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Swiss Transportation Safety Investigation Board STSB

Final Report No. 2354

by the Swiss Transportation Safety Investigation Board STSB

Concerning the serious incident (AIRPROX)

involving the Airbus A320-214 airliner
operated by the Aer Lingus company,
call sign ATC EIN68N,

and the Cessna C525 aircraft,
in private operation,
registration N990FV

on 24 July 2015

at Geneva airport (LSGG) / GE

General information on this report

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

In accordance with 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 investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

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

To ensure data protection, the report uses the generic masculine.

All times in this report, unless otherwise indicated, are stated in coordinated universal time (UTC). At the time of the serious incident, Central European Time (CET) applied as local time (LT) in Switzerland. The relationship between LT, CET and UTC is: $LT = CET = UTC + 2 \text{ hours}$.

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Final report

Summary

Aircraft EI-DEF

Owner	International Lease Finance Corp, Los Angeles, USA
Operator	Air Lingus, Dublin Airport, Ireland
Manufacturer	Airbus Industrie, Toulouse, France
Aircraft type	Airbus A320-214
Country of registration	Ireland
Registration	EI-DEF
Flight number	EI 681
ATC flight plan call sign	EIN68N
Call sign	Shamrock Six Eight November
Flight rules	Instrument flight rules (IFR)
Type of operation	Scheduled flight
Departure point	Geneva (LSGG)
Point of destination	Dublin (EIDW)

Aircraft N990FV

Owner	Aero Service Turbillon Corp. Wilmington, USA
Operator	Cessna Aircraft Company, Wichita, USA
Manufacturer	Cessna Aircraft Company, Wichita, USA
Aircraft type	Citation C525
Country of registration	United States of America
Registration	N990FV
Flight number	-
ATC flight plan call sign	N990FV
Call sign	november niner zero foxtrot victor
Flight rules	IFR
Type of operation	Private
Departure point	Geneva (LSGG)
Point of destination	Glasgow-Prestwick (EGPK)

Location	Concrete runway 05, Geneva Airport (LSGG)
Date and time	24 July 2015, 08:47:11 UTC
ATS unit	Geneva aerodrome control (ADC)
Airspace	Control zone (CTR) LSGG, Class D

Minimum distance between the two aircraft	Horizontal distance: 24 m
Prescribed minimal separation	The protected area of the surface designated for aircraft take-off and landing must be clear.
Airprox category	ICAO category A, high risk

Investigation

The serious incident occurred on 24 July 2015 at 08:47:11 UTC. It was reported to the Swiss Transportation Safety Investigation Board STSB on 27 July 2015 at 11:52 UTC and an investigation was opened on 28 July 2015 at 14:53 UTC.

The STSB notified the serious incident to the authorities of Ireland and the United States of America, each of which nominated an accredited representative.

The final report is published by the STSB.

Synopsis

In the mid-morning of 24 July 2015, the flight crew of the Cessna Citation C525, registration N990FV, parked on the north apron of Geneva Airport, reported to Ground control (GND) that they were ready to taxi. They were making a private flight to Glasgow-Prestwick. The controller cleared the aircraft to taxi to holding bay Z, for runway 05.

The route followed skirts the grass runway as far as its threshold 05, where it joins taxiway Z. The pilots of N990FV stopped at this point then, at the request of the GND controller, waited until a light aircraft on the final approach path for the grass runway passed taxiway Z. They then followed this taxiway and when they were close to the holding bay, the GND controller informed them that it was "*here right ...*" and instructed them to contact the control tower.

The N990FV flight crew read back the clearance though continued straight ahead nevertheless and the aircraft crossed the CAT I runway holding position of concrete runway 05. N990FV came into a converging conflict with an A320 Airbus on take-off roll, registration EI-DEF, making flight EIN68N bound for Dublin.

The GND controller instructed N990FV to wait where it was and then the TWR controller who was at his side reported the conflict to the flight crew of EIN68N. The aircraft continued its take-off and the tip of its left wing passed approximately 24 m from the nose of N990FV.

Causes

The serious incident is attributable to the dangerous convergence between an Airbus A320 on its take-off roll on concrete runway 05 and a Cessna C525 which had crossed the CAT I runway holding position of taxiway Z without clearance.

Factors contributing to the runway incursion:

- lack of a hot spot indicating the danger of a concrete runway 05 incursion at taxiway Z;
- lack of situational awareness of the flight crew of N990FV;
- lack of vigilance of the GND controller;
- lack of a stop bar at runway holding position CAT I on taxiway Z;
- air traffic control operational procedures not adapted to the risk of a runway incursion for aircraft taxiing from the north apron.

- **Safety recommendations**
- The report highlights several safety deficits which gave rise to 4 safety recommendations.

1 Factual information

1.1 Pre-flight history and history of the serious incident

1.1.1 General

The history of the serious incident was established using the recordings of the radiotelephone communications, the radar data and plots, the information from the SAMAX runway monitoring system¹ and the Mode S downlink transmissions. It is also based on the reports, comments and statements of the pilots and air traffic controllers concerned.

The two aircraft involved in the serious incident were following instrument flight rules (IFR) and were in radiotelephone contact with two different sectors of the Geneva control tower (TWR): N990FV was being handled by Ground control (GND), and EIN68N by Aerodrome control (ADC).

The 05 concrete and grass runways were in operation and the weather conditions were good.

1.1.2 History

On 21 June 2015, the commander and copilot of the Cessna Citation C525, registration N990FV, began a tour in Europe with 5 passengers, during which they stopped over in Geneva on 23 and 24 July 2015. They worked together from the beginning of this journey and their experience on this aircraft type was 3 months and 1 month, respectively. Both were coming to Geneva airport for the second time as part of their professional activity.

On the evening of 23 July, they prepared the flight from Geneva (LSGG) to Glasgow-Prestwick (EGPK) which was scheduled for the following day.

1.1.3 Flights during which the serious incident occurred

On 24 July 2015, the flight crew of aircraft N990FV arrived at Geneva airport at approximately 07:00 local time to carry five passengers bound for Glasgow-Prestwick.

The two pilots carried out the pre-flight check of their aircraft which was parked on the north apron "F", then the commander went to the general aviation terminal to welcome the passengers there. During this time, the copilot prepared the aircraft and completed the load and trim sheet.

Once he had returned and when the passengers had boarded, the commander checked the performance calculation and then, with his colleague, carried out the departure briefing including, among other things, the taxi phase to go to the beginning of concrete runway 05 from where he intended to take off. He noted the presence of a hot spot² on taxiway Z. The commander was the flying pilot. The pilots spoke to each other in Spanish but carried out the operational procedures in English.

¹ SAMAX – Swiss airport movement area control system

² A hotspot is intended to draw the pilot's attention on particularly tricky intersections, where runway incursions or collisions might occur, should a flight crew not give appropriate attention to the situation.

At 08:26:47 UTC, the copilot, who was handling radiotelephone communications, requested departure clearance from the "Geneva GND" control sector. Flight N990FV was cleared for destination EGPK via standard instrument departure (SID) SIROD 5N and its start-up was approved.

At 08:41:19 UTC, N990FV called "Geneva GND" to report that it was ready to roll. In the interval between the two calls, a new air traffic controller took over the GND workstation. He answered: *"Roger, November nine nine zero Foxtrot Victor, taxi to holding bay Zulu runway zero five."* N990FV read this back in these terms: *"Zulu, runway zero five, niner zero Foxtrot Victor."* The workload and complexity in the GND sector were assessed as "normal" by its controller.

The pilots of the Cessna C525 started to taxi even though they had not completed the full flight preparation; they were under time pressure because a take-off slot had been assigned to them. They thought they would be able to reach taxiway Z by the shortest route and left the stand by the left. The GND controller did not notice that they were leaving in the wrong direction. This route is a dead end and they were obliged to turn around and pass by the east of the north apron to join taxiway Y which skirts grass runway 05, the centre line of which is 252 m from that of the concrete runway.

At 08:43:26 UTC, the ADC controller made radiotelephone contact with EIN68N, an Airbus A320 which was making a flight to Dublin and which was approaching the threshold of concrete runway 05. He intended fitting it in between a Dash 8 in final approach phase and a British Airways Airbus A320 established on the ILS³, the airspeed of which he brought down to its minimum value. The flight crew of EIN68N replied that they were ready to depart after the next landing.

The ADC controller, who was also handling the VFR traffic, then successively cleared the landings of a light aircraft on grass runway 05 and then the Dash 8 on concrete runway 05.

At 08:44:23 UTC, EIN68N was cleared to line up and prepare for an imminent take-off after the landing of the Dash 8.

When they arrived at the end of taxiway Y, the pilots of N990FV saw, in front of them and slightly to the left, a light aircraft on final approach for grass runway 05. Its path would take it over taxiway Z which they would be using and which would give them access to the holding bay and then to concrete runway 05.

Not knowing if they were cleared without any further formalities to pass below this aircraft's path, they stopped at the "GATE Z" taxiway intersection sign and at 08:45:22 UTC reported to the GND controller that they were *"holding at Z"*. The latter thought this was a call from a different flight, Belavia BEL872, requested its source and obtained confirmation of the message. He replied *"Roger, you may taxi into the holding bay."* Since the pilots did not seem to understand the clearance, the controller reconsidered and instructed them to let pass the traffic *"on very short final for the grass"*. The pilots reported that they had the traffic in sight, then entered taxiway Z located directly on their left, at a right angle.

The GND controller then replied to BEL872 which requested its departure clearance for Minsk: *"Roger BEL872, expect route MOLUS 3N and I will call you back in a few minutes, unable yet to activate your flight plan."*

³ ILS: Instrument Landing System

At 08:46:17 UTC, the ADC controller informed EIN68N that a helicopter was flying over the runway centre line from left to right then cleared it for immediate take-off at 08:46:31 UTC.

At the same time, when N990FV was approaching holding bay Z, the GND controller indicated *“here right”* to the crew and instructed them to contact the control tower on the 118.7 MHz frequency: *“November nine nine zero Foxtrot Victor, here right and contact tower on one one eight decimal seven, goodbye.”* The commander replied that they were going right and read back the frequency change: *“Going to right, eighteen point seven, goodbye, merci, nine zero Foxtrot Victor.”* The Cessna C525, however, continued straight ahead at an average speed of 12 kt. It crossed the CAT I Z runway holding position markings⁴ at 08:46:56 UTC and approached concrete runway 05. The copilot, who was busy carrying out tasks in the cockpit, was not looking outside.

At 08:46:59 UTC, the RIMCAS⁵ safety net reported a critical convergence on the runway, generating the aural warning “RIMCAS” and illuminating the radar labels of N990FV and EIN68N in red on the screens of the SAMAX runway monitoring system. The latter was then approximately 670 m from the intersection of taxiway Z with concrete runway 05, at a speed of 77 kt. N990FV was advancing at 11 kt.

When the Cessna C525 was almost 30 m from the edge of the runway, the GND controller became aware of the runway incursion⁶, got up from his seat, swore and instructed it immediately to stop: *“hold position here!”*. The instruction given at 08:47:02 UTC overlapped the radiotelephone contact by a light aircraft which requested taxi clearance to the local aero club’s stands.

The ADC controller, who was busy with the workload and complexity of the traffic which he judged to be moderate to heavy, was not aware of the runway incursion by N990FV which, at that time, had still not contacted him. He did not hear the RIMCAS warning but, alerted by his colleague’s expressive reaction, saw the Cessna C525 approaching the edge of the concrete runway. He judged that EIN68N was moving quickly and that instructing a rejected take-off risked causing it to deviate to the left in the direction of the intruder. He consequently chose to inform it and to tell it to proceed to the right: *“Shamrock six eight November, caution, ?????, proceed to the right, traffic is interfering on runway.”* The message was transmitted at 08:47:05 UTC when the speeds of EIN68N and N990FV were 106 kt and 9kt respectively.

The commander of N990FV saw on his right, on concrete runway 05, the Airbus A320 on its take-off roll, braked hard and immobilised his aircraft.

EIN68N immediately acknowledged receipt of the warning and at the same time N990FV called ADC control, causing garbling.

The commander of EIN68N had already seen and reported to the copilot the aircraft on taxiway Z which was advancing slowly and which seemed to him not yet to have crossed the markings located before the edge of the runway. When he carried out a very slight evasive manoeuvre to the right, it appeared clear to him that the conflicting aircraft had stopped before the runway. He nevertheless

⁴ Runway-holding position: a designated position intended to protect a runway, an obstacle limitation surface, or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower.

⁵ RIMCAS - runway incursion monitoring and collision avoidance system

⁶ Runway incursion: any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.

scheduled a rejected take-off but considered that this manoeuvre was likely to cause handling difficulties. The Airbus A320 took off normally, positioned on the centre line of runway 05.

At 08:47:10 UTC the aural “RIMCAS” warning ended.

At 08:47:11 UTC the Airbus crossed taxiway Z and the tip of its left wing passed approximately 24 m from the nose of the Cessna C525.

At 08:47:25 UTC, the ADC controller instructed the British Airways A320 Airbus which was on final approach approximately 0.5 NM from the runway threshold to go around.



Figure 1: Paths of N990FV (yellow) and EIN68N (blue). The parts shown in red indicate when the “RIMCAS” aural warning was generated.

1.1.4 Location and time of the serious incident

Position	Swiss territory, Geneva Airport, intersection of taxiway Z and runway 05
Date and time	24 July 2015, 08:47:11 UTC
Lighting conditions	Daylight

1.2 Personnel information**1.2.1 Flight crew EIN68N****1.2.1.1 Commander****1.2.1.1.1 Training**

Person	Irish citizen, born 1979
Licence	Airline transport pilot licence aeroplane – ATPL(A) according to ICAO (International Civil Aviation Organisation) - Part – FCL – Standards, first issued by the Irish Aviation Authority (IAA) on 18 May 2005

All the data available indicates that the commander began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.2.1.1.2 Flying experience

Total hours	7947 hours
Of which on the type involved	7609 hours
During the last 90 days	193 hours
Of which on the type involved	193 hours

1.2.1.2 Copilot**1.2.1.2.1 Training**

Person	Irish citizen, born 1984
Licence	ATPL(A) according to ICAO - JAR-FCL Standards, first issued by the IAA on 7 April 2011

All the data available indicates that the copilot began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.2.1.2.2 Flying experience

Total hours	5431 hours
Of which on the type involved	3111 hours
During the last 90 days	222 hours
Of which on the type involved	222 hours

1.2.2 Flight crew N990FV

1.2.2.1 Commander

1.2.2.1.1 Training

Person	Venezuelan citizen, born 1978
Licence	ATPL(A) according to FAA (Federal Aviation Administration), issued by the FAA on 4 March 2015

All the data available indicates that the commander began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.2.2.1.2 Flying experience

Total hours	3148 hours
Of which on the type involved	88 hours
During the last 90 days	88 hours
Of which on the type involved	88 hours

1.2.2.2 Copilot

1.2.2.2.1 Training

Person	Venezuelan citizen, born 1965
Licence	ATPL(A) according to FAA, issued by the FAA on 15 April 2015

All the data available indicates that the copilot began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.2.2.2.2 Flying experience

Total hours	5422 hours
Of which on the type involved	50 hours
During the last 90 days	85.7 hours
Of which on the type involved	50 hours

1.2.3 Air traffic controllers

1.2.3.1 ADC air traffic controller

Function	Aerodrome control (ADC)
Person	Swiss citizen, born 1970
Licence	Air Traffic Controller, based on Directive EU-R805/2011 of the European Community, first issued by the FOCA on 11 October 1996 and valid till 23 March 2016
Ratings	Unit endorsement TWR; Location LSGG Rating: ADI (aerodrome control instrument) Rating endorsements: AIR (air control); TWR (tower control); RAD (radar) (ADI)

All the data available indicates that the controller began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.2.3.2 GND air traffic controller

Function	Ground control (GND)
Person	Swiss citizen, born 1982
Licence	Air Traffic Controller, based on Directive <i>EU-R805/2011</i> of the European Community, first issued by the FOCA on 18 July 2003 and valid till 12 July 2016
Ratings	Unit endorsement TWR; Location LSGG Rating: ADI Rating endorsements: AIR; TWR; RAD (ADI) GMS (ground movement surveillance), GMC (ground movement control)

All the data available indicates that the controller began his duty rested and in good health. There is no indication that fatigue contributed to the occurrence of the serious incident.

1.3 Aircraft information

1.3.1 EIN68N

Aircraft type	Airbus A320 – 214
Characteristics	Short- and medium-haul twin-jet
Manufacturer	Airbus Industrie, Toulouse, France
Year of manufacture	2004
Serial number	2256
Owner	International Lease Finance Corp, Los Angeles, USA
Operator	Air Lingus, Dublin Airport, Ireland
Wingspan	34.10 m

1.3.2 N990FV

Aircraft type	Cessna 525 Citation M2
Characteristics	Business twin-jet, 8-seater, medium haul, metal construction
Manufacturer	Cessna Aircraft Company, Wichita, USA
Year of manufacture	2015
Serial number	525-0863
Owner	Aero Service Turbillon Corp. Wilmington, USA
Operator	Cessna Aircraft Company, Wichita, USA
Significant equipment	Garmin 3000 integrated flight information system For each pilot, display of aeronautical charts on an iPad
Length	12.98 m
Height	4.24 m

1.4 Meteorological information

1.4.1 General meteorological situation

Ahead of a depression centred over the Bay of Biscay, a pressure distribution with a gentle gradient prevailed on the ground.

1.4.2 Meteorological situation in the Geneva region at the time of the serious incident

The weather was sunny and the wind was light; there was cumulus along the Jura and over the Salève.

Weather/cloud	1/8 to 2/8 at 3,500 ft AAE ⁷
Visibility	30 km
Wind	Variable, 4 kt
Temperature / dew point	25 °C / 16 °C
Atmospheric pressure	1013 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Evolution	No significant change scheduled

1.4.3 Astronomical information

Position of the sun	Azimuth: 112 °	Elevation: 46 °
Light conditions	Daylight	

1.4.4 Meteorological and operational information relating to take-off

At 08:20 the Geneva automatic terminal information service (ATIS) provided UTC information L:

INFO LIMA RWY: RWY IN USE 05 ILS GRASS RWY IN OPS FOR VFR TFC

MET REPORT LSGG 1520Z

VRB 3 KT CAVOK⁸ 25/17 QNH 1013 NOSIG

In clear text this means that the approach in use was the runway 05 ILS instrument landing system and that the grass runway was in operation for VFR⁹ traffic.

The prevailing meteorological conditions were as follows:

Cloud	No cloud below an altitude of 10,600 ft
Wind	Variable, 3 kt
Horizontal visibility	≥ 10 km
Temperature	25 °C
Dew point	17 °C

⁷ AAE: above aerodrome elevation

⁸ The expression "CAVOK" (ceiling and visibility OK) is used instead of the visibility, weather and cloud groups when horizontal visibility is ≥ 10 km, when there is no cloud below 5000 ft or the minimum sector altitude (MSA), when there is no cumulonimbus or no significant meteorological phenomenon at the time of the observation.

⁹ VFR: visual flight rules

Atmospheric pressure QNH	1013 hPa
Short-term forecast (significant change expected for the 2 hours following the observation time)	No significant change scheduled

1.5 Aids to navigation

The two aircraft involved in the incident were on the ground. The Geneva airport navigation aids therefore played no part.

1.6 Communications

The serious incident occurred when the aircraft in conflict were in radiotelephone contact with two different sectors of the Geneva control tower: N990FV was being handled by Ground control GND, and EIN68N by Aerodrome control ADC. Communications took place in English.

1.7 Aerodrome information

1.7.1 General

Geneva Airport is located in the west of Switzerland. In 2014, 187,596 movements (take-off or landing) occurred there, including 182,268 on the concrete runway.

Runways

Designations and surface	Dimensions	Equipment
23/05 – concrete	3900 x 50 m	23 - ILS Cat III and 05 - ILS Cat I
23/05 – grass	823 x 30 m	23 - APAPI ¹⁰ 4.5° and 05 – APAPI

Runway 05

Take off run available – TORA:

- from the offset runway threshold: 3900 m
- from the intersection with taxiway Z: 2750 m

Landing distance available - LDA: 3570 m.

1.7.2 Stop bars

All the taxiways which access runway 05 are equipped with stop bars¹¹ at their CAT II runway holding position. Those of the 4 taxiways B, C, D and E located to the south are permanently illuminated by default; only by the authority of the air traffic services are they extinguished in order to indicate to an aircraft or a vehicle that the path to the runway is clear.

1.7.3 Markings

1.7.3.1 Centre line marking of taxiway Z at the entrance to holding bay Z

At the entrance to holding bay Z, the axial markings of the taxiway split into two lines, one leading straight to the CAT I runway holding position, the other turning right into the holding bay.

¹⁰ APAPI: abbreviated precision approach path indicator

¹¹ Stop bars consist of lights spaced at uniform intervals of 3 m across the taxiway, showing red in the intended direction(s) of approach to the intersection or runway-holding position. A stop bar is illuminated to stop traffic and is extinguished to indicate that the path is clear.

1.7.3.2 CAT I runway holding position on taxiway Z markings

As with the markings in force at the airports in the United States of America, the approach of the CAT I Z runway holding position is indicated to pilots by the enhanced taxiway centre line marking.

The CAT I Z runway holding position markings are emphasised by the runway protection lights consisting of two pairs of unidirectional flashing yellow lights ("Wig-Wag") each positioned on the sides of the taxiway. They are preceded by a mandatory marking consisting of a white inscription of the figures "23-05" on a red background. Unlike the CAT II Z holding point markings which precede them, they are not indicated by a stop bar.

1.7.4 Intended take-off location

The Aeronautical Information Publication (AIP) Switzerland, which contains information which is of an enduring character and which is essential for aerial navigation, does not specify explicitly that the information concerning the location where take-off is intended (runway threshold, runway intersection) should be communicated by the controller or the flight crews.

1.7.5 Aeronautical charts of Geneva - LSGG used by the pilots of N990FV

Each of the pilots of N990FV had JEPPESEN electronic aeronautical charts. The "JEPPESEN 10-9B" Geneva aerodrome chart is the one which provides the most details about taxiing on the north apron. Unlike the rather more detailed signalling of taxiway Y and its two holding bays Y1 and Y2, that of taxiway Z and its holding bay consists only of the letter "Z" alone, affixed to the representation of the latter. Two hot spots designated "*HOT SPOT HS1*" feature on it; their legend on chart "JEPPESEN 10-9" draws the attention of flight crews to the proximity of taxiways located under the final path or under the take-off centre lines of the grass runway.

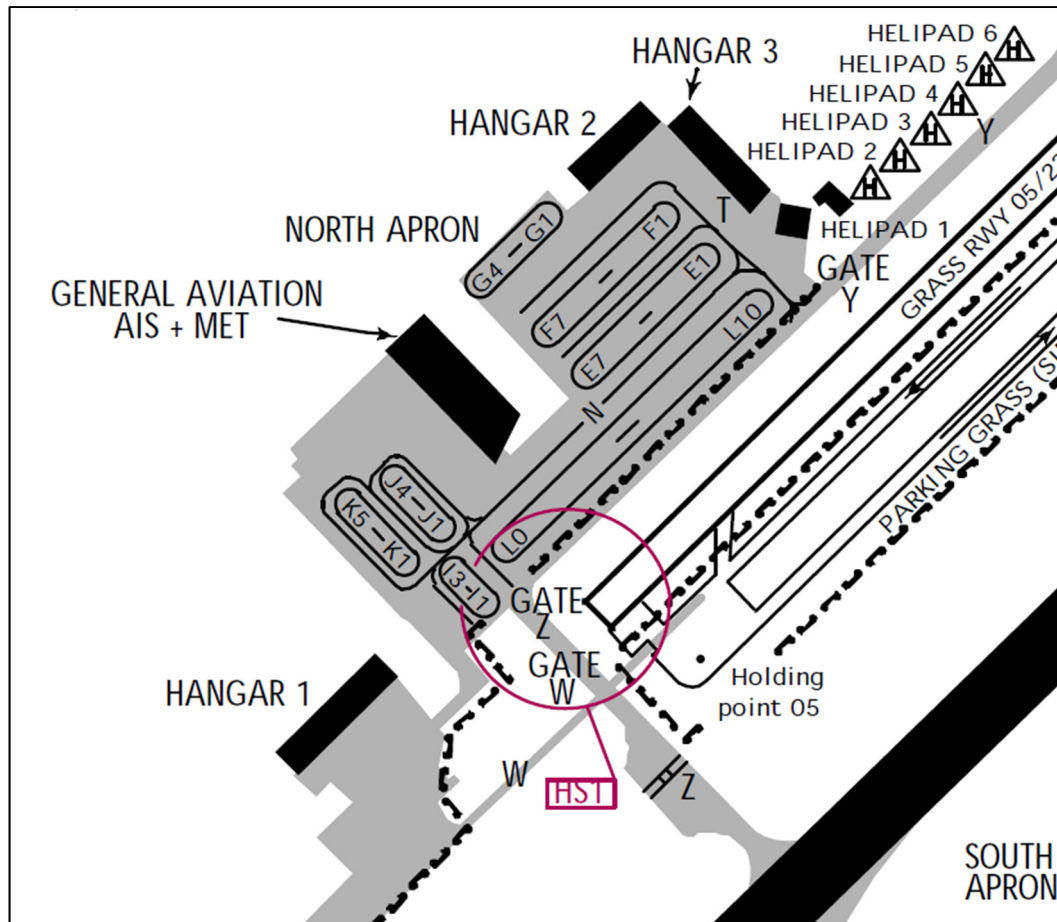


Figure 2: North apron, hot spot HS1 on taxiway Z

1.7.6 Hot spots before runway holding position CAT I Z

In some earlier versions of the aeronautical charts for Geneva airport - LSGG, the CAT I runway holding position of taxiway Z was identified as a hot spot because of the runway incursion risk. Depending on the case, the legends relating to this spot indicated the danger in various ways: for example, the JEPPESEN version dated 4 November 2005 drew attention to the default red light stop bar and specified that crossing could not be undertaken without being explicitly cleared to enter the runway. The version dated 10 September 2010 merely stipulated: “*Never cross red stop bars*”.

1.8 Onboard recorders

At the moment when the serious incident was reported to the STSB, the recordings of conversations in the cockpit (cockpit voice recorder - CVR), were no longer available. Taking into account the elements already available for the needs of the investigation, it was not necessary to have recourse to the flight data recordings (flight data recorder - FDR).

1.9 Tests and research

Not applicable

1.10 Organisational and management information

1.10.1 Air navigation service

1.10.1.1 General

Originating from the Swisscontrol private limited company, the Skyguide company has since 1 January 2001 been providing air traffic control in Swiss airspace and the foreign airspace for which control has been delegated to Switzerland.

The following information consists of extracts, or where necessary summaries, of the ATMM air traffic management manuals for Switzerland, "Section 9 Aerodrome Control" and Geneva TWR/APP "Section TWR". The specific references are indicated at the beginning of the sub-section.

1.10.1.1.1 Issuing of departure clearances and taxi clearance

"ATM MANUAL SWITZERLAND SECTION 9 AERODROME CONTROL, 3.1 TAXI CLEARANCE"

This section begins with a note (Note 1) drawing attention to the fact that on board an aircraft the flight crew's vision is limited during taxiing. It indicates that it is consequently important that the control instructions given for their attention are concise and that the information is appropriate to assist them in determining the correct taxiways and to avoid a collision with other aircraft or objects, as well as to reduce the danger that the aircraft may inadvertently intrude onto a runway which is in operation.

The taxi clearance must include:

- a) the clearance limit (normally in terms of runway-holding position) specifying the runway to be used for departure;
- b) the route to follow on the manoeuvring area, using taxiway designators and runway designators when the aircraft will taxi across or on runways.

It is not explicitly specified (and this is the case in all the air traffic manuals concerning taxiing on Geneva airport) that the information concerning the location where take-off is intended (start of runway, runway intersection) should be communicated.

Only the following section mentions a mandatory and explicit instruction to make an aircraft wait short of an active runway:

"When a taxi clearance contains a taxi limit beyond a RWY, it shall contain an explicit clearance to cross or an instruction to hold short of that RWY."

When the risk exists that an aircraft might inadvertently taxi onto an active RWY, append the taxi clearance with the following instruction:

- *HOLD SHORT OF RUNWAY (position)".*

1.10.1.1.2 Obstructed runway

"ATM MANUAL SWITZERLAND SECTION 9 AERODROME CONTROL, 4.2.4.3 OBSTRUCTED RUNWAY"

If, at any time, and especially after a take-off clearance or a landing clearance has been issued, you become aware of a RWY incursion or the imminent occurrence thereof, or the existence of any obstruction on or in close proximity to the RWY likely to impair the safety of an aircraft taking off or landing, appropriate action shall be taken as follows:

- a) cancel the take-off clearance for a departing aircraft;

- b) instruct a landing aircraft to execute a go around or missed approach;
- c) in all cases inform the aircraft of the RWY incursion or obstruction and its location in relation to the runway.

Note 2: An aborted take-off or a go-around executed after a touchdown may expose the aircraft to the risk of overrunning the RWY. ...

Note 3: The decision to continue, or abort the take-off, or land, rests solely with the PIC.

1.10.1.1.3 Taxiway Z vs grass runway movements

“ATMM GENEVA TWR/APP TWR, D.1.6.5 TWY Z VS GRASS MOVEMENTS”

GND is assigned the task for the prevention of collisions between traffic on taxiway Z and grass runway operations (ARR 05 and DEP or option 23). In order to achieve this task, Gate W and Gate Z (see Picture below) may be used as taxi clearance limit if required.

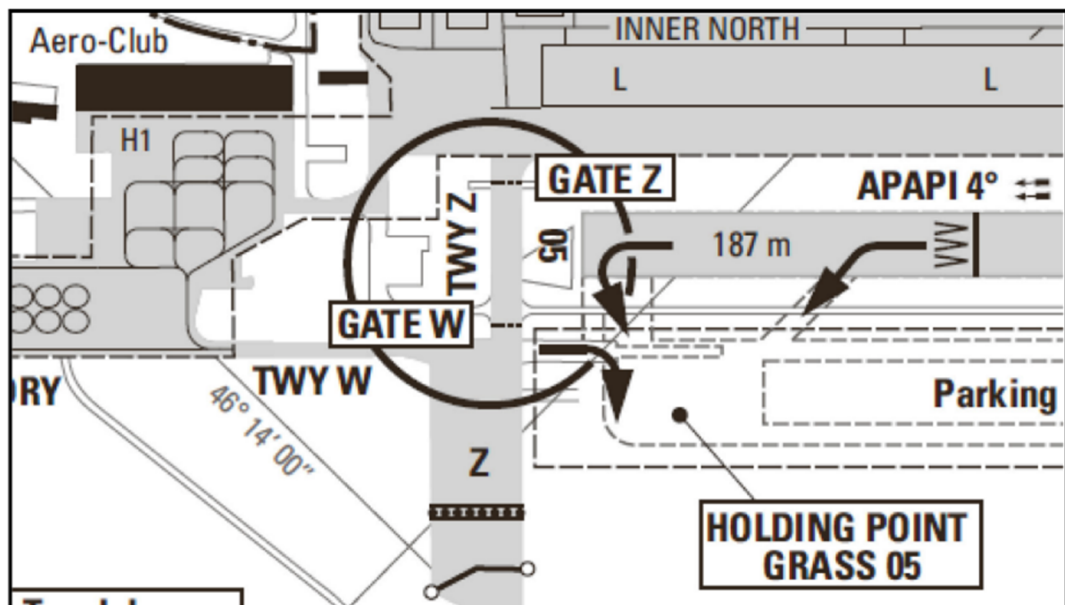


Figure 3: Taxiway Z vs grass runway movements

As Gate W and Gate Z are not RWY holding positions, pilots will not automatically stop at these intermediate holding positions. Similarly, a clearance beyond these intermediate holding positions does not require a specific "crossing" clearance.

1.10.1.1.4 Hot spots

“ATMM GENEVA TWR/APP TWR, K.8 LSGG HOTSPOTS”

The hot spots are introduced and described in reference to the Swiss AIP, i.e. as points intended to draw pilots' attention.

For the hot spots located on the north apron, it is mentioned only that they draw the attention of flight crews to the proximity of taxiways located below the final approach path or below the take-off centre lines of the grass runway.

1.11 Additional information

1.11.1 Take-off roll of the Airbus A320

The take-off roll is split into two segments above and below a speed of 100 kt, reported by the pilot monitoring (PM) and critical for the commander as far as the decision to reject take-off is concerned.

Below this speed, the aircraft is in the segment deemed “low speed” and a rejected take-off constitutes a manoeuvre which is judged to be low-risk. Above 100 kt, the aircraft enters the “high-speed” segment and such a decision can potentially present more risks, with consequences whose severity increases with speed; the energies involved are high, and braking and keeping the aircraft on the runway centre line is more difficult to control. Overruns or runway excursions occur mainly at the time of take-offs aborted at high speed.

Statistics and experience have shown that above 100 kt the safest solution for flight crews is to continue the take-off unless a malfunction or a serious event occurs.

1.11.2 Stop bars

In the “5.3.20 Stop bars” section of Volume I of Annex 14 to the Convention on international civil aviation, entitled “Aerodrome - Design and technical operation of aerodromes”, note 2 stipulates: “*Runway incursions may take place in all visibility or weather conditions. The provision of stop bars at runway- holding positions and their use at night and in visibility conditions greater than 550 m runway visual range can form part of effective runway incursion prevention measures.*” At the world symposium on runway safety held at the headquarters of the ICAO from 24 to 26 May 2011, the use of stop bars in accordance with Annex 14 was encouraged, even in the case of good visibility.

1.11.3 RIMCAS safety net

Geneva Airport is equipped with the RIMCAS safety net which, within a volume consisting of the approach path and the runway protection areas, detects possible conflict situations between aircraft in flight and vehicles and aircraft moving on the runway and in its environs. It operates using information provided by the SAMAX system. The parameterisation and operation of the system are a function of the operating procedure in force, i.e. in low or good visibility.

At the ADC and GND control positions, the serious incident generated a warning indicating a critical situation which may require immediate corrective control action, symbolised by the illumination in red of the radar labels of EIN68N and N990FV and by the generation of the aural “RIMCAS” warning.

The warning commenced at 08:46:59 UTC when EIN68N was rolling for take-off at a ground speed of 77 kt and 675 m from the intersection of taxiway Z with concrete runway 05. At this time N990FV was approximately 12 m away from the CAT 1 Z runway holding position and was taxiing at 12 kt. The warning ended at 08:47:10 UTC; EIN68N was rolling at a ground speed of 126 kt and was at a distance of approximately 60 m from N990FV, which was taxiing at 5 kt in deceleration phase.



Figure 4: "RIMCAS" aural warnings

1.11.4 Speeds of N990FV after runway holding position CAT I Z



Figure 5: Speeds of N990FV

N990FV stopped approximately 15 m from the edge of concrete runway 05.

1.11.5 Reason's system approach methodology

James Reason's system approach methodology¹² makes it possible to determine how a human can significantly interfere with a complex system, in this case the serious incident, this methodology consists of the following elements: airport - air traffic control - flight management, which are interactive and protected by strict rules and standards, and by elaborate monitoring equipment.

It distinguishes between two types of error, depending on the imminence of their consequences.

- Latent error, generated by one or more decisions or measures taken long before the incident and whose consequences can take a long time to appear. These errors originate from inappropriate decisions or measures taken by people far off in time and space from the event ("decision makers and operational managers" according to Reason); they are not harmful when considered in isolation but may on the other hand act together to create a favourable framework within which, for example, a pilot or an air traffic controller commits an active error which circumvents all the defences of the system and causes an incident.
- Active error, consisting of an error or a violation which causes immediate harmful effects; this is generally attributable to those directly involved (pilots and air traffic controllers in the case of the serious incident).

1.11.6 Statements and declarations

1.11.6.1 Statements of the pilots of N990FV

For the purpose of the investigation, the commander and the copilot of N990FV were interviewed by the investigation bureau of the United States National Transportation Safety Board - NTSB.

The two pilots stated they had difficulties in understanding the air traffic controller because of his pronounced accent in English. The commander stated on several occasions that the radiotelephone conversations were unclear; the term "holding bay" was unknown to him.

They explained that a new standard instrument departure had been assigned to them while they were taxiing. The commander stated that such a change when they were rolling close to an active area constituted by the portion of taxiway Z located below the final approach path for grass runway 05 represented a challenge.

The commander recalled that he had been cleared to cross runway 05 after he had heard the registration of the aircraft which was landing on the grass runway.

The copilot stated that at the time of the serious incident he was not looking outside because he was busy finding the new standard departure.

The commander recalled having identified runway holding position CAT I Z but did not see the Wig-Wag runway guard lights.

1.11.6.2 Statement of the commander of EIN68N

In the ASR (air safety report) which he completed at the time of the serious incident, the commander of EIN68N described N990FV as being a large white single-engined piston-engined aircraft. He saw it and reported it to the copilot when their aircraft was exceeding a speed of 100 kt.

¹² A detailed explanation of this method does not fall within the scope of the investigation but interested parties can refer to the work by James Reason entitled Human error (1990).

1.11.6.3 Statement of the GND controller

The GND controller stated that pilots seldom read back clearances in their entirety and that consequently he found it normal that the flight crew of N990FV had never read back the "Holding bay Z" limit.

He recalled having heard the aural "RIMCAS" warning but it was not that which drew his attention to the runway incursion by N990FV.

He was aware of the hot spot on taxiway Z and considered that it was primarily information intended for pilots.

1.11.7 Safety recommendation no. 358

Incursions on runway 23-05 have occurred on several occasions. They have been the subject of investigation reports leading to the following safety recommendation:

Safety recommendation no.358

The Federal Office of Civil Aviation should require that all intersections and runway thresholds be equipped with stop bars and that these be activated in all weather conditions during the airport's hours of activity.

2 Analysis

2.1 Technical aspects

2.1.1 RIMCAS warnings

On taxiway Z, in the good visibility operating condition, the protected area of the runway is delimited by runway holding position CAT I. When crossing it causes a runway incursion, it would be appropriate for the RIMCAS warning to be issued at this moment. In the case of the serious incident, this would then have been 3 seconds earlier, when EIN68N's speed was 15 kt lower.

The aural "RIMCAS" warning signalled the runway incursion of N990FV though did not attract the attention of the GND and ADC controllers who were managing ordinary traffic situations: the RIMCAS system therefore did not play its role of a safety net. This is explained by the fact that it is better suited to low-visibility operational procedures, during which controllers manage their traffic essentially on radar screens. In addition to the aural warning, a visual RIMCAS warning indicating the critical convergence of two mobile vehicles is indicated on the radar screens by the illumination in red of their radar label.

2.1.2 Runway holding position CAT I Z

When taxiing to runway 05, taxiways G, Z, Y and A widen to a holding bay. To enable optimal management of the traffic flows entering the runway, the stop bars at the Cat II runway holding position markings are not permanently illuminated. On taxiway Z, access to concrete runway 05 is therefore not barred by default by the lights, the red colour of which indicates to pilots an absolute boundary which must not be crossed. The risk of a runway incursion is identified there and was, moreover, indicated in advance by a hot spot on the aerodrome charts.

The stop bars located south of the concrete runway are permanently illuminated to prevent aircraft entering these by-pass taxiways in error and to prevent runway incursions: the same procedure should consequently be applied north of the runway. If this is not the case for reasons of easing traffic movement, the installation of a stop bar at runway holding position Cat I Z should be undertaken in accordance with the measures stipulated in section "5.3.20 Stop bars" of volume I of Annex 14 of the ICAO.

The serious incident which is the subject of this report reveals that a runway incursion at taxiway Z remains sufficiently probable for preventive measures to be taken. The installation of a stop bar and the establishment of a hot spot at this point are two such measures.

2.2 Human and operational factors

2.2.1 Air traffic control aspects

2.2.1.1 The GND ground controller

Between the moment when the taxi clearance was requested by the copilot of N990FV and the occurrence of the serious incident, several facts reveal that the vigilance of the GND controller was relaxed:

- He accepted that the readback of the taxi clearance issued to N990FV at 08:41:29 UTC did not include the clearance limit "*holding bay Z*";
- He did not notice that N990FV had left its stand to the left, towards a dead end;
- He did not realise that the hesitant and somewhat imprecise phraseology of the pilots of N990FV might be a sign of a lack of familiarity with taxiing on the airport's north apron;

- He did not anticipate that the light aircraft on final approach to grass runway 05 in the direction of the hot spot mentioned in the AIP constituted a disturbing factor for the pilots of N990FV, leading them to stop at "Gate Z";
- When N990FV was taxiing to runway holding position CAT I Z, he did not check if his approximate instruction "N990FV *here right..*" had been obeyed by the flight crew of N990FV.

Although this lack of attention had no consequences as long as N990FV was the only aircraft moving on the north apron, it did, however, play a significant role in the evolution of the risk of collision when the aircraft was approaching concrete runway 05 which was in operation.

2.2.1.2 The ADC aerodrome controller

The ADC controller became aware of the runway incursion in an unexpected way: N990FV appeared and suddenly penetrated into traffic which he was monitoring, the speed of which he knew or was aware of. When launched on its take-off roll on the ground, in these circumstances EIN68N became his basis of reference in the convergence with N990FV. The ADC controller did not have time to evaluate and integrate the speed of the latter into the evolution of the conflict. Furthermore, the control tower is located almost opposite taxiway Z, which makes it difficult to evaluate the speeds of aircraft which are moving there. At the moment when the GND controller instructed N990FV to stop on the spot, the latter was moving at 9 kt.

It was therefore obviously under the influence of surprise that the ADC controller reported the danger to the flight crew of EIN68N and spontaneously how to avoid it. At this time the intruder was slowing down at approximately 1 kt/s^2 , which meant that it would stop in approximately ten seconds. Strictly speaking, the initial reaction of the ADC controller should have been to instruct EIN68N to reject its take-off in order to reduce the kinetic energies in the event of a collision. However, the recording of the radiotelephone communications shows that the instruction given initially consisted of alerting EIN68N by the term "*caution*" and then to indicate "*proceed to the right*" to avoid the danger represented by the runway incursion "*traffic is interfering on runway*".

In his statement, the ADC controller expressed his concern about the risk of collision which an instruction to EIN68N to reject its take-off would involve.

By indicating the danger, he in fact transferred, directly and without delaying it by an instruction, the decision to continue or reject the take-off to its commander; adding "proceed to the right" is explained by the reflex action of wishing to avoid danger to the aircraft he was controlling.

2.2.2 Flight management aspects

2.2.2.1 Flight crew of flight N990FV

Several extraneous factors may have contributed to impairing the situational awareness of the pilots of N990FV, but the latter nevertheless failed to comply with the basic rules of taxiing which are laid down to prevent incidents. They did not make use of standard phraseology, which determines the effectiveness of radiotelephone communications and which limits the risks of incomprehension. Readbacks of the clearance limit "*holding bay Z*" and "*holding bay*" were never carried out. Likewise, if N990FV had been cleared to cross concrete runway 05, a readback of such a clearance would have been obligatory. The recordings of the radiotelephone communications do not mention this clearance or its readback.

It is possible that the pilots of N990FV believed that standard instrument departure MOLUS 3N communicated to BEL872 was addressed to them: "*Roger BEL872,*

expect route MOLUS 3N and I will call you back in a few minutes, unable yet to activate your flight plan." The fact that it was a matter of an imminent departure clearance which the GND controller still had to confirm a little later could have confused them. However, the reply "MOLUS 3N" from BEL872 should have cleared their confusion.

In addition, the markings and the runway guard lights of runway holding position CAT I Z are identical to those which are common in the United States of America. They thus constitute an indication of an entrance to a runway of which the pilots of N990FV could not be unaware.

Even though almost a quarter of an hour elapsed between the issuing of the departure clearance and the roll request, the preparation for taxiing seems to have been deficient: though the Geneva aerodrome chart "JEPPESSEN 10-9B" provides few details about the routes on the north apron, the dead end which can be taken when leaving the stand, however, is shown on it. The turning made in this way probably increased the state of stress of the pilots, who were already under the pressure imposed by a take-off slot.

The commander stated that he had noted the presence of the hot spot on taxiway Z; this draws attention to the disruptive element which the proximity of the final approach path for the grass runway may represent. At the time of the serious incident, the danger of a runway incursion at the end of taxiway Z was not indicated on the aerodrome charts. It is possible, however, that although they genuinely identified it, the pilots perceived the hot spot as the only barrier to crossing concrete runway 05, which opened after the passage of the light aircraft. Taking the liberty of linking the latter to a clearance to cross does not comply with any taxiing rules.

2.2.2.2 Flight crew of flight EIN68N

The warning message by the ADC controller "*Shamrock six eight November, caution, ?????, proceed to the right traffic is interfering on runway*" lasted 4 seconds, during which the Airbus A320 EIN68N accelerated from 106 to 122 kt. The aircraft was consequently in the "high-speed" segment in which pilots have only very little time to decide to continue or reject take-off. At the decision speed¹³, this time is reduced to one second (recognition time) and for this reason pilots are trained to react mainly in a conditioned manner by rejecting the take-off only for not inhibited warnings indicating a serious malfunction.

However, the problem arising from the runway incursion by N990FV did not allow such a binary solution: while flying the aircraft, the commander must very quickly establish visual contact with the intruder, determined its speed, integrated it in relation to that of his own aircraft and, as a function of these factors, assess the risk of collision. At the same time the ADC controller's warning message was transmitted and 2 seconds after it ended the aircraft in conflict passed each other.

In such a rapid and hectic course of events, even while moving perpendicular to N990FV, integration of the intruder's speed, i.e. surmising its position in the following seconds, represents a very complex cognitive process. At the moment when the commander saw the intruder (100 kt), the latter appeared to him to be moving slowly; the radar data show that it was moving at 10 kt, decelerating, and that it stopped (abruptly according to the statements of its commander) 1 second from the crossing.

¹³ Decision speed V1 is the maximum speed at which the crew can decide to reject the take-off, and is ensured to stop the aircraft within the limits of the runway.

2.3 Causal sequence leading to the serious incident

The serious incident arose from actions carried out by pilots and air traffic controllers who aimed at performing their task in a professional manner in their eyes, but under conditions which were favourable at this precise time to the interaction of omissions and errors present in the complex airport - air traffic control - flight management system. It is therefore appropriate to consider this system as a whole, and the components thereof which combined to cause the serious incident are identified in this report according to James Reason's system approach.

2.3.1 Latent errors

In the causal sequence leading to the serious incident, apart from the lack of vigilance of the pilots of N990FV and of the GND controller, the investigation identified 3 latent errors, in the levels of organisation of the following system: the design and the layout of the airport, identification of the hot spots on taxiway Z and the air traffic control operational procedures.

2.3.1.1 Design and layout of the airport

Because of its layout, the intersection of taxiway Z with concrete runway 05 constitutes a location at risk of a runway incursion. It is indicated only by Wig-Wag runway guard lights, which do not represent an obstacle of the same importance as that represented by a stop bar. Moreover, the location was previously identified as a hot spot with information drawing pilots' attention to the default red lights. It was also specified that a crossing could not be undertaken without an explicit clearance to enter the runway.

2.3.1.2 Hot spot on taxiway Z

In order to access concrete runway 05 from the north apron, aircraft must take one of the two taxiways Y or Z which, unusually, pass below the final approach path of grass runway 23 - 05. On these two taxiways, pilots who are not used to Geneva airport may be concerned by light aircrafts on final approach for the grass runway, which they would judge to be in conflict with their own route. The hot spot which signals this particular characteristic may monopolise pilots' attention and diminish their perception of the risk of an incursion on runway 05 at the intersection with taxiway Z.

In these circumstances, the "GATE Z" indicator panel located in the corner at the boundary of the intersection of taxiways Y and Z may be interpreted by flight crews as a limit conditioning the continuation of movement because of VFR traffic on final approach in the direction of grass runway 05. If the progress of an aircraft is not subsequently limited by clear instructions given and read back using standard phraseology, the risk of an incursion on concrete runway 05 at the intersection with taxiway Z is not negligible.

2.3.1.3 Air traffic control operational procedures

When a departure clearance and then a taxi clearance is issued, it is not explicitly specified in the air traffic control manuals or in the documentation available to pilots that the information concerning the location where take-off is intended (runway threshold, runway intersection) should be communicated by the controller or flight crews. It is generally admitted by controllers that when runway 05 is in operation, an aircraft taxiing from the north apron is supposed to take off at the intersection with taxiway Z.

When he clears an aircraft to taxi towards the CAT I or Cat II holding points or a holding bay located at the entry to a runway in operation, the GND controller is not

obliged systematically to indicate to pilots that they must wait short of this runway by means of the instruction "HOLD SHORT OF RUNWAY (position)".

Despite these two deficiencies with a risk of an incursion on concrete runway 05 at taxiway Z, the reference to the hot spots in the air traffic control operational procedures does not mention any special attention which the controllers should pay to these locations.

2.3.2 Active errors

The parties directly involved in the serious incident consist of two pairs: GND controller - flight crew of N990FV and ADC controller - flight crew of EIN68N. Although the first pair is involved in the origin and sequence of the conflict, the second, however, suffered the effects and attempted to mitigate them.

The lack of vigilance of the GND controller, in particular the failure to verify execution of the instruction "*N990FV here right...*" constitutes an active error.

In terms of flight management, the lack of situational awareness of the flight crew of N990FV, leading to the crossing without clearance of runway holding position CAT I Z, constitutes an active error.

Dangerous convergence between N990FV and EIN68N

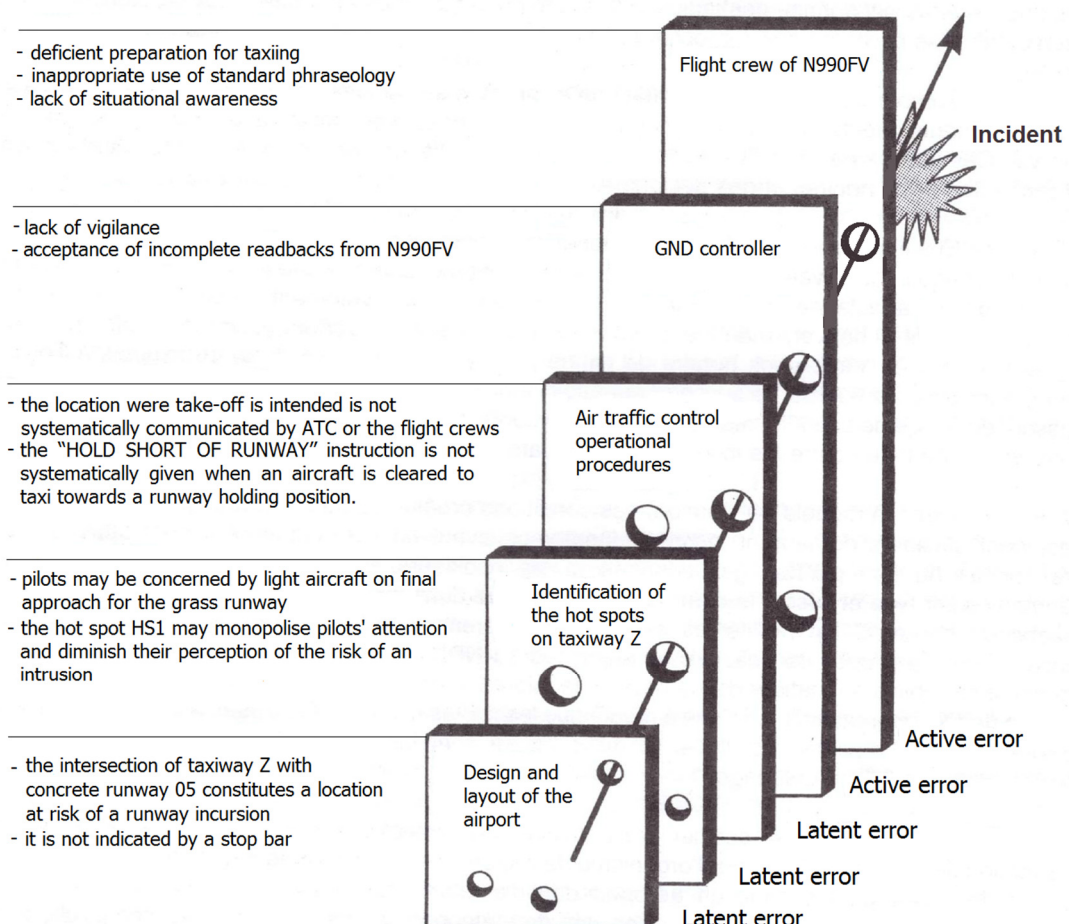


Figure 6: Causal sequence leading to the serious incident

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- Runway holding position Cat I Z is not equipped with a stop bar.
- The risk of a runway incursion on concrete runway 05 from taxiway Z is not identified by a hot spot.
- The RIMCAS warning was generated when C550 N990FV had passed runway holding position CAT I Z by approximately 12 m.

3.1.2 Flight crews

- The pilots of flights EIN68N and N990FV held the licences and ratings required to manage the flight in accordance with the regulations in force.
- The commander of N990FV indicated that the term “*holding bay*” was unknown to him.
- The copilot of N990FV stated that at the time of the serious incident he was not looking outside because he was busy finding the new standard departure.
- The commander of N990FV recalled having identified runway holding position CAT I Z but did not see the Wig-Wag runway guard lights.

3.1.3 Air traffic control

- The air traffic controllers involved in the serious incident held the licences and ratings in accordance with the regulations in force.
- The GND controller assessed the workload and the complexity as “normal” in his sector.
- The ADC controller assessed the workload and the complexity of work as moderate to heavy in his sector.
- The GND controller recalled having heard the aural “RIMCAS” warning but it was not that which drew his attention to the runway incursion by N990FV.
- The ADC controller did not hear the RIMCAS warning.
- The operational procedures do not specify that the “HOLD SHORT OF RUNWAY” instruction should be systematically given when an aircraft is cleared to taxi towards a holding bay or a runway holding position.

3.1.4 History of the serious incident

- The two aircraft involved in the serious incident were following instrument flight rules and were in radiotelephone contact with two different sectors of the Geneva control tower (TWR).
- The commander of N990FV intended taking off from the threshold of concrete runway 05.
- The GND controller had presumed that N990FV would take off from the intersection of taxiway Z with concrete runway 05.
- Under the pressure of a take-off slot, the pilots of N990FV started to taxi even though they had not completed the full flight preparation.
- Seeing a light aircraft on final approach for grass runway 05, the pilots of N990FV stopped at the taxiway intersection sign “GATE Z”.

- When N990FV approached holding bay Z, at 08:46:31 UTC, the GND controller indicated to it: *"November nine nine zero Foxtrot Victor, here right and contact tower on one one eight decimal seven, goodbye."*
- At 08:46:56 UTC, N990FV crossed the runway holding position CAT I Z markings and taxied towards concrete runway 05.
- At 08:46:59 UTC, the RIMCAS safety net reported a critical convergence on the runway, generating the aural "RIMCAS" warning.
- At 08:47:02 UTC the GND controller instructed N990FV to stop on the spot: *"hold position here!"*.
- At 08:47:05 UTC, the ADC controller informed EIN68N of the runway incursion using the terms: *"Shamrock six eight November, caution, ?????, proceed to the right, traffic is interfering on runway."* EIN68N and N990FV were then travelling at speeds of 106 kt and 9 kt respectively.
- The commander of N990FV braked sharply and immobilised his aircraft approximately 15 m from the edge of concrete runway 05 because he saw the Airbus A320 EIN68N on its take-off roll.
- The commander of EIN68N carried out a very slight evasive manoeuvre to the right, then returned to the runway centre line and took off normally.
- At 08:47:10 UTC the aural "RIMCAS" warning ended.
- At 08:47:11 UTC EIN68N crossed taxiway Z and the tip of its left wing passed approximately 24 m from the nose of the Cessna C525 N990FV.

3.1.5 Environmental context

- The weather was sunny and the wind was light.

3.2 Causes

The serious incident is attributable to the dangerous convergence between an Airbus A320 on its take-off roll on concrete runway 05 and a Cessna C525 which had crossed the CAT I runway holding position of taxiway Z without clearance.

Factors contributing to the runway incursion:

- lack of a hot spot indicating the danger of a concrete runway 05 incursion at taxiway Z;
- lack of situational awareness of the flight crew of N990FV;
- lack of vigilance of the GND controller;
- lack of a stop bar at runway holding position CAT I on taxiway Z;
- air traffic control operational procedures not adapted to the risk of a runway incursion for aircraft taxiing from the north apron.

4 Safety recommendations, safety advices and measures taken since the accident

Safety recommendations

According to the provisions of Annex 13 of the International Civil Aviation Organization (ICAO) and Article 17 of Regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC, 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 Safety Investigation of Transport Incidents (OSITI):

„Art. 48 Safety recommendations

¹ The STSB shall submit the safety recommendations to the competent federal office and notify the competent department of the recommendations. In the case of urgent safety issues, it shall notify the competent department immediately. It may send comments to the competent department on the implementation reports issued by the federal office.

² The federal offices shall report to the STSB and the competent department periodically on the implementation of the recommendations or on the reasons why they have decided not to take measures.

³ The competent department may apply to the competent federal office to implement recommendations.”

The STSB shall publish the answers of the relevant Federal Office or foreign supervisory authorities at www.stsb.admin.ch in order to provide an overview of the current implementation status of the relevant safety recommendation.

Safety advices

The STSB may publish safety advices in response to any safety deficit identified during the investigation. Safety advices shall be formulated if a safety recommendation in accordance with Regulation (EU) No. 996/2010 does not appear to be appropriate, is not formally possible, or if the less prescriptive form of a safety advices is likely to have a greater effect. The legal basis for STSB safety advices can be found in Article 56 of the OSITI:

“Art. 56 Information on accident prevention

The STSB may prepare and publish general information on accident prevention.”

4.1 Safety recommendations

4.1.1 Runway holding position CAT I Z

4.1.1.1 Safety deficit

Cleared to taxi to holding bay Z, the flight crew of a Cessna Citation C525 crossed the CAT I runway holding position of concrete runway 05 without clearance. The aircraft stopped approximately 15 m from the edge of the runway and was in converging conflict with an Airbus A320 on its take-off roll.

On taxiway Z, the CAT I runway holding position is not blocked by a stop bar the red lights of which indicate to pilots an absolute boundary which must not be crossed. The risk of runway incursion is identified and was, moreover, signalled in

advance by a hot spot on the aerodrome charts. On several occasions, incursions onto runway 23-05 have occurred and were the subject of safety recommendation no. 358.

In the "5.3.20 Stop bars" section of volume I of Annex 14 to the International Civil Aviation Convention entitled "Aerodrome - Design and technical operation of aerodromes", note 2 stipulates: "*Runway incursions may take place in all visibility or weather conditions. The provision of stop bars at runway- holding positions and their use at night and in visibility conditions greater than 550 m runway visual range can form part of effective runway incursion prevention measures.*". At the world symposium on runway safety held at the headquarters of the ICAO from 24 to 26 May 2011, the use of stop bars in accordance with Annex 14 was encouraged, even in the case of good visibility.

The serious incidents which motivated safety recommendation no. 358, and the serious incident which is the subject of this report, reveal that a runway incursion at taxiway Z remains sufficiently probable for preventive measures to be taken. The installation of a stop bar constitutes one of them.

4.1.1.2 Safety recommendation no. 358

The STSB reiterates safety recommendation no. 358 :

"The Federal Office of Civil Aviation should demand that all the intersections and runway thresholds be equipped with stop bars and that these be activated in any weather conditions whatever during the airport's hours of activity."

4.1.2 Intersection of taxiway Z with concrete runway 05

4.1.2.1 Safety deficit

The flight crew of a Cessna Citation C525, cleared to taxi to holding bay Z, crossed the CAT I runway holding position of concrete runway 05 without clearance. The aircraft stopped approximately 15 m from the edge of the runway and was in converging conflict with an Airbus A320 on its take-off roll.

The intersection of taxiway Z with concrete runway 05 is identified as a location at risk of a runway incursion. In order to attract pilots' attention, it was previously indicated on the aerodrome charts by a hot spot.

The serious incident which is the subject of this report reveals that a runway incursion at taxiway Z remains sufficiently probable for preventive measures to be taken.

4.1.2.2 Safety recommendation no 549

The Federal Office of Civil Aviation should ensure that the risk of a runway incursion at the intersection of taxiway Z with concrete runway 05 is indicated on the aerodrome charts.

4.1.3 Air traffic control operational procedures

4.1.3.1 Safety deficit

The flight crew of a Cessna Citation C525, cleared to taxi to holding bay Z, crossed the CAT I runway holding position of concrete runway 05 without clearance. The aircraft stopped approximately 15 m from the edge of the runway and came into conflict with an Airbus A320 on its take-off roll.

The intersection of taxiway Z with concrete runway 05 is identified as a location at risk of a runway incursion. When he clears an aircraft to taxi towards the CAT I or Cat II holding points or holding bay Z, the GND controller should therefore be

obliged systematically to indicate to pilots that they must wait short of this runway by means of the instruction “HOLD SHORT OF RUNWAY (position)”.

4.1.3.2 Safety recommendation no 550

The Federal Office of Civil Aviation should ensure the air traffic operational control procedures take into account the identified risk of a runway incursion at the intersection of taxiway Z with concrete runway 05.

4.1.4 RIMCAS safety net

4.1.4.1 Safety deficit

The flight crew of a Cessna Citation C525, cleared to taxi to holding bay Z, crossed the CAT I runway holding position of concrete runway 05 without clearance. The aircraft stopped approximately 15 m from the edge of the runway and was in converging conflict with an Airbus A320 on its take-off roll.

On taxiway Z, in good visibility operational condition, the runway's protected area is delimited by the CAT I runway holding position. The RIMCAS warning was generated when the Cessna C525 had passed this point by approximately 12 m.

The aural “RIMCAS” warning indicated the runway incursion though did not draw the attention of the GND and ADC controllers who were managing ordinary traffic situations: the RIMCAS system therefore did not play its role of a safety net.

4.1.4.2 Safety recommendation no 551

The Federal Office of Civil Aviation should ensure that the RIMCAS safety net is parameterised so that it generates an alarm which is perceptible in weather conditions other than those of reduced visibility.

4.2 Safety advices

None

4.3 Measures taken after the serious incident

4.3.1 RIMCAS safety net

On 2 November 2016, Skyguide modified the parameters of the RIMCAS safety net so that a warning is generated when a moving vehicle crosses runway holding position CAT I Z.

Berne, 14 January 2020

Swiss Transportation Safety Investigation Board