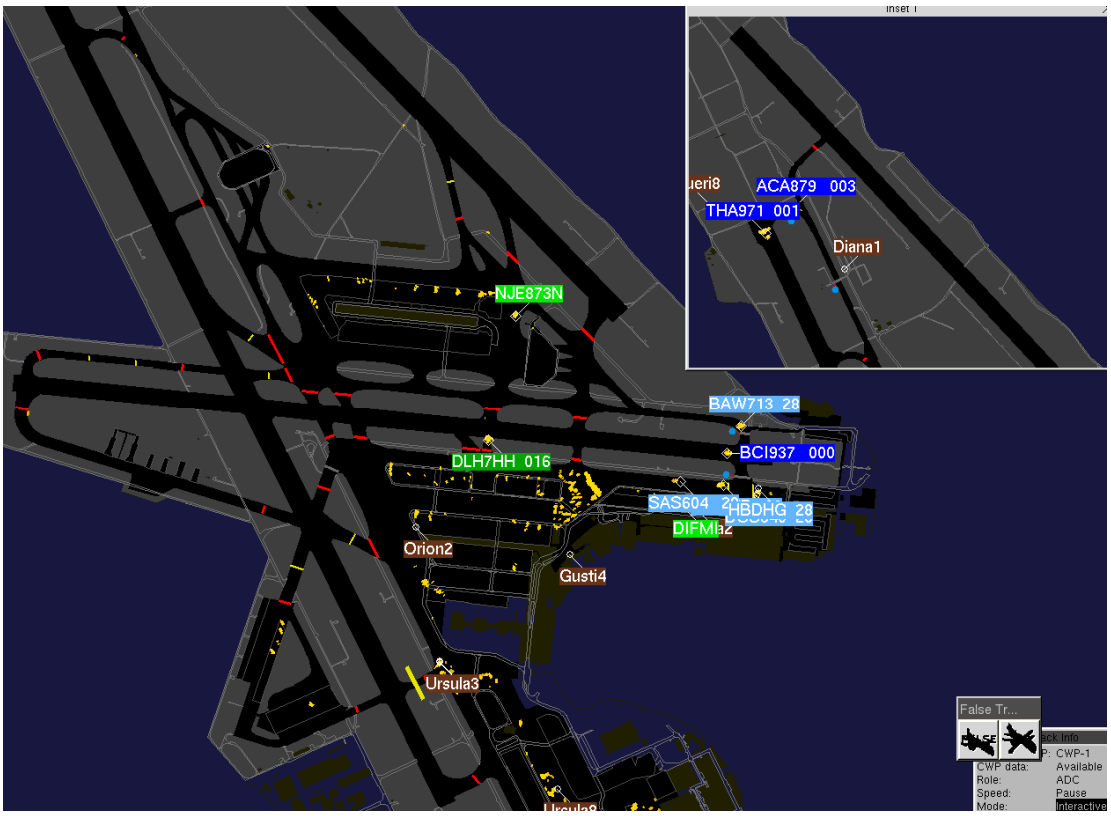
4.2 Measures taken since the serious incident

- Skyguide has expressed to Zurich Airport (Flughafen Zürich AG) the necessity of ensuring that buildings above ground level in/at Zurich Airport are subject to the same procedure as underground civil engineering works. This would ensure the future early detection and assessment of the potential impact and disturbances to control tower operations caused by work on superstructures. A new process, which is also welcomed by the FOCA, is in preparation. According to a statement by Zurich Airport (Zürich Flughafen AG) this new process is in force since April the 1st 2011.
- The incident was analysed as part of the current coordination and monitoring process of the SAMAX/RIMCAS system introduced at the end of May 2010. In order to warn the air traffic controller earlier in similar situations, a parameter adaption in the SAMAX-System has taken place in Juli 2011. This adaption is supported by the responsible persons and by the users even if with this the possibility of additional and unnecessary nuisance alerts exists. A software modification, initiated by skyguide and in work by the supplier should be implemented by the end of 2011. This modification allows the system to distinguish between cars and aircraft and helps to reduce nuisance alerts.
- The incident was reviewed within the framework of regular training, most recently in December 2010, together with the air traffic controllers within the Zurich Tower/Approach ATC unit. This included a discussion and explanation of the BSS function, among other things.
- In order to determine the impact and effects of procedures and processes considered in isolation on the system as a whole, a hazard portfolio for the Zurich Tower/Approach unit will be drawn up by skyguide starting in February 2011. On this basis, overarching problem areas will be defined, recorded in a Safety Survey Document and handed over to the unit for further processing.

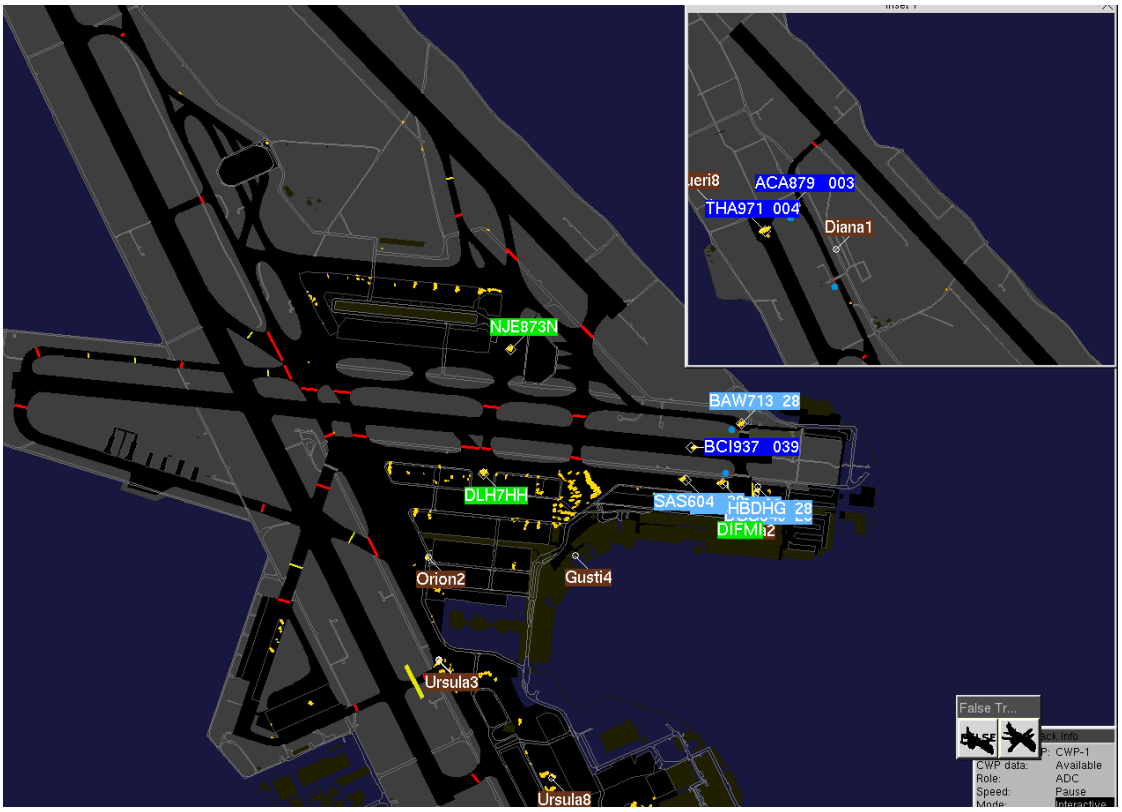
Payerne, 08 September 2011 Aircraft Accident Investigation Bureau

Annexes

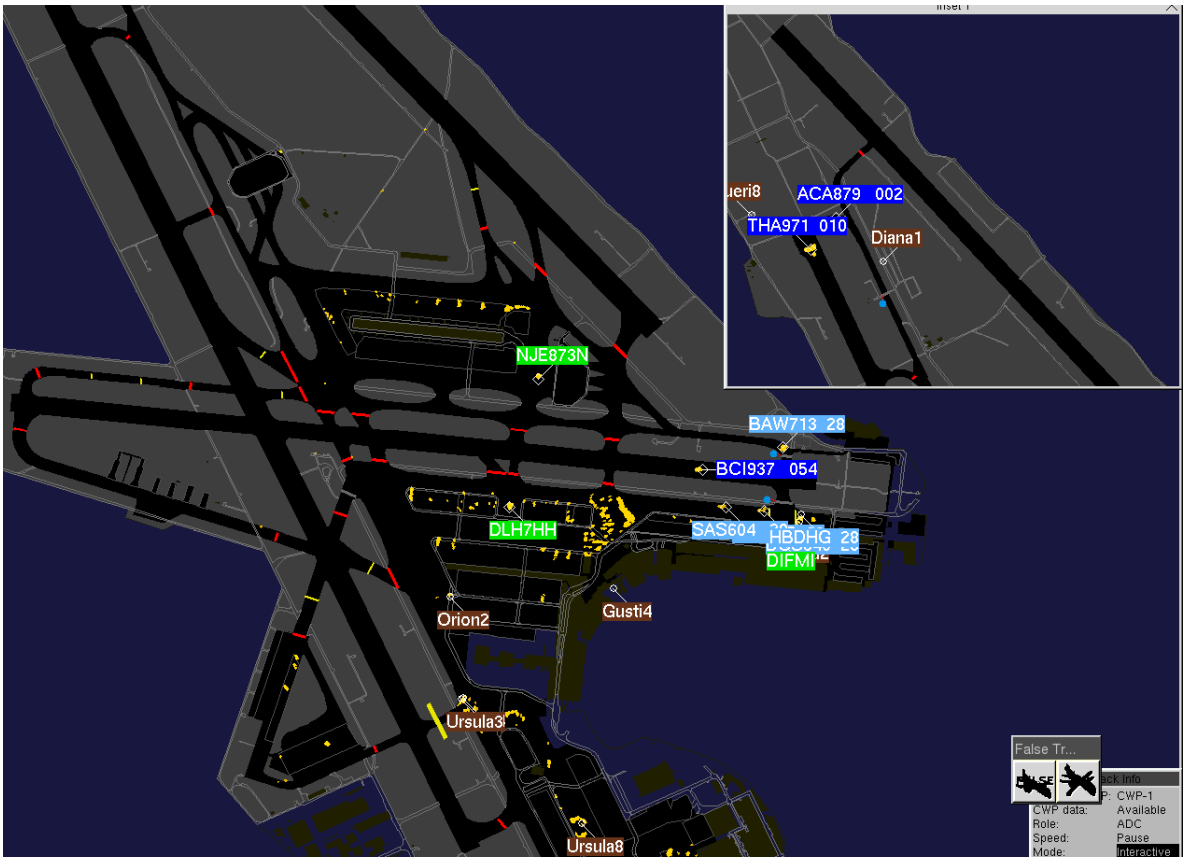
Annex 1: Recordings of the RIMCAS alert system during the take-off roll



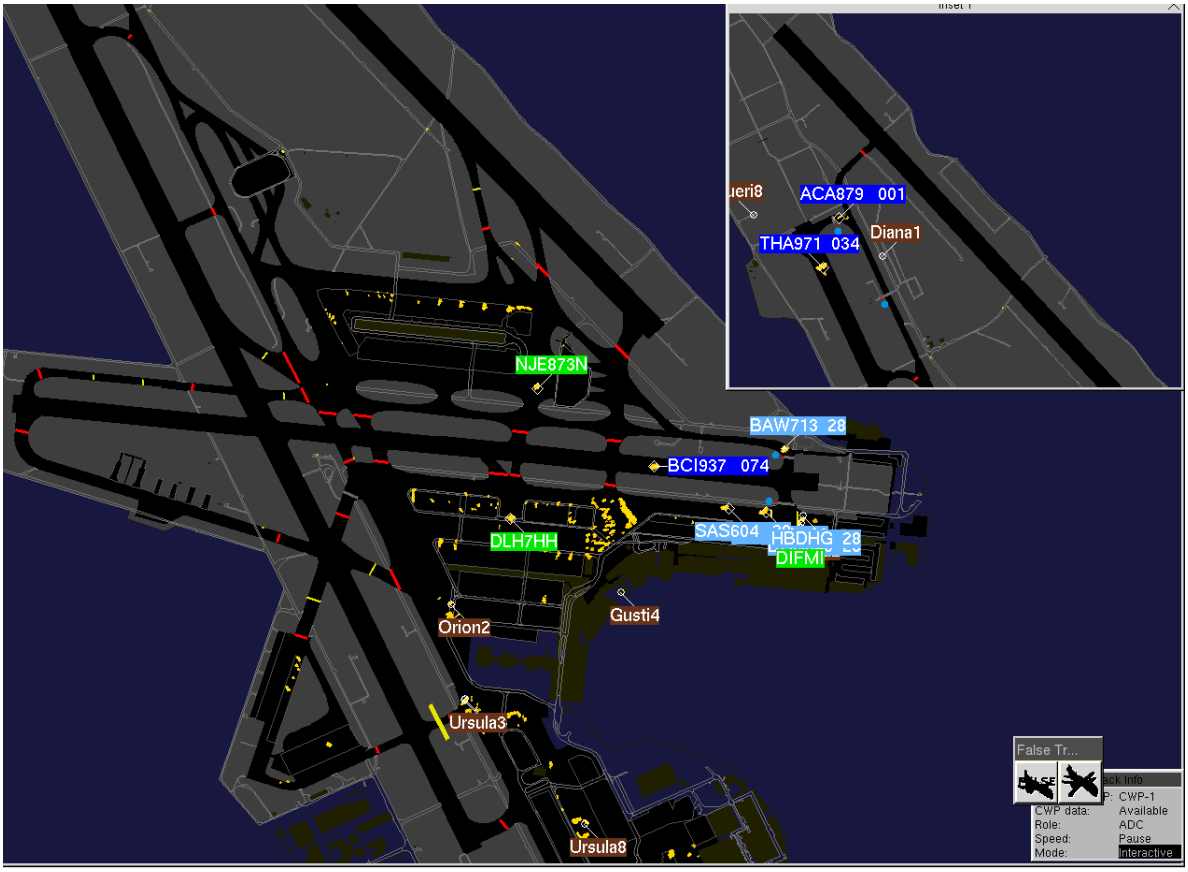
12:02:31 UTC: THA 971 acknowledges the take-off clearance and initiates the take-off



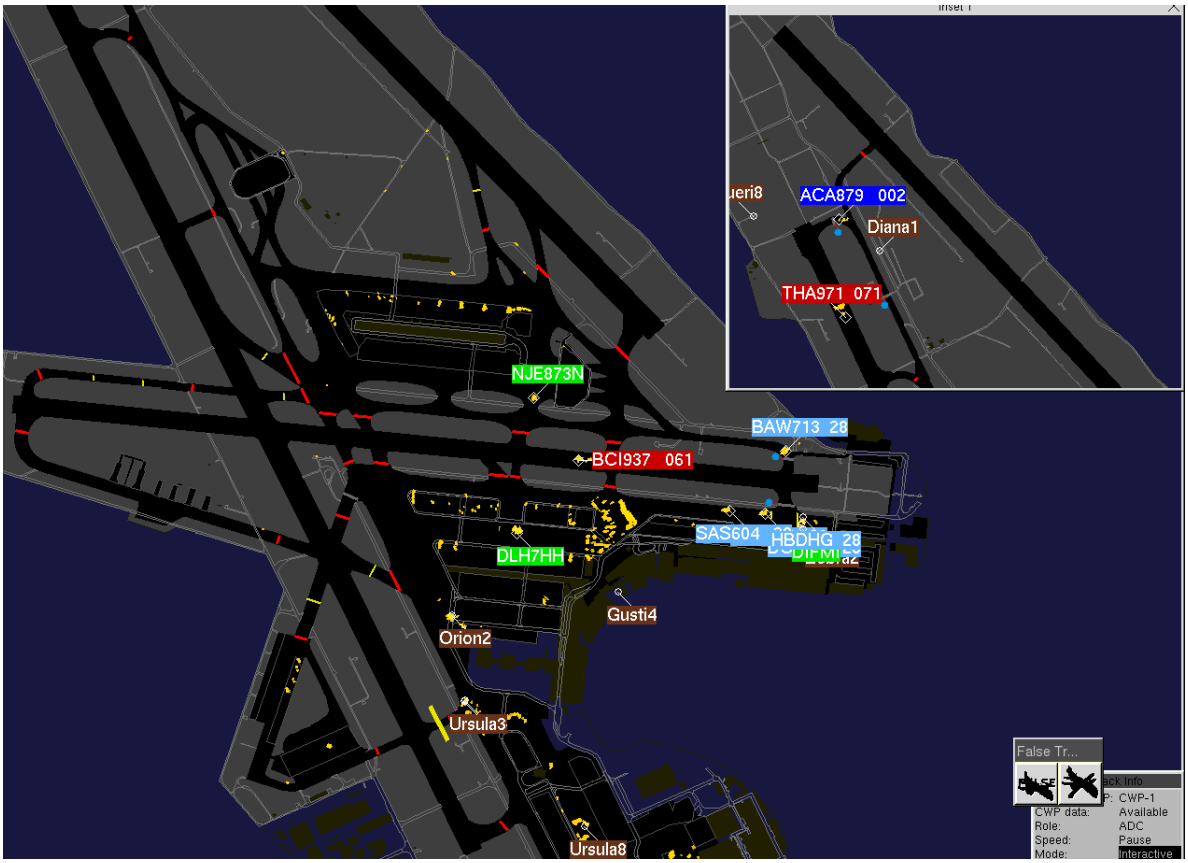
12:02:47 UTC: BWA 713 reports: *"Ah, you may have two aircraft taking off at the moment".*



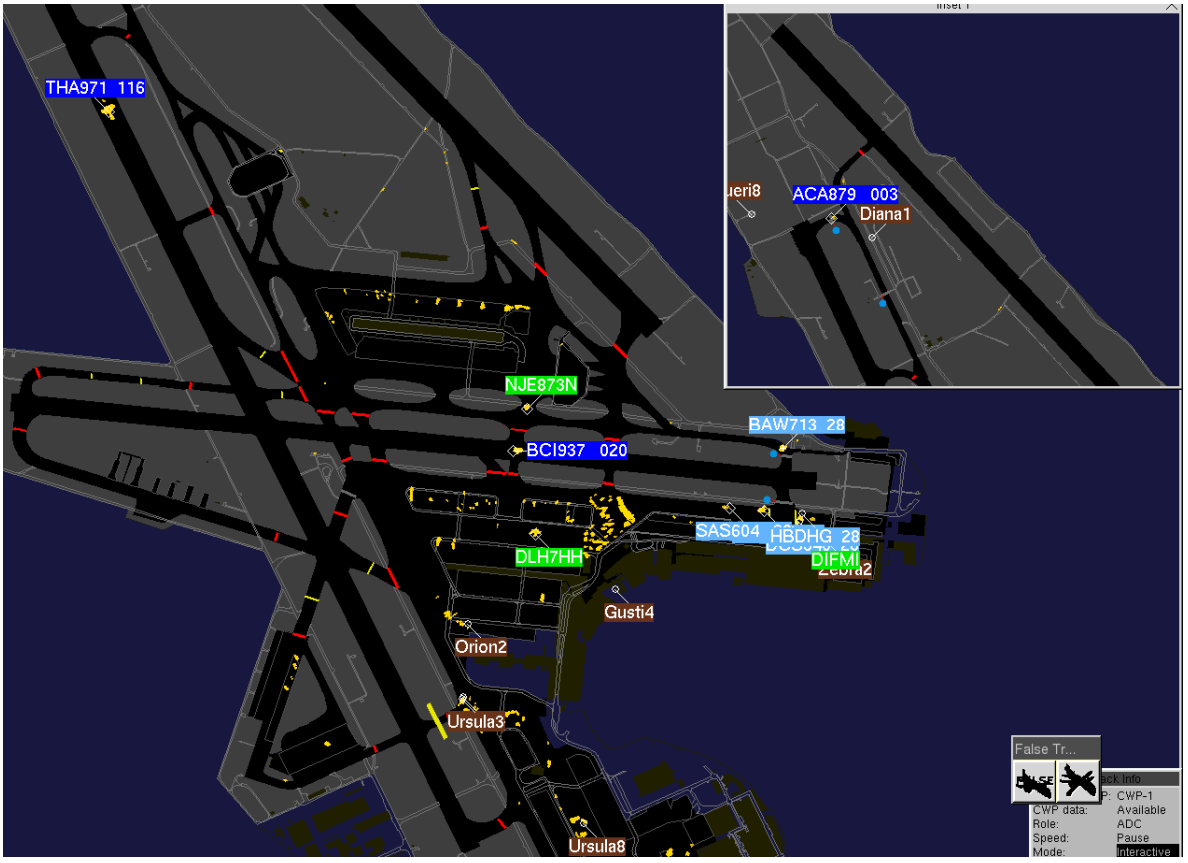
12:02:50 UTC: ADC ATCO instructs BCI 937 to abort take-off (speed of BCI 937: 54 kt)



12:02:55 UTC: maximum speed of BCI 937 during the aborted take-off (74 kt)



12:03:01 UTC: the RIMCAS system generates a Stage 2 alert



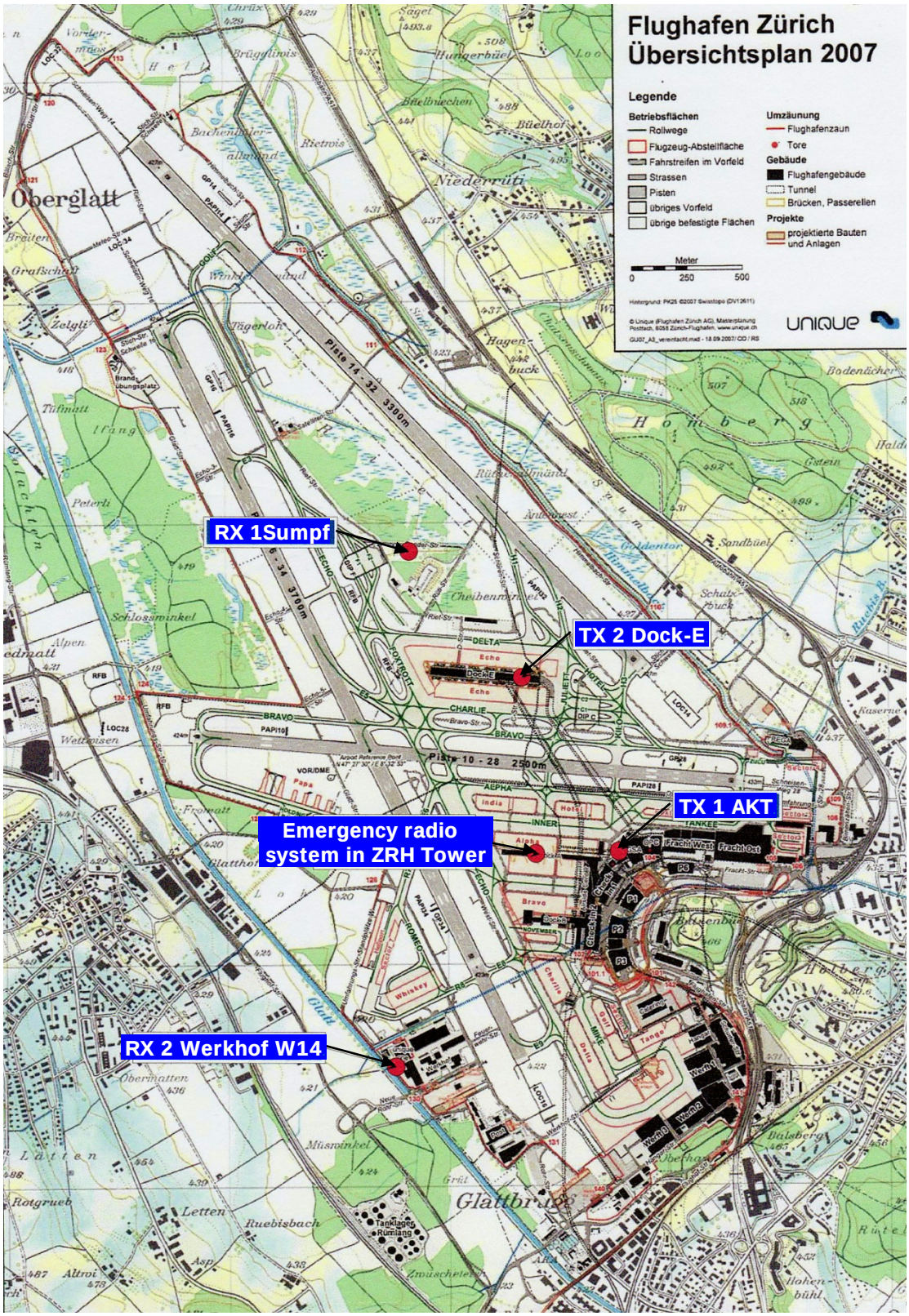
12:03:13 UTC: the RIMCAS system de-activates the Stage 2 alert since no conflict situation exists anymore

Annex 2: Elevator on the north-east side of the tower

Figure 1: ADC workstation; looking right, view when sitting (25 June 2010; 08.27 UTC)

Figure 2: ADC workstation; looking right, view when standing (25 June 2010; 08:28 UTC)

Annex 3: Radio network at Zurich airport



Legend

RX 1 Receiver 1 of the normal radio system; location "Sumpf"

RX 2 Receiver 2 of the normal radio system; location "Werkhof W14"

TX 1 Transmitter 1 of the normal radio system; location old control tower "AKT"

TX 2 Transmitter 2 of the normal radio system; location midfield "Dock E"