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Swiss Transportation Safety investigation Board STSB

Aviation Division

Final Report No. 2215

by the Swiss Transportation Safety investigation Board STSB

concerning the serious incident involving
the B737-400 aircraft, registration TC-TLE

on 11 October 2013

at Zurich Airport

Ursachen

Der schwere Vorfall ist darauf zurückzuführen, dass die Flugbesatzung nicht den grünen *centreline lights* folgte, in der Folge das Flugzeug den Hartbelag verliess und im angrenzenden weichen Untergrund zum Stillstand kam.

Die folgenden Faktoren haben zur Entstehung des schweren Vorfalls beigetragen:

- Die Rollanweisung enthielt keine Angaben über die zu benutzende Enteiserstrasse zum Überqueren der Enteiserfläche.
- Die Enteiserstrassen waren nicht mit einer Rollwegrandbefeuerung ausgerüstet.

Die Tatsache, dass die Grasflächen zwischen den Enteiserstrassen bei Dunkelheit und nasser Oberfläche nur schwer erkennbar waren, hat die Entstehung des schweren Vorfalls begünstigt.

General information on this report

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

In accordance with Article 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 German language.

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

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

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Final Report

Synopsis

Owner	Gamit Ltd. S.A.L. (Off Shore), Downtown, Capitol Building, Plot No.: 45/1365, Port Beirut, Lebanon
Operator	Tailwind Havayollari A.S., IDTM. A2. Block No. 395 Kat-13 Yesilköy, Istanbul, Turkey
Manufacturer	Boeing Commercial Airplanes, P.O. Box 3707, Seattle, Washington 98124, USA
Aircraft type	B737-400
Country of registration	Turkey
Registration	TC-TLE
Flight plan call sign	TWI 327
Radio call sign	Tailwind three two seven
Location	Zurich Airport
Date and time	11 October 2013, 04:41 UTC

Investigation

The serious incident occurred on 11 October 2013 at 04:41 UTC. The notification was received at 05:16 UTC. The investigation was opened at the incident location on the same day at 06:20 UTC by the former Swiss Accident Investigation Board (SAIB) in collaboration with the Zurich cantonal police. The SAIB informed the United States of America and Turkey about the serious incident. These two states each nominated an authorised representative, who assisted with the investigation.

The present final report will be published by the Swiss Transportation Safety investigation Board (STSB).

Summary

After an uneventful landing, a Boeing 737-400 aircraft operated by Tailwind, registration TC-TLE, was taxiing from runway 34 to taxiway E3 at Zurich Airport. The runways and taxiways were wet and nighttime conditions prevailed. On 11 October at 04:40:40 UTC, the flight crew received the following instruction from the Zurich Apron ground movement manager: *"Tailwind three two seven good morning taxi via Foxtrot and Charlie to stand Echo two six."* The crew immediately acknowledged this instruction.

A few metres after the aircraft had passed the turn-off for de-icing lane F2 on taxiway F, a mound of earth to the south of the commander made him feel uncertain and he turned to the right in order to cross the de-icing pad (DIP) F and join taxiway F south of it. After this 55 degree turn to the right the aircraft left the hard surface of taxiway F3 and came to a standstill on the grass triangle between de-icing lanes F2 and F3 and de-icing pad F. The aircraft could no longer move under its own power.

The airport fire brigade was alerted and the passengers were able to exit the front right door of the aircraft via the ramp stairs provided. No crew members or passengers were injured.

Causes

The serious incident is attributable to the fact that the flight crew did not follow the green centre line lights. Subsequently the aircraft left the hard surface and came to a standstill in the adjacent soft ground.

The following factors contributed to the occurrence of the serious incident:

- The taxi clearance contained no information regarding which de-icing-lane to follow when crossing de-icing pad.
- The de-icing lanes were not equipped with taxiway edge lights.

The fact that the grass areas between the de-icing lanes were almost impossible to detect in the dark and when the surface was wet promoted the occurrence of the serious incident.

Safety recommendations

In the context of the investigation, one safety recommendation was issued.

1 Factual information

1.1 Prehistory and history of the flight

1.1.1 General

For the following description of the prehistory and history of the flight, the statements of the crew members, the recordings of the radio communication, the cockpit voice recorder (CVR) and flight data recorder (FDR), the entries in the alarm journal of the Zurich Airport Authority and the airport fire brigade (*Schutz und Rettung Zürich*), as well as air traffic control's radar data were used.

The flight concerned was a charter flight from Antalya (LTAI) to Zurich (LSZH) under instrument flight rules (IFR). For the entire flight the copilot was pilot flying (PF) and the commander was pilot not flying (PNF).

No technical restrictions or air traffic control restrictions applied.

1.1.2 Prehistory

On 11 October 2013 at 00:30 UTC, the cockpit and cabin crew reported for flight preparations at the aviation operator. The cockpit crew studied the documentation which had been prepared for them. This included a so called "notice to airmen" (NOTAM), which contained the following information for Zurich Airport (LSZH) [bold printing in the original]:

"(A0577/13)

*+ TWY^[1] F WITH DEICING PAD LANE F1 CLOSED BTN LINK 6 AND 7 DUE TO WIP.
TAX VIA TWY F2 AND F3 AVBL. AEREA MARKED AND LGTD.

FROM: 10 OCT 2013 17:37 **TO:** 11 OCT 2013 04:00

(A578/13)

*+ TWY E CLOSED BTN LINK 6 AND LINK 7 DUE TO WIP. AREA MARKED AND LGTD.

FROM: 10 OCT 2013 17:40 **TO:** 11 OCT 2013 04:00

(A0579/13)

*+ RWY^[2] 34 EXIT TWY E4 CLSD.

FROM: 10 OCT 2013 17:42 **TO:** 11 OCT 2013 04:00"

Notes on this flight documentation indicate that this information was acknowledged.

The estimated time of arrival in LSZH was indicated on the operational flight plan (OFP) as 05:00 UTC.

1.1.3 History of the flight

The B737-400 aircraft, registration TC-TLE, departed Antalya (LTAI) at 01:28 UTC on 11 October 2013 on a charter flight to Zurich (LSZH). On board the aircraft, flight plan call sign TWI 327 and radio call sign "*Tailwind three two seven*", there were two pilots, four flight attendants and 160 passengers.

After an uneventful flight the crew received after landing on runway 34 from the air traffic control officer (ATCO) of Zurich Airport Aerodrome Control Tower (TWR) at 04:39:49 UTC the instruction to exit the runway via taxiway (TWY) E3. At this moment the aircraft was rolling past the intersection of taxiway E4 at a groundspeed (GS) of 62 knots (kt). The GS indicated on the ATCO's Swiss Airport Movement Area Control System (SAMAX) screen was 65 kt. The runways and taxiways were wet and nighttime conditions prevailed. The crew immediately confirmed this taxi

¹ TWY: taxiway

² RWY: runway

instruction and reported as follows at 04:40:17 UTC: *"Tailwind three two seven, runway vacated"*. The aircraft had just vacated the runway and was taxiing onto taxiway E3 at a GS of 14 kt. The ATCO thanked them for this information and instructed the crew to change to the Zurich Apron frequency at 04:40:21 UTC.

A little later the crew reported to the Zurich Apron ground movement manager (GMMA) and immediately received the following taxi instruction at 04:40:40 UTC: *"Tailwind three two seven good morning, taxi via Foxtrot and Charlie to stand Echo two six."* At this time the aircraft was taxiing at the intersection of taxiway E3 and taxiway E (see Annex 1) at a GS of 12 kt. The crew confirmed this taxi instruction at 04:40:47 UTC with: *"Via Foxtrot Charlie, er, to stand Echo two six thank you three two seven."* The commander then steered the aircraft from TWY E to TWY F (cf. Annex 2) following the taxiway signs and subsequently taxied past de-icing lanes F1 and F2. The average GS was appropriately 10 kt.

According to his statement, the commander saw the mound of earth south of de-icing pad (DIP) F at the same time as the aircraft passed the centre line lights for de-icing lane F2.

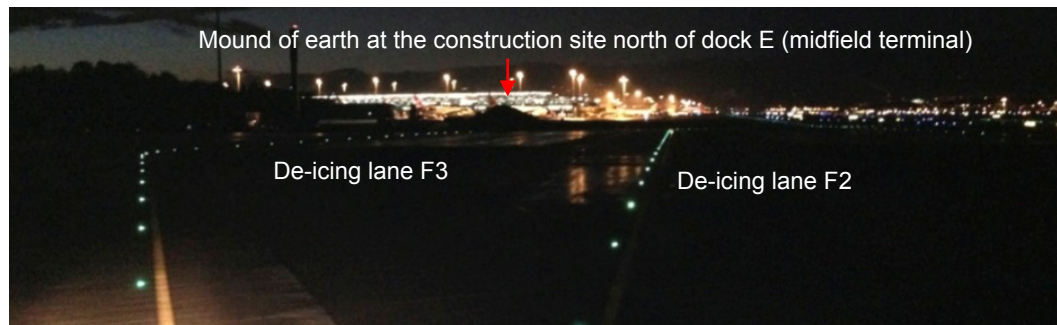


Figure 1: View from the cockpit when passing the green centre line lights for de-icing lane F2

Since he was not sure whether this would restrict the taxi clearance, he decided to turn right and cross the DIP F in order to join taxiway F south of it. At this moment the aircraft was at a location level with the left taxiway edge of de-icing lane F2 (cf. Annex 3). The commander recalled this as follows: *"When I saw the sand-hill at the beginning of F3 I turned to the right earlier for joining F-TWY to be on the safe side. I was informing the F/O about my intention; both of us could not see any grass area in between F3 and F2."*

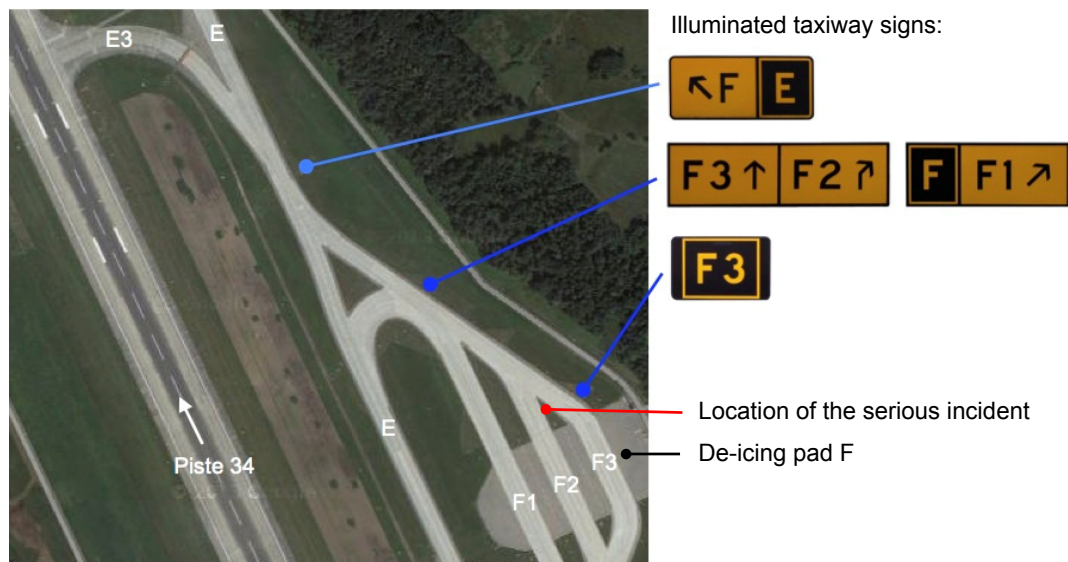


Figure 2: On de-icing pad F, north of dock E (midfield terminal), are three de-icing lanes (F1, F2 and F3).³

At 04:41:59 UTC, the commander initiated a right turn at a GS of 9 KT and after turning 55 degrees onto a southerly heading, the aircraft came to a standstill on the soft ground of the grass triangle between de-icing lanes F2 and F3 and DIP F at 04:42:12 UTC. Shortly before, the commander had attempted to counteract the decreasing speed and a few seconds before coming to a standstill, attempted to increase the thrust of the two engines. During the next 45 seconds, he twice increased the turbine rotation speed to over 80 % N1 (cf. Annex 4). As the aircraft did not move, the commander subsequently reduced power to idle thrust again.

The GMMA saw on his SAMAX screen that the aircraft was no longer moving and called the crew at 04:42:38 UTC with the following query: *"Tailwind three two seven?"* As he received no reply he made the following additional enquiry at 04:42:56 UTC: *"Tailwind three two seven are you able to continue, you are on de-icing lane Foxtrot two?"* The crew responded immediately at 04:43:03 UTC as follows: *"yes, er, I think we are, er, we need push back, er, for about..."* Ten seconds later the GMMA replied that he would send a push-back tractor.

At 04:43:10 UTC the commander again attempted to move the plane forward using the engine thrust. During the following 20 seconds he again increased the power of the two engines to over 80 % N1, however without success.

At 04:45:53 UTC the crew reported to the GMMA as follows: *"Tailwind three two seven we are waiting for the push back, er, we are ..."*. The 'push to talk' button was held down for a further five seconds without the crew providing more information. Only one and a half minutes later did the crew call the GMMA again and enquire about the push-back tractor. The GMMA immediately responded at 04:47:39 UTC as follows: *"Yes, there is the airport authority on the way and push-back truck is coming as well, needs a bit time, they are not so fast"*, whereupon the crew thanked him for this information.

After the commander had opened the window on his side to familiarise himself with the position of the aircraft, he increased the turbine rotation speed one last time to over 70 % N1 at 04:49:38 UTC in order to move the aircraft under its own power

³ As a general rule the designation "de-icing lane" (F1, F2 and F3) only applies to the section within de-icing pad F. The continuations of the de-icing lanes north and south of DIP F do not have any official designation. For reasons of clarity these continuations will be designated in the same way as the corresponding de-icing lanes in the present final report.

(cf. Annex 4). As the attempt was unsuccessful, he again reduced power to idle thrust. The commander then informed the passengers (first in Turkish and then in English) that they would have to wait in the current position for five to ten minutes before they could taxi to their stand.

The commander discussed the situation with the copilot and the senior cabin crew member (SCCM) and one and a half minutes later informed the passengers again in Turkish and English that they would have to wait a little longer in the current position.

In the meantime, the responsible airport manager (AM) had arrived at the incident location and at 04:53 UTC made contact with the commander, who had opened the cockpit window. Prior contact via the interphone was not possible to establish. When asked by the AM whether he could move the aircraft forward, the commander replied at 04:57:40 UTC that he did not believe it possible as he had tried twice unsuccessfully. The commander and the AM agreed to turn off the engines and continue to run the auxiliary power unit (APU) to supply power and air.

Meanwhile, the crew had made contact with the cabin crew member (CCM) in the rear galley, whereupon she asked the passengers in Turkish and German to remain seated and keep their seatbelts fastened until the corresponding signs were turned off.

At 04:58:02 UTC the commander asked the AM whether the passengers could exit the aircraft at its current location. The latter replied shortly afterwards that it was possible, but that he would have to wait until the fire brigade arrived.

During this conversation the airport authority informed the control room at 04:59 UTC and "Alarm 21"⁴ was raised.

The push-back tractor arrived at the aircraft at 05:10 UTC. After it was established that it was not possible to push the aircraft back onto the taxiway, the airport authority organised passenger buses. At the same time the AM informed the crew that they could prepare the passengers for exiting with hand luggage.

After the SCCM received the information from the commander that the passengers could exit via the front door of the aircraft and via the ramp stairs that had been provided in the meantime, the SCCM gave the following command at 05:11:43 UTC: *"cabin crew slides disarm and cross-check."* According to her statement, the passengers were then provided with the standard information and were instructed to exit the plane via the front right door.

At 05:41 UTC the passenger buses arrived and the passengers were able to exit the aircraft. The luggage was also unloaded at the incident location and transported to the airport terminal. No passengers or crew members were injured.

At 10:25 UTC, "Alarm 21" was cancelled.

1.1.4 Location and time of the serious incident

Location	Zurich Airport, between de-icing lanes F2 and F3 and de-icing pad F
Date and time	11 October 2013, 04:41 UTC
Lighting conditions	Night

⁴ "Alarm 21" means that the landing will take place within the next 15 minutes and the crew has to get in their vehicles and drive to the stand-by locations.

1.2 Injuries to persons**1.2.1 Injured persons**

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	6	160	166	Not applicable
Total	6	160	166	0

1.3 Damage to aircraft

The aircraft was not damaged.

1.4 Other damage

There was minor crop damage.

1.5 Personnel information**1.5.1 Flight crew****1.5.1.1 Commander****1.5.1.1.1 General**

Person

Turkish citizen, born 1952

Licence

Airline transport pilot licence aeroplane – ATPL(A) according to Joint Aviation Requirements (JAR), issued by the Republic of Turkey, Ministry of Transport, Directorate General of Civil Aviation

All available evidence suggests that the commander started duty well-rested and in good health. There are no indications that fatigue played a role.

1.5.1.1.2 Flying experience

Total	19 333:15 hours
on the type involved in the incident	11 822:10 hours
during the last 90 days	272:10 hours
of which on the type involved in the incident	272:10 hours

1.5.1.1.3 Additional Information

The commander stated that they had approached Zurich Airport several times before.

1.5.1.2 Copilot

1.5.1.2.1 General

Person	Turkish citizen, born 1969
Licence	ATPL(A) according to JAR, issued by the Republic of Turkey, Ministry of Transport, Directorate General of Civil Aviation

All available evidence suggests that the copilot started duty well-rested and in good health. There are no indications that fatigue played a role.

1.5.1.2.2 Flying experience

Total	3021:45 hours
on the type involved in the incident	2422:45 hours
during the last 90 days	253:50 hours
of which on the type involved in the incident	253:50 hours

1.5.1.2.3 Additional Information

The copilot stated that they had approached Zurich Airport several times before.

1.5.2 Apron control officer

Function	Ground movement manager (GMMA)
Person	Swiss citizen, born 1984
Licence	GMMA licence, issued by the Federal Office of Civil Aviation (FOCA)
	Language proficiency: English level 5

All available evidence suggests that the apron control officer started duty well-rested and in good health. There are no indications that fatigue played a role.

1.6 Aircraft information

1.6.1 General information

Registration	TC-TLE
Aircraft type	B737-400
Characteristics	Twin-jet short-haul and medium-haul commercial aircraft
Manufacturer	Boeing Commercial Airplanes, P.O. Box 3707, Seattle, Washington 98124, USA
Owner	Gamit Ltd. S.A.L. (Off Shore), Downtown, Capitol Building, Plot No.: 45/1365, Port Beirut, Lebanon
Operator	Tailwind Havayollari A.S., IDTM. A2. Block No. 395 Kat-13 Yesilköy, Istanbul, Turkey
Engines	2 CFM56-3C1 jet engines

Mass and centre of gravity

Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM).

1.6.2 Nosewheel steering

The nosewheel steering on the aircraft type involved in the serious incident can only be operated from the left seat. As on this flight the copilot was acting as PF and the commander as PNF, a handover of controls was necessary after landing in order to taxi to the parking position.

1.7 Meteorological information

1.7.1 General meteorological situation

In the wake of a pronounced depression the previous day, a defined low remained over large parts of France and Switzerland.

1.7.2 Weather at the time of the serious incident

After rain during the night, dry weather temporarily prevailed in the early hours of the morning. The runways and taxiways were still wet. The sky was overcast and the ground winds were light.

Wind Variable at 2 kt

Visibility 10 km or more

Cloud 1/8-2/8 700 ft above aerodrome level (AAL)
3/8-4/8 1100 ft AAL
5/8-7/8 1800 ft AAL

Temperature/dewpoint 5 °C / 4 °C

Atmospheric pressure 1011 hPa
QNH (LSZH)

1.7.3 Astronomical information

Lighting conditions Night

1.7.4 Webcam recording

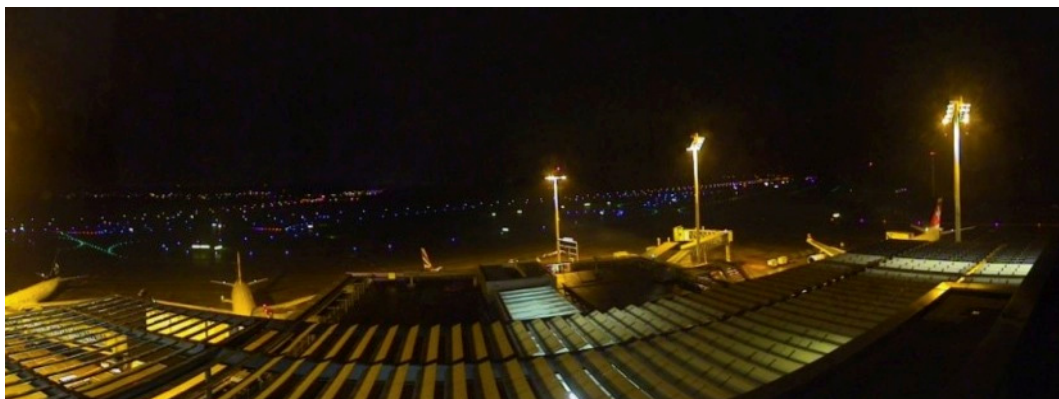


Figure 3: Webcam image from the roof of dock E (midfield terminal) of Zurich Airport at 04:30 UTC, looking north-west

1.8 Aids to navigation

Not applicable

1.9 Communications

Radio communication between the flight crew and Apron Control took place appropriately and without any difficulties. The language of communication was English.

1.10 Aerodrome information

1.10.1 General

Zurich Airport is in north-east Switzerland. In 2012 it handled a traffic volume of approximately 270 000 movements, with 24.8 million passengers.

The reference elevation of the airport is 1416 ft AMSL and the reference temperature is 24.0 °C.

1.10.2 Runways

The Zurich Airport runways have the following dimensions:

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

Due to the implementing regulations of the Air Traffic Ordinance (*Durchführungsverordnung zur Luftverkehrsordnung – DVO*), runway 34 was designated for landings and runway 32 for take-offs at Zurich Airport at the time of the serious incident (cf. chapter 1.17.2). It was possible to use the full landing distance available (3230 m) for landings on runway 34.

1.10.3 Specific factor

At the time of the serious incident construction work was underway with major earthworks for the creation of a new "Echo North" parking area between de-icing pad F and dock E (midfield terminal). There were therefore large mounds of earth up to 12 metres high in this area (cf. Annex 5). This construction did not result in any taxiing restrictions on TWY F or de-icing lanes F1, F2 or F3.

1.10.4 Responsibility for taxiways

Traffic management is divided into different areas of responsibility. The runways and occasionally taxiways fall under the area of responsibility of skyguide, while the apron and virtually all taxiways fall under the area of responsibility of Zurich Apron. Apron control management divides this into two parts: Apron North and Apron South (cf. Section 1.17.2).

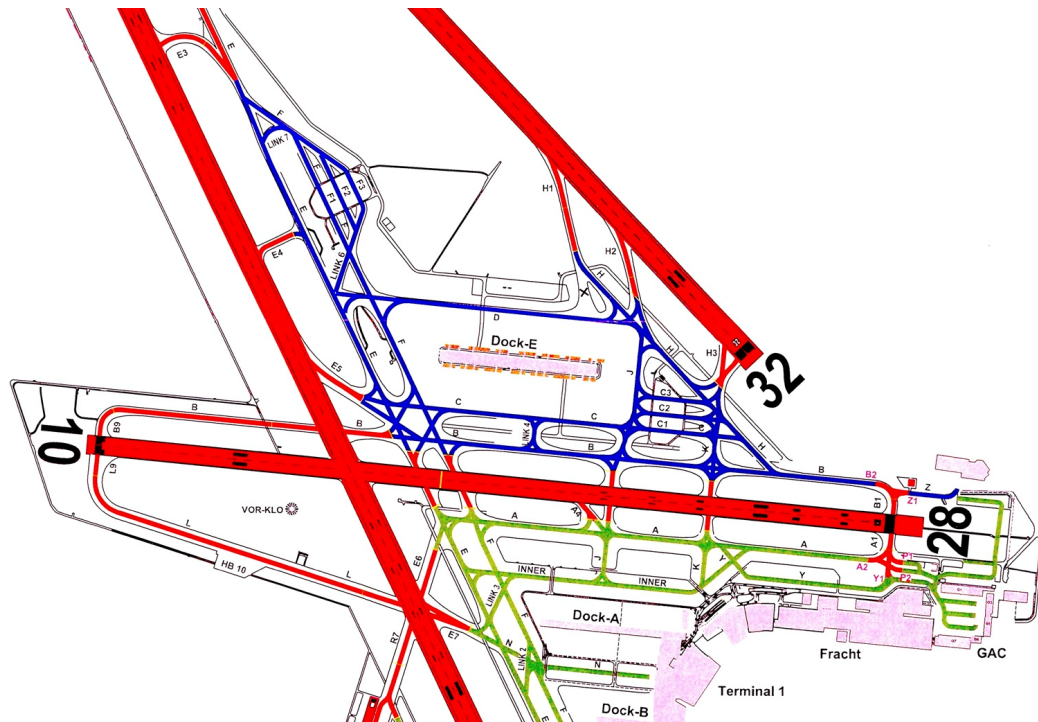


Figure 4: traffic management area skyguide (red), Apron North (blue) and Apron South (green)

1.10.5 Changes to runway designations

According to Flughafen Zürich AG, after the 5th construction phase at Zurich Airport it became clear that there was also need for action in the north of the airport during discussions concerning the taxiway signs in the south (dual taxiway dock B). In 2010 corresponding planning work commenced under the title *"Concept for taxiway designation LSZH 2011 - Implementation 2012"*. Part of this concept was the designation of taxiways surrounding de-icing pad (DIP) F on Apron North, north of dock E (midfield terminal). This consisted of three de-icing lanes with strips of grass between them (cf. Figure 2 chapter 1.1.3). Neither taxiway F nor the individual de-icing lanes were equipped with blue taxiway edge lights⁵ and the centre line lights of all three de-icing lanes were simultaneously and identically illuminated. Furthermore, the bearing strength of the ground surface is only guaranteed for aircraft along de-icing lanes F1, F2, F3, i.e. within the de-icing pad aircraft can only move within these de-icing lanes. The development of this concept involved not only airport partners, but also representatives of the aircraft operators and air traffic control. Representatives of the FOCA were also included as observers from the outset.

With regard to DIP F, a change of designation of the taxiways and de-icing lanes was considered useful, similarly to de-icing pad C in the south-east of the midfield terminal and north of runway 28. The change provided amongst others the following:

⁵ Annex 14 of the ICAO, Section 5.3.17.1 (and with introduction of AMDT 11-A in November 2013 accordingly in chapter 5.3.18.1) states the following: "Taxiway edge lights shall be provided at the edges of a runway turn pad, holding bay, de-icing/anti-icing facility, apron, etc., intended for use at night and on taxiway not provided with taxiway centre line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means."

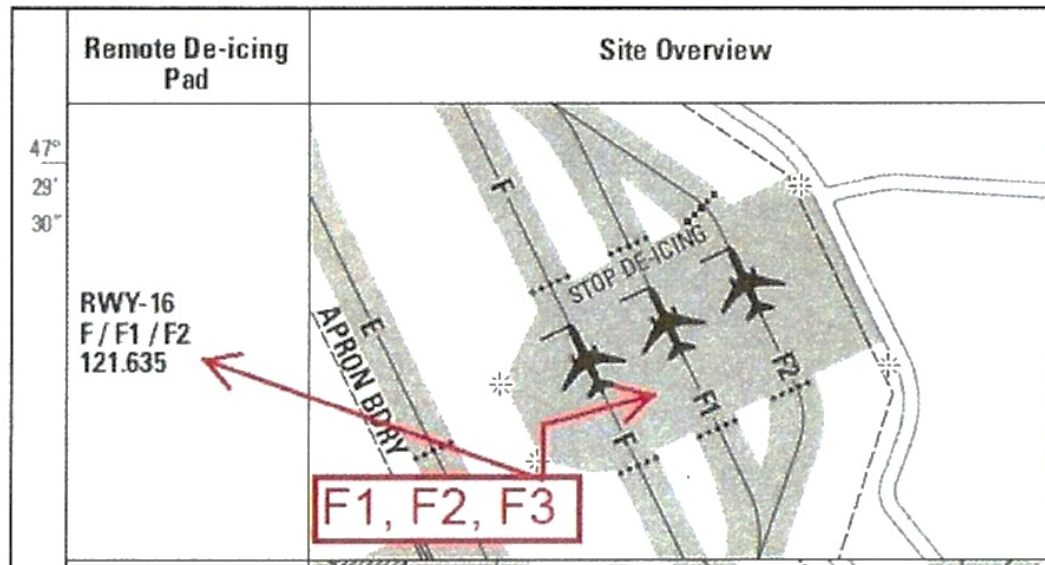


Figure 5: Detail from the taxiway designation concept LSZH 2011, Version 5 April 2012, as commissioned on 22 August 2013 (cf. Figure 2 chapter 1.1.3).
The de-icing lanes have red crossbar lights on the northern and southern edges of the de-icing pad. The purpose of this is to improve taxiing traffic control when de-icing the aircraft.

Due to lack of guidelines on the part of the International Civil Aviation Organization (ICAO) the proposed changes were subjected to a safety assessment and a corresponding report. In it the individual changes were assessed according to the criteria of hazard/cause, event, frequency class, frequency, severity class and risk level, and appropriate measures with regard to comments adhered to.

The following was noted with regards to the TWY F designation in the safety assessment report of 9 February 2011 [translated from German]:

<i>Hazard/cause:</i>	<i>Used as both a taxiway and de-icing lane in the winter. Signs for F remain, no additional designation F1 as provided for lanes F2/F3. Published in the chart as F1.</i>
<i>Event:</i>	<i>Pilot possibly confused, as he is looking for F1, asks via radio. Radio congestion. Congestion on the DIP.</i>
<i>Frequency class:</i>	<i>5 (frequent)</i>
<i>Severity class:</i>	<i>D (low)</i>
<i>Severity:</i>	<i>Low</i>
<i>Risk:</i>	<i>Tolerable</i>
<i>Measures/ comments:</i>	<i>As recommended no additional risk or deterioration as regards the previous designation. Measure: Possibly less confusion if de-icing-lane F is published on the chart without reference to F1.</i>

The following was recorded for designation F1 [translated from German]:

<i>Hazard/cause:</i>	<i>Used as both a taxiway and de-icing lane in the winter. Signs for TWY Section F will be changed to lane F1 and the previous lane F1/F2 will become newly F2/F3. These changes will also published on the chart.</i>
<i>Event:</i>	<i>Pilot possibly confused, as in normal operation (no de-icing) TWY F is interrupted by the sign for lane F1. Queries</i>

from crews unfamiliar with the area can lead to radio congestion, unnecessary stops and congestion on the DIP.

In de-icing operation, however, the designation F1/F2/F3 is clearer.

Frequency class: 4 (occasional)

Severity class: D (low)

Severity: Low

Risk: Tolerable

Measures/ comments: There are several other locations at the airport as well where a yellow line merges seamlessly into another (Alpha Inner Yankee, Foxtrot Mike, November-E7). This presents little to no comprehension problems with voice clearance. For example, when crews on exit D17 receive clearance to "turn right, taxi via link 1, F, inner to HP [holding point] A1", they rarely enquire whether they can taxi via Echo or Alpha, which are not mentioned in the clearance.

This is also to be expected for TWY Foxtrot - (F1) - Delta - Echo.

Only the following was noted in relation to the existing designation F2:

Hazard/cause: No hazards. New lane designation provides more clarity with F2/F3.

In the same safety assessment report, Flughafen Zürich AG's self-assessment included amongst others the following [translated from German]:

"From the perspective of the airspace user it was pointed out that the voice, respectively the clearance in the case of the new designation of DIPs, links as well as new TWY sections and holding points must be clear. From the perspective of Apron Control, this is ensured. The designations should not cause confusion and few or no queries from the flight crews regarding clearance can be expected"

The airport representatives as well as the GMMA involved responded to the question as to which de-icing lane a pilot who had received taxi instruction with only the designation taxiway F would use to cross the de-icing pad with the answer "via F1". They based it on the evidence that the most direct and hence shortest link between the respective segments of taxiway F north and south of DIP F was via *de-icing lane F1*.

The "Concept for taxiway designation LSZH 2011 - Implementation 2012" was subjected to an "aviation audit" by the FOCA. The resulting report, dated 20 July 2012, specified the following [translated from German]:

"The FOCA was already involved as an 'observer' in the decision-making process in the context of development in the 'New taxiway designations working group'."

Section 4 De-icing pads, paragraph b) De-icing pad F of this aviation audit also stipulated the following [translated from German]:

"The taxiway section F1 along the de-icing pad should be referred to as such both in publications and on signs on the field. Although the other proposal for a continuous taxiway F and F2 / F3 for the de-icing lanes, which was discussed and partially documented, was considered, the first proposal was considered better. This

was also assessed accordingly in the safety assessment and classified as within the tolerable range.

This implementation means that certain hazards still exist with regard to inconsistent signage and instructions to pilots by Apron Control.

The signs are provided correctly, markers will not be required.

ORDINANCE [red in original] *The situation in the case of de-icing pad F is to be reanalysed based on the operating procedure after a winter season with the new designations. The analysis is to be submitted to the FOCA for examination by 30 April 2014 at the latest. The FOCA reserves the right, based on the experiences and results of the analysis gathered to date, to prescribe the most suitable measures for mitigating the situation."*

1.10.6 Rescue and fire-fighting services

Zurich Airport is equipped with Category 10 fire-fighting resources. The airport's professional fire brigade is on permanent standby duty during flight operations.

1.11 Flight recorders

1.11.1 Flight data recorder

Type	F1000
Manufacturer	Fairchild Aviation Recorders, Sarasota, Florida, USA
Number of parameters	460
Recording medium	Solid state memory
Duration of recording	approx. 100 hours

It was possible to evaluate the flight data recorder and all available data was at the disposal of the investigation.

1.11.2 Cockpit voice recorder

Type	FA2100
Manufacturer	L3 Communications, Sarasota, Florida, USA
Number of parameters	4 channels
Recording medium	Solid state memory
Duration of recording	30 minutes

It was possible to evaluate three out of four channels of the cockpit voice recorder (CVR) and these were at the disposal of the investigation.

1.12 Wreckage and impact information

1.12.1 Location of the serious incident

Grass triangle between de-icing lanes F2 and F3 and de-icing pad (DIP) F (cf. Figure 2, chapter 1.1.3 and Annex 6).

1.12.2 Impact

There was no impact. The aircraft came to a standstill with the nosewheel off the grass triangle. However, the main landing gear remained sunk in the soft ground and the aircraft was not able to move under its own power (cf. Annex 6).

1.12.3 Wreckage

The aircraft was not damaged. During the course of the morning eight tons of fuel were defueled from aircraft TC-TLE and the recovery began at 11:10 UTC. In order to return the aircraft to the hard surface, the soil behind the main landing gear had to be removed. A hard surface was then created using gravel and sheet metal panels, which allowed the aircraft to be pushed back onto TWY F (cf. Annex 7) using a towbar.

1.13 Medical and pathological information

Following the serious incident, both crew members were subjected to a breathalyzer test. No traces of alcohol were found in either of the crew members.

1.14 Fire

Fire did not break out.

1.15 Survival aspects

Not applicable

1.16 Tests and research

None.

1.17 Organisational and management information

1.17.1 General

Traffic management at Zurich Airport is the responsibility of the Operations Division. In this Division, one of four at Flughafen Zürich AG, the "Flight Operations" position within the "Airport Operations" department is responsible. It adhered to the rules and responsibilities for Apron Control in the corresponding documentation.

1.17.2 Apron Control

The ground movement manager (GMMA) working positions are located one floor below the air traffic control officer's (ATCO) working positions of the Aerodrome Control Center in the control tower at Zurich Airport. The workstations are similarly equipped to those of the ATCOs (cf. Annex 8).

As mentioned in chapter 1.10.2, runway 34 was in operation for landings at Zurich Airport at the time of the serious incident. In corresponding instructions there are eight different methods and corresponding conditions published under the title "*Traffic Management for Apron North and Apron South*". The OPS Manual defines the appropriate procedure at the time of the serious incident as follows [translated from German; bold in original]:

"4. DVO ↓ RWY 34 ↑ RWY 32 ↑ RWY 34 ↑ RWY 28

Runway crossings from RWY 28 to TWY A into TWY B and vice versa must be coordinated by telephone.

All other TWYs may be used for crossings without coordination.

Crossing RWY 34 from R7-E6 is only permitted with a marshaller.

↓ RWY 34

Exits TWY B and E5 including the associated section TWY E to RWY 28 are within skyguide's area of responsibility.

If there is an aircraft on ILS⁶ 34, a "heavy" category aircraft (self-powered or towed) may neither cross RWY 34 via R8 nor line up.

↑ RWY 34

From the W stands, GAC⁷ 7-9:

Transfer points to TWR must be coordinated."

This method, which is described in Section 4, allocated landings and take-offs on runway 34 as well as take-offs on runways 32 and 28.

As mentioned in chapter 1.10.3, Zurich Apron was responsible for traffic management on the apron and practically all taxiways. The corresponding process requirements for the ground movement managers (GMMAs) are recorded in the OPS manual.

The operating instructions for Apron Control specify amongst others the following under Item 5.2 'Aircraft management' [translated from German]:

"Taxi clearance must necessarily include the taxiways to be used when the route is unclear, if several route options exist or if the traffic situation so requires.

Taxi clearance must not include the taxiways to be used if the route is clear."

Section 5.3 'Incoming aircraft' also specifies amongst others the following [translated from German]:

"Incoming aircraft should taxi to their assigned stand independently in accordance with the clearance issued by Apron Control. If the flight crew realise that it is not possible to taxi to the allocated stand, they must stop the aircraft and inform Apron Control immediately."

The "Principle and framework" section of corresponding instructions specifies, as published under the title "Traffic Management for Apron North and Apron South", that Apron North and Apron South must coordinate taxiing traffic which affects both aprons. The following is also specified with respect to traffic management on Apron North (AN) [translated from German]:

"AN may manage traffic as it sees fit within the area of responsibility of Apron North."

The GMMAs must also consider the following during management:

"Keeping runways free has first priority. Newly arrived traffic entering the apron from the runway has therefore priority over other taxiing traffic."

Under these conditions, southbound traffic taxiing on TWY E is generally directed as quickly as possible onto TWY F in order to keep TWY E clear for landing aircraft, which vacate runway 34 via TWY E4, E5 or B.

1.18 Additional information

1.18.1 General

In the course of the investigation it was found that the taxiway designations around DIP F were not entered consistently and uniformly on all plans and drawings. This is also true for the various publications which the crews have to hand. The following subsections show several images which illustrate this issue.

⁶ ILS: instrument landing system

⁷ GAC: general aviation center

1.18.2 Publication in the Aeronautical Information Publication

The ground chart published in the Aeronautical Information Publication (AIP) Switzerland is shown in Figure 6. The taxiway designation is not clear and the designation for TWY F north of DIP F is missing entirely.

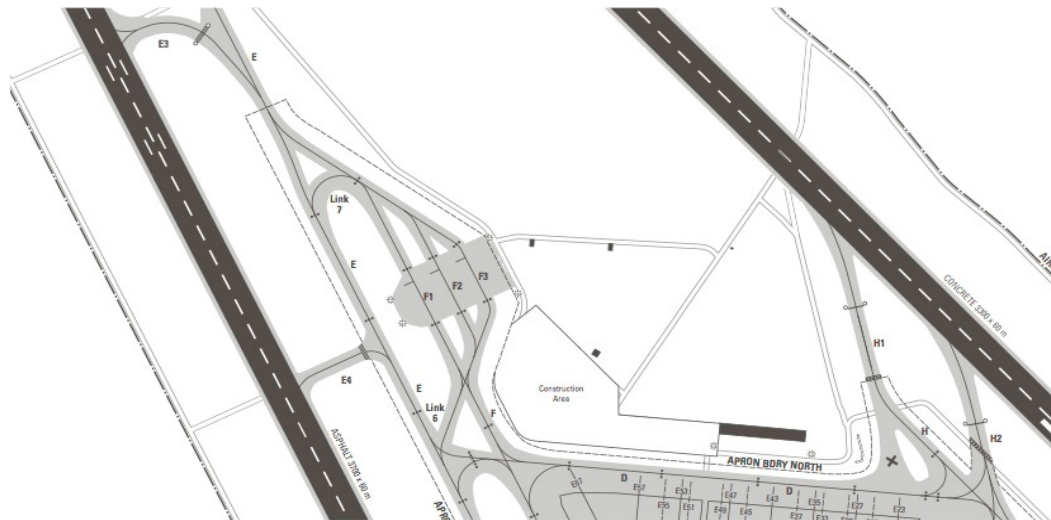


Figure 6: Detail from the AIP Switzerland LSZH AD⁸ 2.24.3-3 dated 22 August 2013

1.18.3 Jeppesen publications

As a provider of aeronautical charts, Jeppesen bases its charts on national publications, usually the AIP. In Figures 7 and 8 the corresponding maps have been reproduced as they were published by Jeppesen and as they were available to the flight crew at the time of the serious incident.

The black on white printed sheets in A5 format had basically the following layout: The first sheet, LSZH/ZRH (10-9) shows a general overview of the runway system and the taxiways (cf. Figure 7); the second sheet, LSZH/ZRH (10-9B), is an excerpt, on which primarily dock E, the eastern part of runway 10/28 and dock A are displayed with the corresponding stand numbers. The northern part of the apron was no longer visible.



Figure 7: Excerpt from the Jeppesen LSZH/ZRH (10-9) chart dated 16 August 2013

⁸ AD: aerodrome

The de-icing lanes are displayed on the DE-ICING PADS "LSZH/ZRH (10-9E)" chart (cf. Figure 8).

DE-ICING PADS

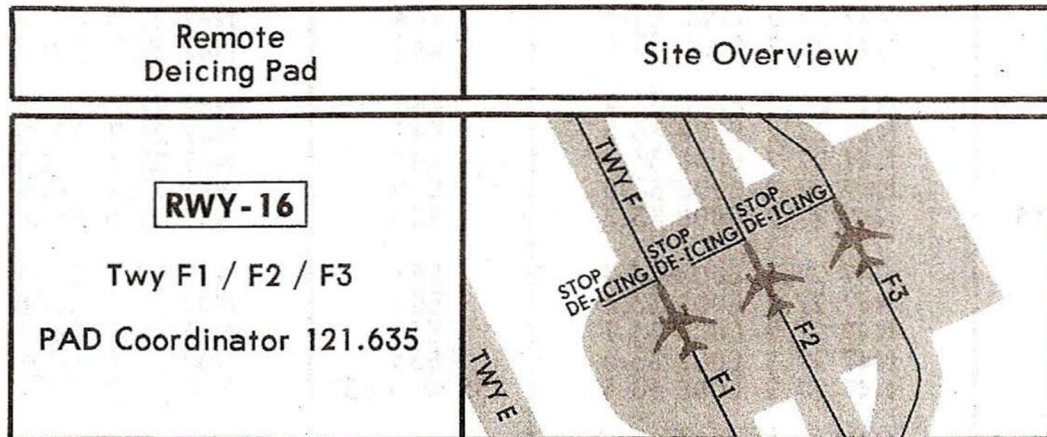


Figure 8: Excerpt from the Jeppesen LSZH/ZRH (10-9E) chart dated 16 August 2013

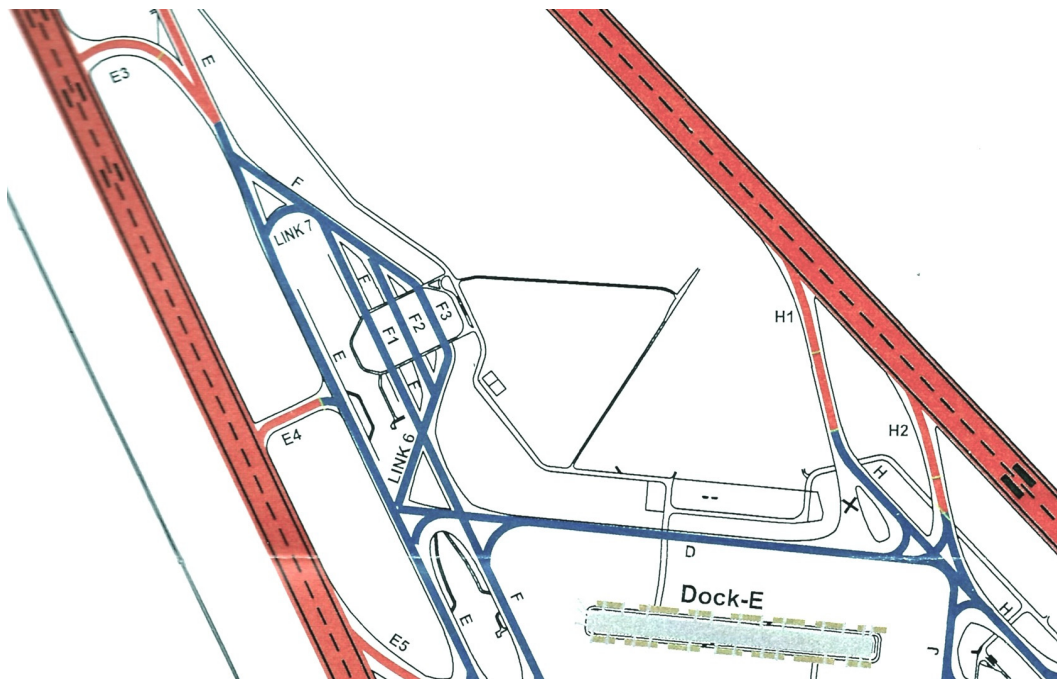


Figure 9: Excerpt from the Zurich Airport "Runway and taxiway designation system with areas of responsibility" documentation dated 16 May 2013

1.19 Useful or effective investigation techniques

Not applicable

2 Analysis

2.1 Technical aspects

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

2.2 Operational and human aspects

2.2.1 Zurich Airport

2.2.1.1 Taxiway designations

As mentioned in chapter 1.10.5, in 2010, as part of the "Concept for taxiway designation LSZH 2011 - Implementation 2012", the designation of taxiways (TWY) around de-icing pad (DIP) F were reassessed and a change deemed useful.

A safety assessment determined that changing the designations F, F1 and F2 to F1, F2 and F3 (cf. Figure 5, chapter 1.10.5) to be an improvement. The Concept also addressed the issue of possible uncertainties among crews who were unfamiliar with Zurich Airport, but this was deemed to be rather negligible. The safety assessment gave greater weight to the clarity achieved as a result of the new taxiway designation during de-icing operations on Apron North.

In light of the serious incident, it seems appropriate to reassess this point in the safety assessment. The designations of taxiways with taxiway signs are misleading in that TWY F suddenly becomes TWY F3 and then de-icing lane F3 (cf. Annex 1, Figure 11 and Annex 2, Figures 13 and 14). One complicating factor is that at night the green taxiway centre line lights for all three de-icing lanes are illuminated and north of DIP F there are no red stopbars immediately after the respective turn-offs, which could prevent taxiing onto a specific taxiway.

An inspection carried at the same time of day as the serious incident five days later indicated that it was very difficult for flight crews to see the grass area between the three de-icing lanes to the north and south of DIP F at night and especially in the case of a wet, reflective surface (cf. Annex 2 and 3). These taxiways were not equipped with blue taxiway edge lights. These would have made the crew additionally aware that they should not leave the green taxiway centre line lights. The lack of an additional means of orientation to the flight crew contributed to occurrence of the serious incident.

In some representations, the southern and northern parts of de-icing lane F1 are displayed as belonging to TWY F (see Figures 8 and 9, chapter 1.18.3). Although this is certainly in accordance with the concept of using TWY F via de-icing lane F1, as was the case before the taxiway designation was changed (cf. chapter 1.10.5), but contradicts the designation on the taxiway signs (yellow with a black background, respectively black with yellow background).

2.2.1.2 Apron Control

The operating instructions for Apron Control mention that taxi clearance does not have to contain information regarding the taxiways if the route is clearly identified. The ground movement manager (GMMA) involved, and those responsible at the Zurich Airport "Flight Operations" position were of the opinion that in a statement such as was issued to the crew of TC-TLE, the route was clearly identified: namely to follow taxiway F via de-icing lane F1.

Without clarification as to which of the de-icing lanes to use (F1, F2 or F3), this taxi clearance could very well lead to confusion among crews, especially given poor visibility, as the present case indicates. Following the taxiway signs with the designation F, the crew of TC-TLE taxied past the two de-icing lanes F1 and F2 and

suddenly found themselves on de-icing lane F3, which was the continuation of taxiway F (cf. Annex 1, Figure 11 and Annex 2, Figures 13 and 14). The taxi clearance was therefore unclear and contributed to the occurrence of the serious incident which is the subject of the investigation.

2.2.2 Operational documentation

In the present serious incident the necessary information for the crew was derived from the navigation charts provided by Jeppesen and was published on a number of charts:

For taxiing after landing the crew normally uses the LSZH/ZRH (10-9) chart, which gives a general overview (cf. Figure 7). However, this chart does not give the crew any indication as to where TWY F begins after exiting runway 34 via TWY E3 or E. This is visible only on the DE-ICING PADS "LSZH/ZRH (10-9E)" chart (cf. Figure 8), which is not usually consulted for taxiing after landing but before taxiing-out in the case of de-icing before taking off.

Here, it should be mentioned that only on the 10-9E chart is it clearly visible that there is no hard surface (i.e. no surface suitable for taxiing) between de-icing lanes F1, F2 and F3.

While modern screen display devices allow image details to be enlarged for enhanced clarity, this is not possible with maps which are printed on paper.

It should be mentioned in this context that the publication of the Aeronautical Information Publication (AIP) Switzerland (LSZH AD 2.24.3-3, AIRAC of 22 August 2013 - cf. Figure 6) was also ambiguous in relation to taxiway designations. This meant that the designation for TWY F north of de-icing pad F was missing entirely and it was not clear how to proceed from TWY E to TWY F. For chart providers, such national aeronautical information publication guidelines are inadequate and represent room for ambiguity.

2.2.3 Apron Control personnel

The GMMA issued the flight crew of TC-TLE taxi clearance to the stand via TWY F and C without stating that it was necessary to use de-icing lane F1 to cross DIP F. This was because he believed the route was clear and therefore, as specified in the operating instructions for Apron Control, would need no further information.

When the GMMA noted on the Swiss Airport Movement Area Control System (SAMAX) that TC-TLE had taxied past the turn-off to de-icing lane F1, he paid increased attention to it. Once TC-TLE stopped moving he immediately called the crew to enquire as to the reason why. His actions were prompt and safety-conscious.

By the time the crew told him that they would probably require a push-back tractor, it was already clear to him that TC-TLE was on the grass and was no longer able to move under its own power. He immediately organised a push-back tractor, sent a marshaller to the aircraft and the duty manager also informed the airport authority. The actions of the GMMA were appropriate to the situation and he acted with foresight.

As shown in the present investigation, the taxi clearance was unclear. Not mentioning the de-icing lane F1 as part of the clearance to the flight crew contributed therefore to the occurrence of the serious incident.

2.2.4 Flight crew

The nosewheel steering on the aircraft TC-TLE can only be operated from the left seat. As on the flight the copilot was acting as pilot flying (PF) and the commander as pilot not flying (PNF), a handover of controls was necessary after landing. Therefore the commander took over control of the aircraft after the landing and the copilot was responsible for radio communication.

The commander followed the Aerodrome Control air traffic control officer's (ATCO) instruction and vacated runway 34 via TWY E3. He taxied at a speed that was appropriate to the situation (cf. Annex 4).

It should be mentioned that in addition to the handover of controls, the copilot's workload in the present case was high due to various tasks: frequency change and related communication, working through the checklist after landing, organising the navigation charts in the cockpit and monitoring the commander during taxiing. The copilot's attention was therefore mainly focussed inside the cockpit.

When the crew received the instruction to taxi to stand E26 via TWY F and C, this was acknowledged by the copilot. It was clear to the commander that he had to follow the appropriate taxiway signs, which meant that he taxied past de-icing lane F1 (cf. Annex 1, Figure 11 and Annex 2, Figure 13). It can be assumed that the commander knew that the de-icing lane F1 was no longer closed after 04:00 UTC, as was stated in the relevant NOTAM (cf. chapter 1.1.2).

According to his own statement, when the commander saw the mound of earth to the south of DIP F immediately after passing the taxiway centre line of de-icing lane F2, he was not sure whether it would restrict the taxi clearance. After consulting with the copilot, he decided to turn right to join TWY F south of DIP F.

The fact that the crew did not detect the grass area between the de-icing lane F2 and F3 might possibly be explained by the fact that they were looking forwards and that the soft ground was difficult to detect at night against a hard surface which was wet. This was a promotive factor in the occurrence of the serious incident.

An inspection at the same time of day as the serious incident five days later, found that the mound of earth to the south of DIP F appeared more threatening when backlit by the floodlights of dock E (midfield terminal) at night than in daylight (cf. Annex 3, Figures 16 and 17). From this point of view the reaction of the commander is understandable, but it should not have caused him to leave the green illuminated taxiway centre line. Informing his copilot of his intention corresponded to the principles of working methods in a two-man cockpit.

Not bringing the aircraft to a standstill in order to be informed by Apron North before leaving the green illuminated taxiway centre line was prone to risks. This explains why neither crew member recognised the embedded grass area between de-icing lanes F2 and F3 in the prevailing light conditions and therefore assumed that the hard surface was contiguous throughout the DIP. In this context it should be mentioned that the bearing strength of the ground surface when changing de-icing lanes also within DIP F would not have been guaranteed.

The commander then had discussions with the copilot and the senior cabin crew member (SCCM), as well as the authorities involved on the ground before a decision on further action was made. This behaviour demonstrates prudence and was appropriate to the situation.

Considering the power setting, the commander's attempt to leave the soft ground using engine thrust was not appropriate to the situation and subject to risk.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was licensed for VFR/IFR transport.
- Both the mass and centre of gravity of the aircraft were within the permitted limits according to the aircraft flight manual (AFM) at the time of the serious incident.
- The investigation did not reveal any indications of any pre-existing technical faults which might have influenced the serious incident.

3.1.2 Crews

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

3.1.3 History of the flight

- After an uneventful flight, aircraft TC-TLE landed on runway 34 at Zurich Airport.
- During roll out, the crew received an instruction to vacate the runway via taxiway (TWY) E3.
- After changing to the Zurich Apron frequency and calling the ground movement manager (GMMA) the crew received the following instruction: *"Tailwind three two seven good morning, taxi via Foxtrot and Charlie to stand Echo two six"*.
- The crew confirmed this taxi instruction at 04:40:47 UTC with: *"Via Foxtrot Charlie, er, to stand Echo two six thank you three two seven"*.
- The aircraft then taxied along taxiway E and onto taxiway F, subsequently passing de-icing lanes F1 and F2.
- When passing the centre line lights of de-icing lane F2, the commander saw a mound of earth south of de-icing pad (DIP) F.
- He therefore decided to turn right in order to cross the DIP F and join taxiway F south of it.
- After this 55 degree right turn onto a southerly heading the aircraft came to a standstill in the soft ground on the grass surface between de-icing lanes F2 and F3 and DIP F.
- The crew's attempts to bring the aircraft back onto the taxiway by increasing thrust to over 80 % N1 were unsuccessful.
- After consultation with the airport authority and the airport fire brigade, the passengers were able to vacate the aircraft via the front right door using the ramp stairs provided.
- No passengers or crew members were injured.
- During the course of the morning, eight tons of fuel were defueled from the TC-TLE aircraft before recovery began.
- The aircraft was not damaged.

3.1.4 General conditions

- The wet surface of the taxiways, de-icing lanes and the de-icing pad led to reflections, which hindered recognition of the edge of the asphalt.
- The centre line lights of all three de-icing lanes F1, F2 and F3 were simultaneously and identically illuminated.
- Neither taxiway F nor de-icing lanes F1, F2 and F3 were equipped with blue taxiway edge lights.
- The taxiway designations on the documentation available to the crew (Jeppesen LSZH/ZRH (10-9) chart) were not very helpful.
- The inconsistent taxiway designations on the taxiway signs made it difficult for the crew to follow the taxi instructions.

3.2 Causes

The serious incident is attributable to the fact that the flight crew did not follow the green centre line lights. Subsequently the aircraft left the hard surface and came to a standstill in the adjacent soft ground.

The following factors contributed to the occurrence of the serious incident:

- The taxi clearance contained no information regarding which de-icing-lane to follow when crossing de-icing pad.
- The de-icing lanes were not equipped with taxiway edge lights.

The fact that the grass areas between the de-icing lanes were almost impossible to detect in the dark and when the surface was wet promoted the occurrence of the serious incident.

4 Safety recommendations, safety advices and measures taken since the serious incident

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 advice 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 Taxiway designations

4.1.1.1 Safety deficit

After an uneventful landing, a Boeing 737-400 operated by Tailwind, registration TC-TLE, was taxiing from runway 34 to taxiway E3 at Zurich Airport. The runways and taxiways were wet and nighttime conditions prevailed. At 04:40:40 UTC on 11 October, the crew received the following instruction from the Zurich Apron ground movement manager: *“Tailwind three two seven good morning taxi via Foxtrot and*

Charlie to stand Echo two six." The crew immediately acknowledged these instructions.

A few metres after the aircraft had passed the turn-off for de-icing lane 2 on taxiway (TWY) F, the mound of earth to the south of the commander made him feel uncertain and he turned to the right in order to cross the de-icing pad (DIP) F and join TWY F south of it. After this 55 degree turn to the right the aircraft left the hard surface and came to a standstill on the grass triangle between de-icing lanes F2 and F3 and de-icing pad F. The aircraft could no longer move under its own power.

The airport fire brigade was alerted and the passengers were able to vacate the aircraft via the front right door using the ramp stairs provided. No crew members or passengers were injured.

4.1.1.2 Safety recommendation No. 485

"Das Bundesamt für Zivilluftfahrt (BAZL) sollte zusammen mit den Verantwortlichen des Betreibers des Flughafens Zürich geeignete Massnahmen treffen, damit die Besatzungen durch eindeutige und konsistente Anweisungen und Bezeichnungen den vorgegebenen Rollwegen folgen können."

[The Federal Office of Civil Aviation (FOCA), in cooperation with those responsible for operations at Zurich Airport, should take appropriate measures so that crews can follow the prescribed taxiways using clear and consistent instructions and designations.]

4.2 Safety advices

None

4.3 Measures taken since the serious incident

None

Payerne, 9 February 2015

Investigation Services STSB

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014).

Berne, 21 April 2015

Annexes

Annex 1: Position of TWI 327 and view as from the cockpit

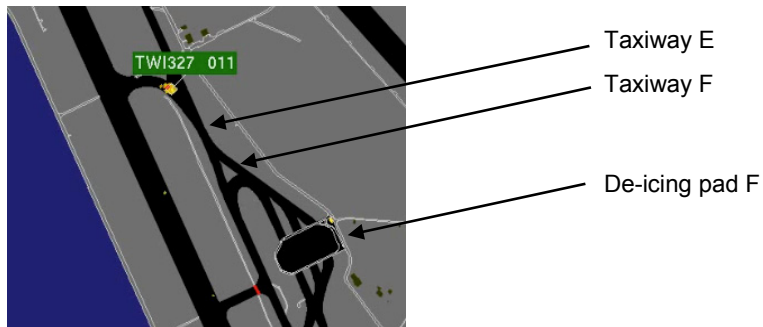


Figure 10: Image on the SAMAX display screen of the ground movement manager (GMM) (excerpt) at 04:40 UTC

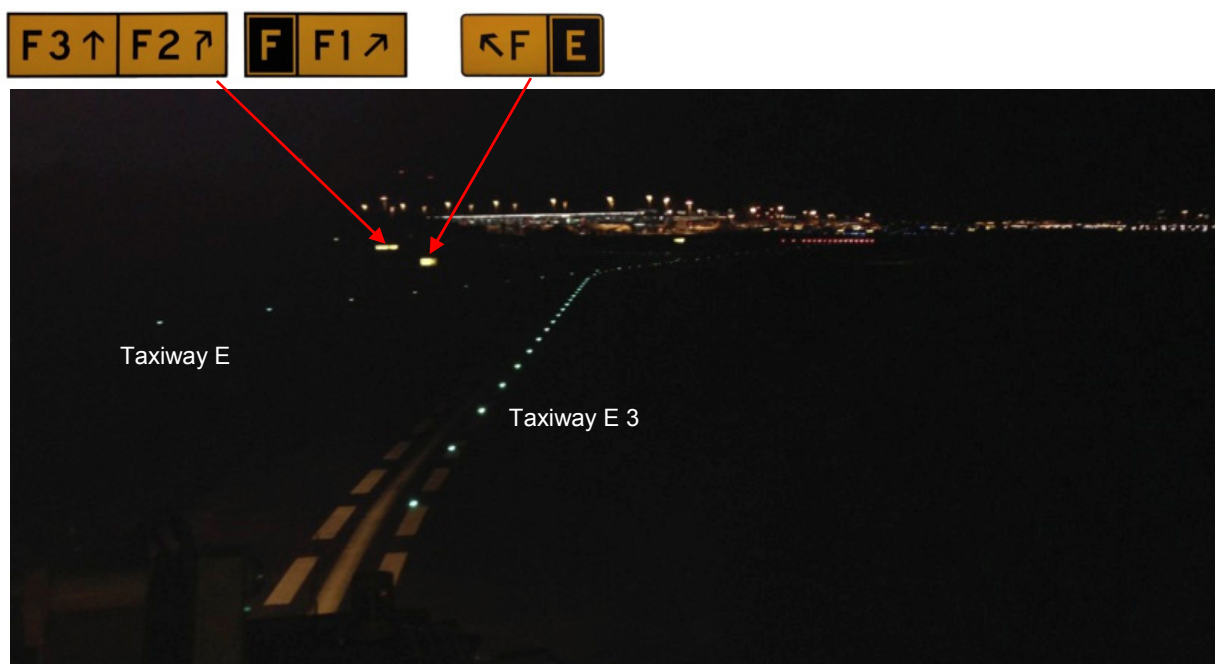


Figure 11: View as from the cockpit (image from 16 October 2013 at 04:40 UTC)



Figure 12: For comparison: view in daylight

Annex 2: View as from the cockpit during taxiing on taxiway F

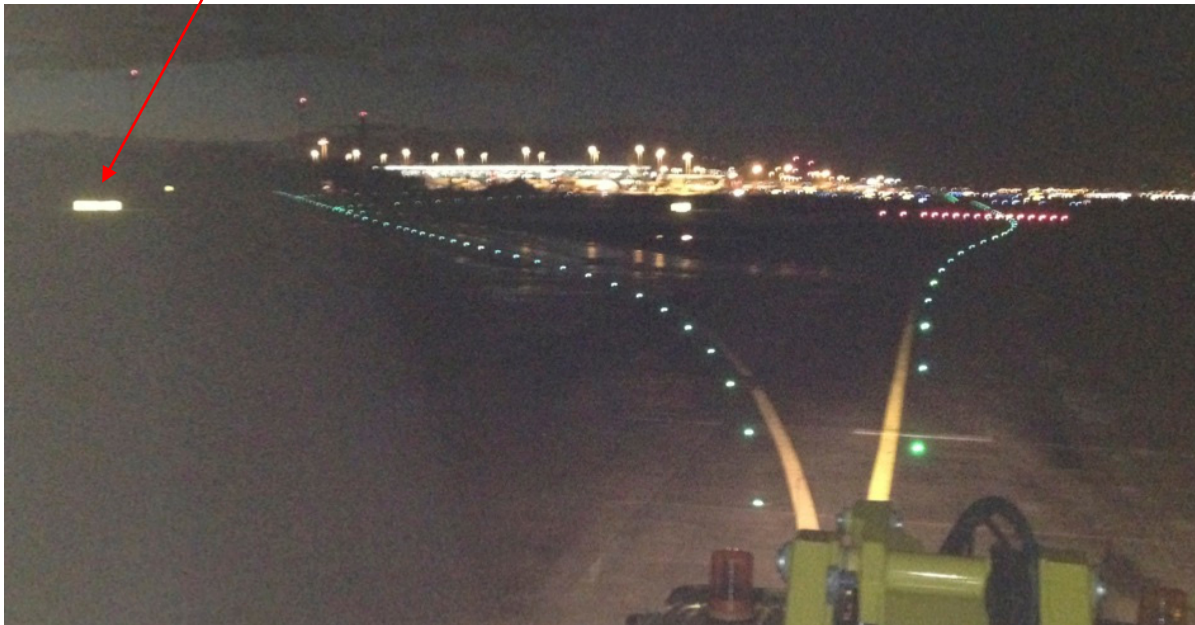


Figure 13: View as from the cockpit: left: taxiway F, straight ahead: taxiway E. (image from 16 October 2013 at 04:45 UTC (marked as closed with red crossbar on 16 October 2013))



Figure 14: On taxiway F: right turn-off: de-icing lanes F1, F2 and F3 (image from 16 October 2013 at 04:50 UTC)

Annex 3: View as from the cockpit when passing centre line lights of de-icing lane F2

Figure 15: Image on the SAMAX display screen of the GMMA (excerpt) at 04:40:57 UTC

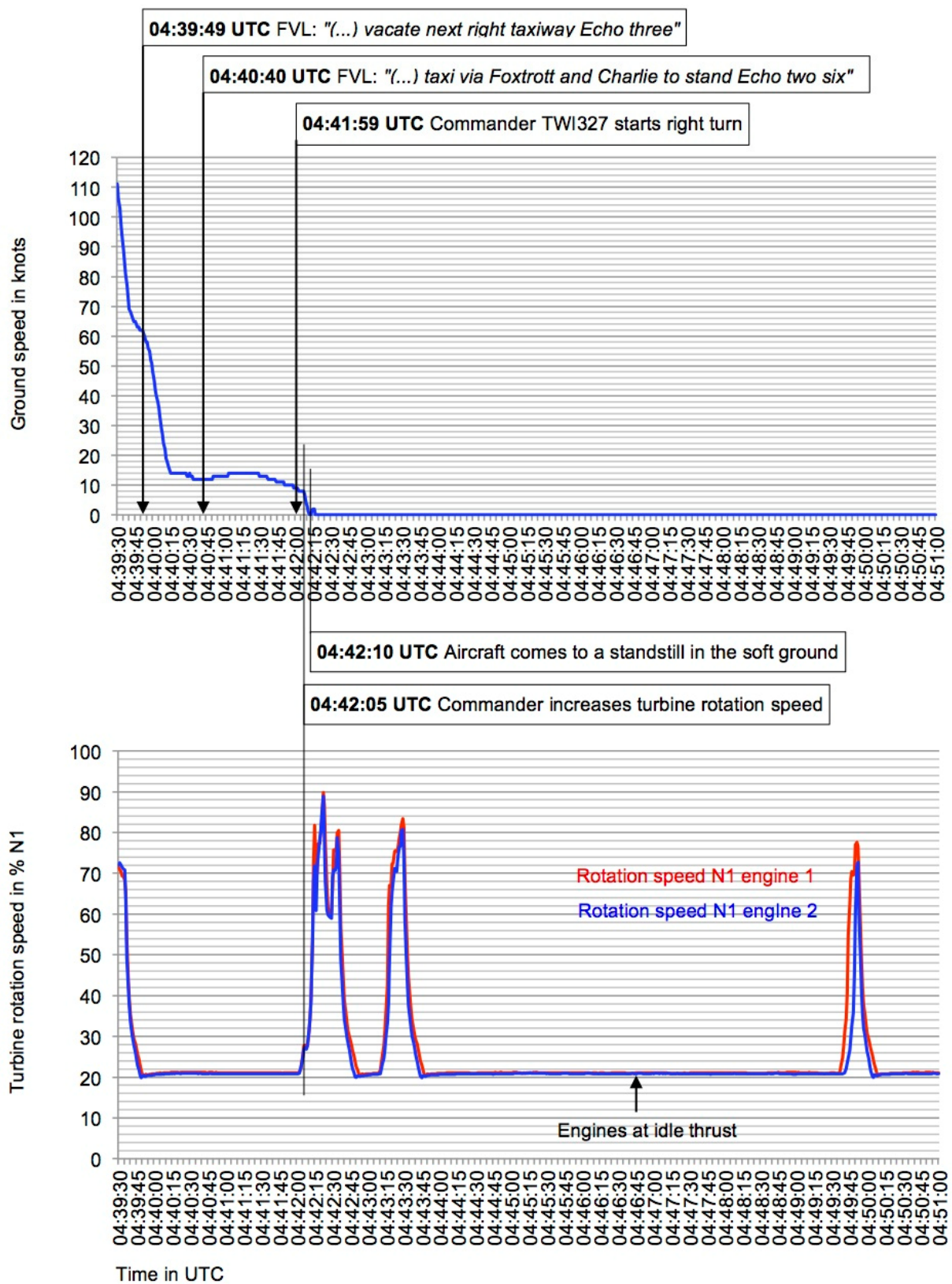


Figure 16: View as from the cockpit on taxiway F; right: de-icing lane F2, straight ahead and then to the right: de-icing lane F3, in the background: the mound of earth on the construction site (image from 16 October at 04:55 UTC).

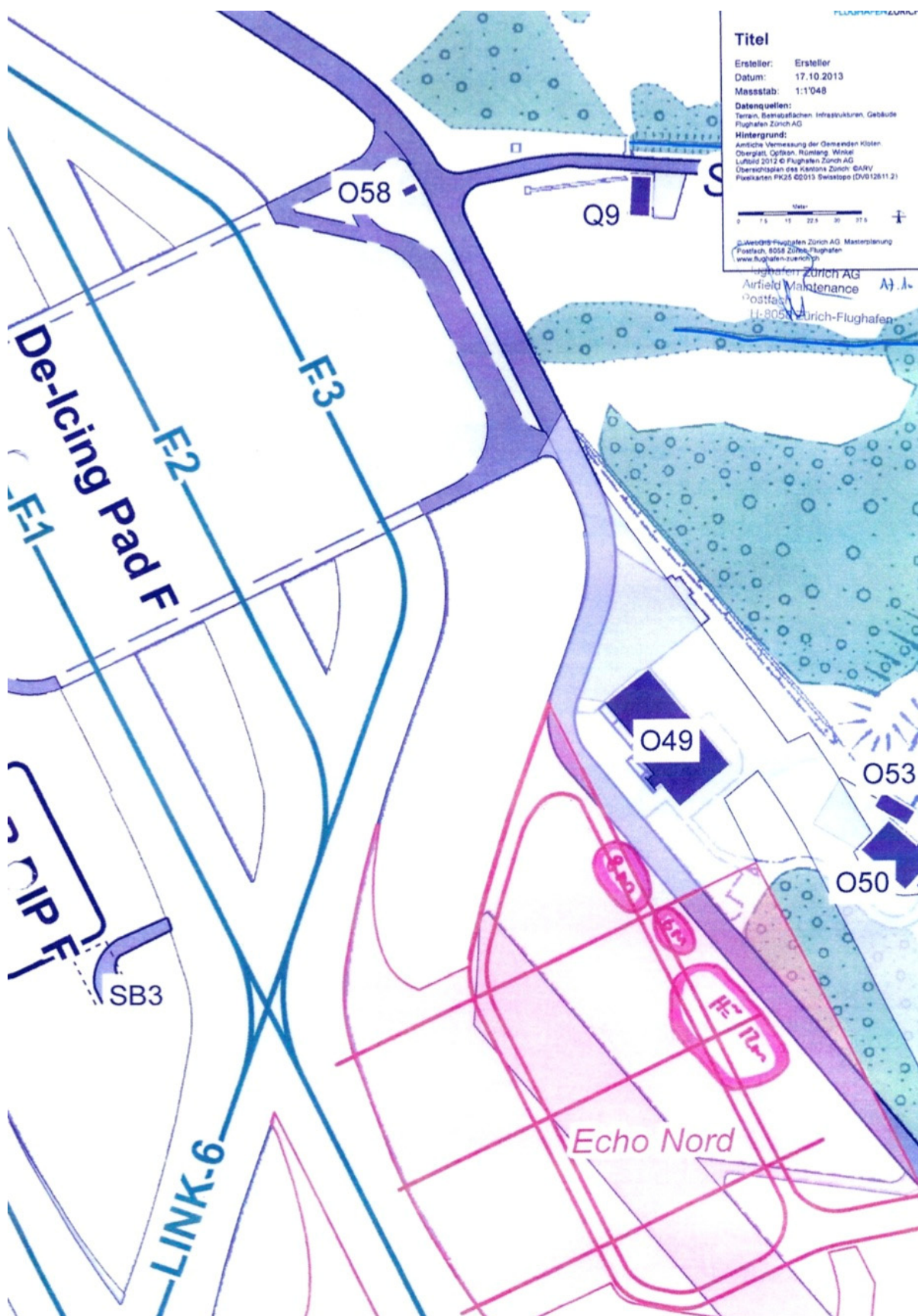


Figure 17: For comparison: view in daylight

Annex 4: Speed and engine power after the landing



Annex 5: Construction site south of de-icing pad F



Annex 6: Aircraft in the grass triangle between de-icing lanes F2 and F 3

Figure 18: Looking north: nosewheel on de-icing lane F2



Figure 19: Looking north: right main landing gear, left: de-icing lane F2



Figure 20: Looking towards the aircraft nose: left main landing gear, in the foreground: de-icing lane F2

Annex 7: Recovery of the aircraft

Figure 21: Removal of the earth behind the right main landing gear, creation of a weight-bearing base, right: de-icing lane F2



Figure 22: Right main landing gear. Jacking of the landing gear and insertion of a hard base



Figure 23: Looking north: pushing back the aircraft using a tractor and towbar, tractor on de-icing lane F2

Annex 8: GMMA working position (1/2)

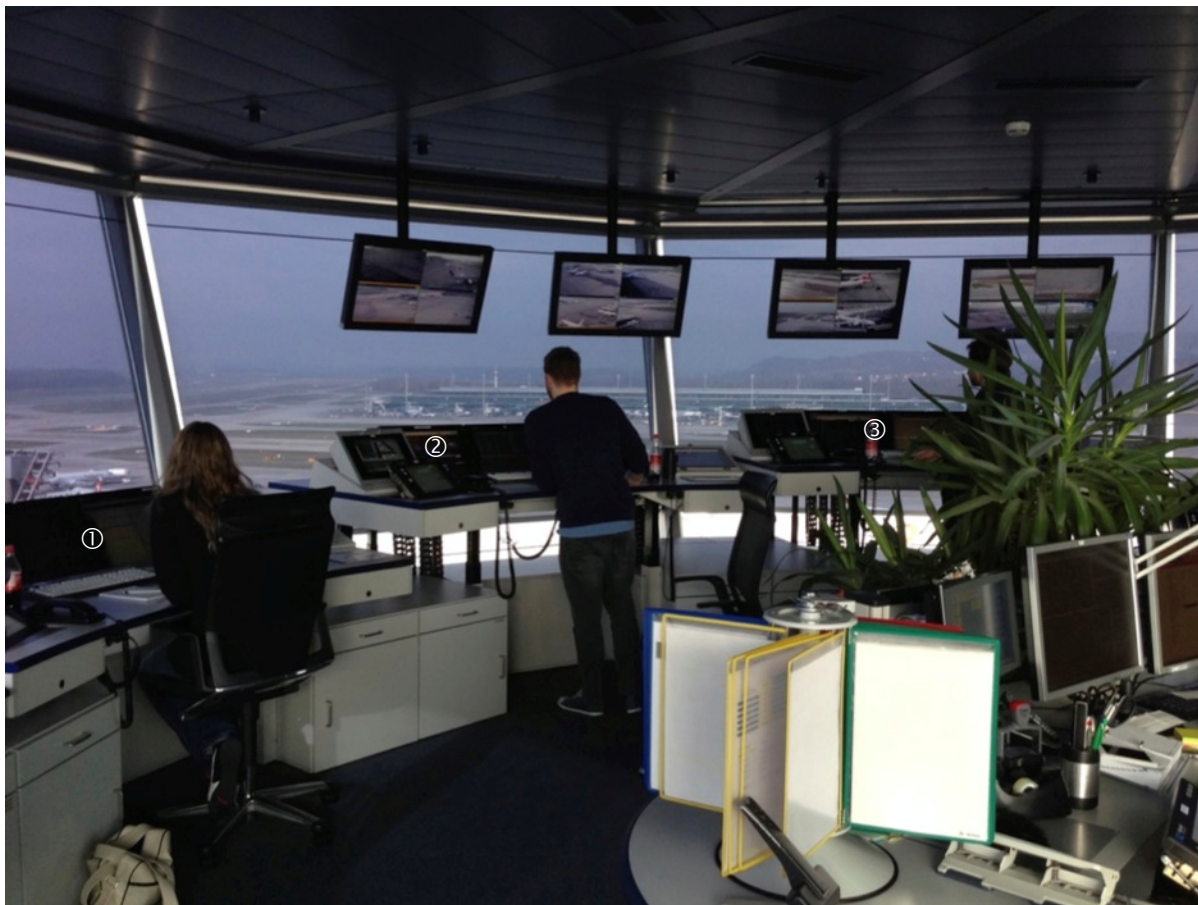


Figure 24: ① Coordinator working position, ② Apron South working position (AS), ③ Apron North working position (AN)

Annex 9: GMMA working position (2/2)



Figure 25: Apron Control North working position. The working position is similarly equipped to those of air traffic control officers at skyguide.

- ① INCH (Information System Schweiz);
- ② SAMAX (Swiss Airport Movement Area Control System)
- ③ TACO (Tower and Approach Coordination System)
- ④ Telephone (quick selection (push button) system for defined connections)
- ⑤ Camera image (one of eight)

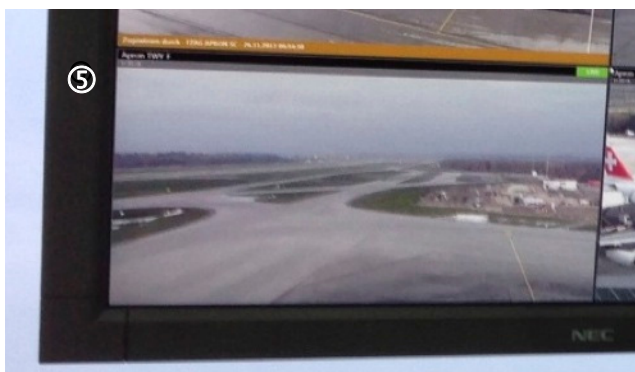


Figure 26: Webcam image: taxiways E and F, and de-icing pad north (DIP F), de-icing lanes F1, F2 and F3