Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössische Flugunfallkommission
Commission fédérale sur les accidents d'aviation
Commissione federale sugli infortuni aeronautici
Federal Aircraft Accident Board

Final Report No. 1934
by the
Federal Aircraft Accident Board

concerning the serious incident

to the aircraft AVRO 146-RJ100, HB-IXR,

operated by Swiss European Air Lines

under flight number LX 0815

on 26 January 2006

at Zurich Airport

This final report has been prepared by the Federal Aircraft Accident Board after a review procedure according to art. 22 – 24 of the Ordinance dated 23 November 1994 relating to the Investigation of Aircraft Accidents and Serious Incidents (VFU/SR 748.126.3). This report is based on the Investigation Report by the Aircraft Accident Investigation Bureau dated 16 February 2007.

The report has been prepared for the sole purpose of aircraft accident prevention. The legal assessment of accident causes and circumstances is no concern of the accident investigation (article 24 of the Federal Air Navigation Law of 21. December 1948, LFG, SR 748.0)

General information on this report

In accordance with appendix 13 of the Convention on International Civil Aviation, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. It is not the purpose of this investigation to determine blame or clarify questions of liability.

According article 24 of the Federal Air Navigation Law the legal assessment of causes of aircraft accidents and serious incidents is no concern of the accident investigation

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

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

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

Contents

Final Report

Owner	Swiss International Air Lines Ltd, CH-4002 Basel
Operator	Swiss European Air Lines AG, CH-4052 Basel
Aircraft type	AVRO 146-RJ100
Country of manufacture	Great Britain
Country of registration	Switzerland
Registration	HB-IXR
Flight rules	Instrument flight rules (IFR)
Location	Zurich Airport
Date and time	26 January 2006, 09:50 UTC

General

Brief description

On 26 January 2006, the aircraft AVRO 146-RJ 100, registration HB-IXR, of Swiss European Air Lines, arriving from Hanover, landed at Zurich airport at 09:41 UTC.

The aircraft reached its assigned stand, A-57, at 09:47 UTC. During processing of the parking checklist, the crew noticed an explosive flame, accompanied by extensive smoke, in the area of the copilot's rudder pedals.

The commander immediately decided to execute an emergency evacuation and gave the corresponding order. Since the passenger bridge was already docked to the aircraft, when the forward left door was opened the package with the emergency slide fell onto the floor of the passenger bridge, without opening. The crew then decided to carry out a rapid disembarkation. All the passengers, including the cabin crew, had disembarked the aircraft within two minutes.

After the aircraft came to a stop at stand A-57, a worker of the relevant service provider connected the external power supply cable to the aircraft. The worker then proceeded to the fingerdock to switch on the power. Immediately afterwards, he noticed extensive smoke in the area of the plug connection and raised an alarm with the airport fire brigade using his radio.

Investigation

The AAIB was informed about the serious incident by the airport authority on 26 January 2006 and opened an investigation on the same day.

Causes

The serious incident is very probably attributable to the fact that the dock-side plug had been contaminated with de-icing fluid used for airport movement areas, causing a short circuit.

1 Factual Information

1.1 History of flight

On 26 January 2006, the AVRO 146-RJ100 type aircraft, flight number LX 0815, took off from Hanover (D) on a scheduled flight to Zurich (CH). At 09:41 UTC, the aircraft landed on runway 14 in Zurich after an uneventful flight. After landing, the crew were assigned stand A-57 at Terminal 1.

According to the commander's statement, he taxied relatively slowly to the stand, as the apron was partially covered with snow. He had the impression that the stand, which appeared to be wet, had been de-iced.

After stopping and applying the parking brakes, the commander asked the copilot to process the parking checklist. The copilot complied with this order. Among other things, he used the public address system to issue the following order in accordance with this parking checklist: "disarm slides". This order required the two flight attendants at the front and rear of the cabin to disarm the triggering mechanism of the emergency slides installed in the doors. Even before the copilot had completed the checklist, the commander noticed an explosive flame about 40 cm long, yellow/blue in colour, on the copilot's side, in the area of the rudder pedals. The explosive flame was accompanied by extensive black smoke. The copilot drew back his feet in a reflex action.

Since it was not possible to determine the origin of the explosive flame, the commander decided to evacuate the aircraft in accordance with the emergency evacuation checklist. Among other things, he used the public address system to issue the order: "emergency – open seat belts – evacuate!" According to his statement, he gave this order at least twice.

The copilot heard this order, but according to his statement could not remember that the commander explicitly instructed him to process the points in the emergency checklist for "emergency evacuation". He subsequently did not carry out the corresponding points in the emergency checklist. Among other things, these would have required him to switch off the aircraft's auxiliary power unit (APU). Since, according to his statement, he was sure that the APU could not be the source of the explosive flame, he let the APU run, in order not to interrupt the power supply in the aircraft.

The flight attendant in the front section of the cabin had already disarmed the emergency slides on the two forward doors as part of a normal procedure. He was just about to use the onboard telephone to ask the second flight attendant whether the latter had also disarmed the emergency slides in the two aft doors when he heard the commander's order for an emergency evacuation. The flight attendant then ascertained, using the fisheye lens in the forward left door, whether the passenger bridge had already been positioned against the aircraft. Since he could not see anything, he re-armed the emergency slide and opened the door. While doing so, the package with the emergency slide fell, without opening, onto the floor of the passenger bridge, which had been brought up in the meantime. The flight attendant then decided to allow passengers to disembark rapidly using the normal way.

After the commander had instructed the copilot to inform the fire brigade, he left his seat and went to the cabin. He saw that the flight attendant responsible had already partially opened the forward left door and that several passengers were already standing in the aisle, ready to leave the aircraft.

According to his statement, the commander went immediately to the forward right door (service door) and armed the trigger mechanism for the emergency slide, which at this time was already disarmed according to the parking checklist. He made sure that no fire was visible outside and opened the door. In the process, the emergency slide was inflated.

In the meantime, the door on the left side of the aircraft had been fully opened and the commander supported the flight attendant's decision to allow the passengers to disembark immediately in the normal way (rapid disembarkation). The flight attendant loudly requested passengers several times to leave their hand luggage behind and to leave the aircraft as quickly as possible.

According to his statement, the commander then went back to the cockpit. In the meantime, the copilot, on his own initiative, had emptied the fire extinguisher in the direction from which the explosive flame had originated.

Fire was no longer visible and the black smoke also seemed to be slowly dissipating. In view of this new situation, the commander returned to the passenger cabin. In order not to hinder an expeditious disembarkation through the forward left door, he positioned himself in the forward galley to prevent passengers from using the route via the opened service door.

According to his statement, the flight attendant in the rear section of the cabin heard the emergency evacuation order given by the commander. On the basis of this order, he should have re-armed the two rear emergency slides and opened the two service doors, after checking by looking outside. Since he had no visible indications of an emergency situation, he did not do so. He would have expected the power supply in the aircraft to be interrupted and the emergency lights inside the cabin to come on. In addition, he did not notice any irregularities outside the aircraft through the fisheye lens in both doors. According to his perception, the passengers were disembarking the aircraft normally.

After less than two minutes, according to the crew's statement, all the passengers had disembarked the aircraft and the commander also ordered the two flight attendants to do so.

At 09:48:08 UTC, the crew requested the fire brigade on the Zurich Delivery frequency. Zurich Delivery then requested confirmation that the caller was LX 0815. The copilot confirmed this and requested the fire brigade once more. Zurich Delivery asked for the reason, to which the copilot replied: *"we have a fire in the avionics bay and we do presently an evacuation on the gate"*. At 09:48:53 UTC, Zurich Delivery confirmed that the fire brigade was on its way.

According to the fire brigade's report, the brigade received the alarm at 09:48:30 UTC and arrived at stand A-57 at 09:50:58 UTC. They were unable to detect any fire from outside the aircraft. However, on the right side, in the area of the aircraft nose, there were distinct traces of black smoke and soot.

Ground-side operations at the stand

After the aircraft came to a stop at stand A-57, a worker of the relevant service provider connected the external power supply cable to the aircraft. He then proceeded to the control box at the fingerdock to switch on the power. Immediately afterwards, the worker noticed extensive smoke in the area of the plug connection and raised an alarm with the airport fire brigade using his radio.

The worker was no longer able to say with certainty whether he switched the power off again at the same time or whether it was interrupted automatically.

1.2 Injuries to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly injured or uninjured	4	64	1

1.3 Damage to aircraft

On the aircraft, substantial damage was caused to the connector plate of the aircraft-side connection for the external power supply and in its immediate vicinity. Traces of black soot were deposited over the entire area of the connection and on the surface of the fuselage (see Annex 1).

The surface of the connector plate itself was badly burnt. Three contact pins for transferring the three-phase alternating current had melted and were found in the dock-side plug. Moreover, the connector plate exhibited a fairly small crack between two contact pins and a larger crack from one contact pin to the edge of the plate (see Annex 2).

The connector plate was located in an externally accessible bay in the aircraft's fuselage. The wall of the bay had burned through at one point. This created an opening through which fire and smoke were able to penetrate into the cockpit (see Annex 3).

1.4 Other damage

The plug on the dock-side power supply was destroyed. Three contact pins on the aircraft-side connector plate were melted to the sockets in the plug. The connector housing exhibited signs of melting and was heavily contaminated with soot (see Annex 4).

1.5 Personnel Information

1.5.1 Commander

Person	Swiss citizen, born 1967
Licence	Air Transport Pilot Licence (ATPL) according to JAR, issued by the Federal Office for Civil Aviation (FOCA), valid till 13.07.2010
Ratings	RTI (VFR/IFR) NIT (A) IFR (A)
Last proficiency check (OPC)	20.06.2005
Last line check (LC)	27.06.2005
Registered aircraft types	AVRORJ/BAe146
Medical fitness certificate	Class 1
Last medical examination	31 March 2005, findings: fit
Total flying experience	5801 hours
on AVRO 146-RJ	5044 hours
during the last 90 days	51 hours

1.5.2 Copilot

Person	Swiss citizen, born 1971
Licence	Air Transport Pilot Licence ATPL (A) according to JAR, issued by the Federal Office for Civil Aviation (FOCA), valid till 28.07.2010
Ratings	RTI (VFR/IFR) NIT (A) IFR (A)
Last proficiency check (OPC)	16.07.2005
Last line check (LC)	07.10.2005
Registered aircraft types	AVRORJ/BAe146
Medical fitness certificate	Class 1
Last medical examination	18 January 2006, findings: fit
Total flying experience	3450 hours
on AVRO 146-RJ	660 hours
during the last 90 days	125 hours

1.5.3 Cabin crew

Persons	Two flight attendants

1.5.4 Worker

Person	worker
Ratings	Internally trained, qualified and tested by the service provider.

1.6 Aircraft information

1.6.1 General information

Aircraft type	AVRO 146-RJ100
Manufacturer	British Aerospace Ltd., Woodford, Cheshire, England
Characteristics	Commercial aircraft with four jet engines
Year of construction	1995
Serial number	E3281
Engines	4 Allied Signal LF507-1F
Certification	Cat. IIIA RVR 150 m / DH 50 ft LVTO RVR 125 m RVSM RNP 5 Dangerous goods
Airworthiness certificate	Issued on: 01.11.2005 / No. 2
Maintenance	Swiss Maintenance Basel
Fuel	Jet A1

1.6.2 External power supply to the aircraft

Aircraft HB-IXR is equipped with a connection for the external power supply. This is located on the right side of the aircraft and is accessible after opening a cover. The connection consists essentially of a connector plate, which serves as a holder for the contact pins.

Three-phase alternating current is supplied by the external power supply. The voltage between phases is approximately 200 volts, at a frequency of 400 Hz. The voltage between each phase and neutral is 115 volts. Hence in this respect the external power supply source has the same parameters as the onboard generators (engines and APU).

In order to be able to switch the external power supply to the aircraft, various conditions must be fulfilled. First of all, the dock-side plug must be connected correctly to the aircraft-side connector. Then the voltage and frequency of the external power supply source must be within specified limits and the phase sequence must match. These parameters are monitored in the aircraft by the external power monitor unit.

In no case can the external power supply be connected in parallel with the onboard generators.

After the external power supply plug has been inserted and the voltage switched on at the dock, the “external power available” light illuminates in the cockpit. For the crew, this is an indication that it is now possible to switch over to the external power supply.

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.5 was provided by MeteoSwiss and that in section 1.7.6 by Skyguide.

1.7.2 General weather situation

Switzerland was in an area affected by a small low-pressure area. High-altitude humid cold air was flowing towards the north side of the Alps and caused persistent light snowfalls in the morning in Zurich.

1.7.3 Forecasts and warnings

TAF of Zurich-Kloten (LSZH) airport for the period of the serious incident:

LSZH 260716 VRB03KT 4500 BR FEW015 SCT025 BKN030 BECMG 0912 6000 FEW040 BKN060 PROB30 TEMPO 0716 2500 –SN BKN020

LSZH AAA 260716 VRB03KT 2200 –SN FEW005 SCT015 BKN020 TEMPO 0716 1200

1.7.4 Measured and observed values

METAR of Zurich-Kloten (LSZH) airport for the period of the serious incident:

LSZH 260950Z VRB02KT 1800 -SN FEW003 SCT007 BKN012 M01/M02 Q1011 10490192 14490427 16490148 TEMPO BKN015

1.7.5 Weather conditions at Zurich airport

Cloud	1-2/8 at 1700 ft AMSL, 3-4/8 at 2100 ft AMSL, 5-7/8 at 2600 ft AMSL
Weather	Light snowfall
Visibility	1800 m
Wind	Variable at 2 knots
Temperature/dewpoint	-01 °C / -02 °C
Atmospheric pressure	QNH LSZH 1011 hPa, QNH LSZA 1016 hPa

1.7.6 ATIS reports LSZH

At the time of the serious incident, the following ATIS reports were being transmitted:

INFO BRAVO
LDG RWY ILS APCH
QAM LSZH 0920Z 26.01.2006
310 DEG 3 KT
VIS 1500 M
LIGHT SNOW
CLOUD FEW 300 FT. SCT 700 FT. BKN 1100 FT
-01/-02
QNH 1011 ONE ONE
QFE THR 14 961
QFE THR 16 962
QFE THR 28 961
TREND TEMPO BKN 1500 FT
GEN DE-ICING PROC IN OPS

RWY-REPORT NR. 258 0840

RWY 14.
FULL LEN 60 M WIDE 51 % TO 100 % PATCHES OF DRY SNOW UP TO 4 MM
BA 27. 57. 31

RWY 16.
FULL LEN 60 M WIDE COVERED WITH DRY SNOW UP TO 3 MM
BA 28. 22. 19

RW 28
FULL LEN 60 M WIDE DAMP 51 % TO 100 % PATCHES OF DRY SNOW UP TO 1 MM
BA MEDIUM TO POOR

APN AND TWY PATCHES OF DRY SNOW

INFO DELTA
LDG RWY ILS APCH
QAM LSZH 0950Z 26.01.2006
310 DEG 3 KT
VIS 1800 M
LIGHT SNOW
CLOUD FEW 300 FT. SCT 700 FT. BKN 1200 FT
-01/-02
QNH 1011 ONE ONE
QFE THR 14 961
QFE THR 16 961
QFE THR 28 961
TREND TEMPO BKN 1500 FT
GEN DE-ICING PROC IN OPS

RWY-REPORT NR. 260 0930

RWY 14.
FULL LEN 60 M WIDE 51 % TO 100 % PATCHES OF DRY SNOW UP TO 4 MM
BA 27. 57. 31

RWY 16.
FULL LEN 60 M WIDE COVERED WITH DRY SNOW UP TO 1 MM
BA 55. 61. 48

RW 28
FULL LEN 60 M WIDE DAMP 51 % TO 100 % PATCHES OF DRY SNOW UP TO 1 MM
BA MEDIUM TO POOR

EDGES COVERED WITH DRY SNOW
APN AND TWY PATCHES OF DRY SNOW

INFO FOXTROT
LDG RW 14 ILS APCH
QAM LSZH 1020Z 26.01.2006340 DEG 4 KT
VIS 4000 M
LIGHT SNOW
CLOUD FEW 1000 FT. BKN 1300 FT
-01/-02
QNH 1011 ONE ONE
QFE THR 14 961
QFE THR 16 962
QFE THR 28 961
TREND BECMG BKN 1500 FT
GEN DE-ICING PROC IN OPS

RWY-REPORT NR. 261 1005
RWY 14.
FULL LEN 60 M WIDE 51 % TO 100 % PATCHES OF DRY SNOW UP TO 4 MM
BA 27. 57. 31

RWY 16.
FULL LEN 60 M WIDE COVERED WITH DRY SNOW UP TO 1 MM
BA 55. 61. 48

RW 28
FIRST PART 50 M WIDE WET. SECOND AND THIRD PART 60 M WIDE COVERED WITH DRY SNOW UP TO 17 MM
BA POOR

EDGES COVERED WITH DRY SNOW.
APN AND TWY PATCHES OF DRY SNOW

1.8 Aids to navigation

Not applicable.

1.9 Communication

There are no indications of any irregularities in radiocommunication with the tower and apron air traffic control units. The request for the fire brigade was made on the Zurich Delivery frequency. The corresponding recordings were complete and easily comprehensible.

1.10 Aerodrome information

1.10.1 General

Zurich Airport is located in north-east Switzerland. The airport reference point (ARP) has coordinates N 47 27.5 / E 008 32.9 and an ELEV of 1384 ft.

The dimensions of Zurich airport runways are as follows:

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

1.10.2 Procedures to clear and grit the movement areas on the airport

As part of winter maintenance, the following *"Räum-&Streuverfahren"* (Clearance and Gritting Procedures) (OMSW-3-1-1-011-RL) are applied by the airport operator:

- *Schneeräumung auf Bewegungsflächen* (snow removal on movement areas)
- *Streuverfahren für Bewegungsflächen zur Vorbeugung gegen Vereisung, zur Enteisung und zum Abstumpfen* (gritting procedures for movement areas to prevent icing, to de-ice and to sand[1])
- *Glättebehandlungsarten* (slipperiness treatment methods)

In the case of slipperiness treatment methods a distinction is made between preventive and active treatment. In the case of preventive treatment, solid or liquid movement area de-icer is applied onto the moist surface of the movement area.

The de-icing agent "AVIFORM L50" was used for de-icing during the period of the serious incident.

1.10.3 Energy supply to aircraft at the Terminal 1 fingerdocks

Aircraft are supplied with electrical and/or pneumatic energy at the Terminal 1 fingerdocks. Pneumatic energy can be used for the air-conditioning of aircraft.

The system for supplying aircraft with electrical energy consists essentially of a converter, the dock-side control box and the cable with a cable lift up device. At the open end of the cable there is a plug which features further controls on the back.

The converter is used to convert the three-phase alternating voltage available in the local network (3x400V, 50 Hz) into a three-phase alternating voltage as used on the aircraft (3x200V, 400 Hz).

The cable lift up device is used to suspend and guide the cable. It is affixed to the side of the fingerdock at the top (see Annex 6). When it is not in use, the cable is raised at two points so that it does not touch the ground when the dock is moved. When an aircraft is docked, the cable can be brought to the aircraft by extending the cable lift up device. This has the advantage that the cable does not have to be dragged on the ground over the full distance. Two pushbuttons located on the rear of the plug are used to control the cable lift up device.

[1] Sanding means spreading sand onto ice or compact snow.

A belt with a hook is affixed near the plug. If a corresponding attachment is available on the aircraft, it is hooked to it. The belt serves to relieve strain on the plug.

The plug has six sockets which are pushed onto the contact pins on the aircraft. Four of these serve to convey the three-phase alternating current. The aircraft-side monitoring circuit is completed via the two small sockets 'E' and 'F' (see Annex 9). Socket 'E' is equipped with a microswitch which responds when the aircraft-side contact pin is fully engaged in the socket. The microswitch is part of the dock-side monitoring system. The power supply to the aircraft can therefore be switched on only when the plug is seated correctly.

Two pushbuttons are situated on the rear of the plug which are used to switch on and off the power supply to the aircraft. For safety reasons, the 'ON' pushbutton was already deactivated before the serious incident. Power could therefore be switched on only from the control box on the fingerdock.

Connecting the cable to the aircraft is performed in one-man operation by the service provider Swissport. The worker carries the cable over his shoulder, brings it to the aircraft and inserts the plug. Then he returns to the control box on the fingerdock and switches on the power.

1.11 Flight recorders

Not applicable.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

The crew reported that they had seen an explosive flame in the cockpit which was covered with thick black smoke within a few seconds.

The worker who inserted the plug into the aircraft and subsequently switched on the power reported that he had seen smoke but no fire.

1.15 Survival aspects

Not applicable.

1.16 Test and research

1.16.1 Investigations of the aircraft-side connector plate

A crack was found (see Annex 2) in the aircraft-side connector plate which was removed after the serious incident; parts of it had been burned or had melted.

For the macroscopic examination, the crack in the connector plate was opened and one half of the fracture was spluttered with gold in order to increase contrast. The fracture surface was normal and macroscopically low in deformation. The fracture origin could be located in the inner area of the two holes. In the

centre of the connector plate, in the area of the two holes, about two thirds of the cross-sectional area of the plate had been burned by the short-circuit. The greater the distance from the centre, the less pronounced the thermal deformations.

Although it is not possible to answer with certainty the question of the origin of the crack, it can be assumed that the short-circuit was not caused by the crack.

1.16.2 Investigations of the dock-side plug

The very badly damaged plug was opened to determine whether de-icing fluid had penetrated it. Fluid residue was found in the jacket and in the plug itself (see Annex 7).

For the physical-chemical examination, one specimen respectively of AVIFORM L50 de-icing fluid and of the fluid residues from the plug were taken. The samples were then subjected to qualitative chemical analysis and energy-dispersive X-ray analysis (EDX).

In the scanning electron microscope high levels (>10%) of potassium, carbon, oxygen and silicon were found both in the de-icing fluid and in the fluid residues.

Moreover, considerable levels of copper and zinc were found in the fluid residues.

In the de-icing fluid, as well as in the fluid residues found inside the plug, indications of formates were found as a result of a qualitative chemical analysis. The evaporation residues of both fluids had practically identical elemental compositions.

1.17 Organizational and management information

1.17.1 Swiss European Air Lines

1.17.1.1 General

Swiss European Air Lines is a 100% subsidiary of Swiss International Air Lines. In the autumn of 2005, the latter had decided to split off regional transport to a separate operating company.

The Federal Office for Civil Aviation (FOCA) issued an *air operator certificate* (AOC) to Swiss European Air Lines on 1 November 2005. On behalf of its parent company Swiss, Swiss European Air Lines handles so-called “wet lease” flights. All of Swiss International Air Lines’ regional fleet aircraft (AVRO RJ85/100 and Embraer 145) were transferred to the new company.

1.17.1.2 Regulations and procedures concerning evacuation

The regulations applicable to the airline are laid down in the airline’s operations manual (OM) A.

The relevant procedures are specified in the airline’s “Abnormal and Emergency” checklist. The corresponding actions by the pilot in the event of an on ground emergency are defined under the heading “EMERGENCY EVACUATION”. The commander’s tasks and those of the copilot are defined as follows in section 11.25.1:

CAPTAIN:

AIRCRAFT ..... STOP
WHEELBRAKES ..... PARK
THRUST LEVERS ..... FUEL OFF
PA ..... order evacuation

CO-PILOT

Pressurization ..... MAN-OPEN
APU ..... STOP
APU FIRE EXT ..... DISCH
FIRE HANDLES ..... Pull to full extent
Rotate to EXT 1 or 2
As required

Call ATC on RMP1 / VHF COMM No. 1

BATT POWER ..... Leave ON

The final checklist point for the commander states that he must order the evacuation over the public address system. The wording of the evacuation order is defined as follows in the airline's OM B 1.11.10: "emergency – open seat belts – evacuate!"

1.17.2 The airport operator

1.17.2.1 General

On 25 November 1999, privatisation of the airport was approved in a referendum. In March 2000, the airport management and the airport real estate company FIG were merged, becoming Flughafen Zurich AG. On 6 April 2000, the new airport company was launched under the name Unique.

On 1 June 2001 the new operating licence entered into force and Unique replaced the canton of Zurich as the operator of the airport. The new operating licence has a term of 50 years.

From November 2001 until the end of January 2002, Unique took over various key systems which are central for the airport from different Swissair group companies.

As the infrastructure owner and the operator, Unique is obliged to ensure operation of public aviation transport in Zurich. Under its own responsibility it exercises all functions for the maintenance and smooth running of the operation.

1.17.2.2 Fundamentals of the winter service

Under the licence granted by the Swiss Confederation, the airport operator is obliged to ensure the operability and safety of the airport. In order to allow scheduled and unscheduled aircraft take-offs and landings, in the winter half of the year, under corresponding weather conditions, the operability of the airport is maintained with the aid of appropriate winter service measures.

Among other things, the winter service includes a removal concept which depends on the type of snow, the amount of snow and the time at which snow falls. In addition, snow removal, like de-icing, has to take account of environmental protection, soil protection and ground water protection.

It is the Airport Authority which decides whether and when snow removal and de-icing is carried out. Airfield Maintenance decides how removal and de-icing is carried out and with what resources.

1.17.2.3 Operational implementation of the winter service

The winter service[2] is as a rule split into two areas, the traffic division and the technical division.

The tasks of the traffic division are as follows:

- *Der Verkehrsbereich ist verantwortlich für die Beurteilung des betriebssicheren Oberflächenzustandes der Bewegungsflächen sowie die rechtzeitige Einleitung von Winterdienst Massnahmen.* (The traffic division is responsible for assessing the operationally safe state of the surface of movement areas and for the timely introduction of winter service measures.)
- *Er bestimmt mit der skyguide und in Abstimmung mit dem Winterdienst Koordinator die Einsatzpunkte und Reihenfolge für die Räumung der Bewegungsflächen.* (Together with skyguide and by agreement with the winter service coordinator, it determines the areas of action and the removal sequence of movement areas.)
- *Er kontrolliert den Zustand der Bewegungsflächen periodisch sowie nach Winterdienst-Einsätzen und veröffentlicht die Ergebnisse.* (It monitors the condition of the movement areas periodically, including winter service interventions, and publishes the results.)
- *Er bestimmt den Zeitpunkt der Unterbrechung bzw. Weiterführung des Flugbetriebes. Die FLUGSICHERUNG SKYGUIDE und die Luftverkehrsgesellschaften sind vor derartigen Ereignissen rechtzeitig zu informieren.* (It determines the time at which flight operations are interrupted and resumed. SKYGUIDE AIR NAVIGATION SERVICES and the airlines must be informed of such events in good time.)
- *Grundsätzlich können die Bewegungsflächen nur vom Verkehrsbereich gesperrt und für eine Wiederbenutzung freigegeben werden.* (In principle, movement areas may be closed and reopened for use only by the traffic division.)

The tasks of the technical division are as follows:

Der technische Bereich ist verantwortlich für den technischen Einsatz. Hier insbesondere für: (The technical division is responsible for technical operations, in particular):

- *Die Koordination und Leitung des gesamten Winterdienst-Einsatzes* (coordination and management of the entire winter service operation)
- *Die Bereitschaft und den Einsatz der Winterdienst-Kräfte* (the readiness and deployment of winter service forces)
- *Die Einsatzbereitschaft der Winterdienst-Technik* (the operational readiness of winter service equipment)
- *Das Vorhandensein der Streumittel* (the availability of gritting resources)

[2] OMSW-3-4-1-008-RL, Operational implementation of winter service

- *Die Durchführung des Winterdienstes auf den Flugbetriebsflächen nach Weisungen des Verkehrsbereichs* (implementing the winter service on the aviation surfaces according to instructions from the traffic division)
- *Die Durchführung des Winterdienstes auf den sonstigen Betriebsflächen* (implementing the winter service on the other operational surfaces)
- *Die Planung der voraussichtlichen Dauer der Unterbrechung des Flugbetriebs durch Winterdienst-Massnahmen* (planning of the anticipated duration of interruption of flight operations due to winter service measures)

All the agencies which are responsible for the winter service are obliged to log the information, activities and results pertaining to the winter service.

From the available logs, it is apparent that stand A-57 had last been de-iced on the morning of 22 January 2006. Furthermore it is noted that the northern stands of Fingerdock A, including stand A-57, had not been de-iced on the morning of 26 January 2006, the day of the serious incident. This stand has a heated midfield that as a rule will not be treated with de-icing fluid and out of this will not be contaminated directly.

According to the log, on the day of the serious incident the southern stands of Fingerdock A, as well as the taxiways, had been de-iced. In this context it should be noted that such a taxiway directly skirts stand A-57.

1.17.2.4 The aircraft energy supply

For reasons of environmental protection, great importance is attached to the external supply of electrical power and conditioned air to aircraft.

In order to limit the use of auxiliary power units as far as possible, a central aircraft energy supply system is available at the Terminal 1 fingerdocks. This enables parked aircraft to be supplied with electrical power and conditioned air.

As a Confederation licensee, Unique is responsible for the operation of the infrastructure. Unique commissioned Avireal to ensure that the aircraft energy supply system is available at all times.

This obligation is regulated in detail in so-called W/I (*Wartung/Instandhaltung* - maintenance and servicing) working instructions. These W/I working instructions include on the one hand the flow of work and on the other hand the intervals at which corresponding checks must be carried out (see Annex 8). The corresponding checks are logged.

Up to the time of the serious incident, Unique was content with viewing the logs produced by Avireal. It did not carry out any checks itself.

1.17.2.5 Training

In principle, training of specialists on Unique's installations was carried out independently by the corresponding service providers. Unique itself was responsible for the respective training documentation, directives and information as to how its installations were to be handled. It also informed its service providers about changes and events on a continuous basis.

Regarding the introduction of the new surface de-icing agent, the parties concerned were informed on 20 September 2005, 15 November 2005 and 6 December 2005.

Extract from the minutes from 6 December 2005:

Ab dem Winter 2005/6 wird ein neues Flächenenteisungsmittel (Fabrikat AVIFORM, Hersteller Yara Formates AS) am Flughafen Zürich eingesetzt. Dieses Enteisungsmittel ist biologisch gut abbaubar, kann sich jedoch nachteilig auf die Sicherheit bei der 400 Hz Stromversorgungsanlagen auswirken (mobile und stationäre Anlagen. X [Name ist dem BFU bekannt] hat an einer Information am 15.11.2005 verschiedene Firmen am Flughafen darüber informiert. (with effect from winter 2005/6, a new surface de-icing agent (AVIFORM, manufactured by Yara Formates AS) will be used at Zurich Airport. This de-icing agent has good biodegradability, but may have adverse effects in relation to the safety of the 400 Hz power supply systems (mobile and stationary installations). X [name is known to the AAIB] informed various companies on the airport about this on the occasion of an information on 15.11.2005.)

In the same information, the service providers were instructed, among other things, about the handling of the installations as follows:

- *Der Anschluss und die Bedienung der Stromversorgung darf nur von einer Person vorgenommen werden.* (Connection and operation of the power supply must be carried out by one person only.)
- *Die Einschaltung darf erst erfolgen, wenn alle Personen den Gefahrenbereich von ca. 2 m verlassen haben.* (Power shall be switched on only when all persons have left the hazard area of approximately 2 m.)
- *Ab sofort kann in den Wintermonaten nicht mehr vom 400 Hz Stecker zugeschaltet werden, das Einschalten ist nur noch am Schalter beim Fahrwerk der FGB (Fluggastbrücke) möglich.* (With immediate effect, in the winter months, power can no longer be switched on from the 400 Hz plug, but only from the switch on the passenger bridge undercarriage.)
- *Die Flugzeugstecker dürfen nicht auf den Boden gelegt werden.* (The aircraft plugs must not be placed on the ground.)

Furthermore, under the item “Massnahmen zur Risikominimierung" (measures to minimise risk), the following points were made, among others:

- *Die Geräte der Stromversorgung dürfen nicht mit dem Enteisungsmittel besprüht werden (mobile und stationäre Anlagen).* (The power supply equipment (mobile and stationary installations) must not be sprayed with de-icing agent.)
- *Das Enteiserteam meldet der Avireal, wann Flächen und Docks enteist wurden.* (The de-icing team reports to Avireal when surfaces and docks have been de-iced.)

These instructions were not last based on an incident which had occurred on 29 November 2005. On the basis of a report concerning voltage fluctuations in the 400 Hz system, an electrician wished to measure the voltage at the plug. It was snowing and the stands had been de-iced. The work was carried out correctly, but when power was switched on there was a bang and arcing occurred. The electrician suffered burns to his face, neck and hand. The internal investigation came to the conclusion that when de-icing agent had been sprayed onto the stands, it must have found its way into the plug, causing a short-circuit.

Unique independently provided one-day courses twice a year, with each service provider individually. According to the course synopsis, the key points in these courses were:

Ziele (Objectives)

- *Richtige Bedienung* (correct operation)
- *Weniger Schäden* (less damage)
- *Sicherheit im Betrieb* (safe operation)
- *Feedback an Anlagebesitzer* (feedback to systems owners)

Ablauf (Procedures)

- *Zuständigkeiten bei Unique und Avireal* (the competencies of Unique and Avireal)
- *Bedienung der 400 Hz Stromversorgung* (operation of the 400 Hz power supply)
- *Bedienung Klimaversorgung PCA* (operation of the PCA air-conditioning supply)
- *Hauptsächliche Bedienungsfehler* (main operating errors)
- *Feedback*

1.17.3 The maintenance company Avireal AG

Avireal describes itself as the leading provider in the Integrated Facility Management (IFM) market. Avireal specialises in the management of technically complex building infrastructures and operating installations.

In 1997, the Facility Management Division was split off from the former Swissair company, became independent and was transferred to Avireal AG.

For Zurich Airport, Avireal was obliged by Unique to maintain and repair the following installations, among other things:

- aircraft energy supply
- aircraft de-icing system

The Avireal employees responsible for maintenance are able to monitor and control the functions of the aircraft energy supply from a central monitoring console.

Avireal's fault-clearing service reported the serious incident to the technical division by telephone. Since the responsible supervisor was monitoring the telephone call, he immediately set off in a car with a colleague without consulting the central monitoring system. At stand A-57, the two of them made sure that the cable was not live and switched off the "Gate-Abgangsschalter" (gate outlet switch). They then informed the appropriate Unique office.

1.17.4 The service company Swissport

1.17.4.1 General

Until 1996, today's Swissport operated under the name "Swissair Ground Services". After 1996 it was part of SAirServices and worked as an independent ground handling company.

Worldwide, Swissport provides various services at more than 170 stations. At Zurich Airport these are:

- Ground handling services
- Executive aviation
- Aviation security
- Maintenance services

Among other things, Swissport is responsible for connecting Swiss European Air Lines aircraft to the external energy supply on the fingerdocks.

1.17.4.2 Employment and training of workers

According to Swissport, the minimum requirements for new workers are, among other things, Swiss citizenship or residence permit C, the possession of a category B driving licence and the ability to understand and speak German.

When a new worker is employed, he undergoes a three-day internal training course. During this training, he is introduced to administrative matters. In addition, he must undergo the dangerous goods training prescribed according to JAR-OPS, which is concluded with a test. This training also includes passing the Unique's safety test, which is a prerequisite for obtaining the airport permit. At the end of this three days of training, driving lessons take place on the apron.

Tests are partly verbal and partly computer-based. Printed test results must be signed by the employee. The test results are filed for each worker in his personal dossier and form part of Swissport's skill database.

Training of workers on the corresponding equipment takes place in a practical environment. Since this equipment is in daily use, no recurrent training is provided in this regard.

A technical report takes place every two weeks. Innovations or problems are addressed and any questions are dealt with.

Every two years, the Federal Office for Civil Aviation (FOCA) requires proof that the dangerous goods course has been repeated successfully.

1.17.4.3 Quality control within the company

Swissport considers employees' sense of responsibility as an important component of company quality control. This is manifested by the fact that supervisors must certify with their signature on a daily basis that the work has been carried out in accordance with the regulations and instructions currently in force.

The workers' job is internally checked on site every month in order to ensure that work is being performed in accordance with the regulations in force. In addition, external audits are carried out by Unique and Swissport customers. In the case of the audits by Unique, compliance with the ramp safety instructions is checked.

1.17.4.4 Dealing with unusual incidents

Workers are informed of unusual incidents by means of a "FACHINFO RAMP" or a "Safety Information" on the notice board.

Safety Information which is classified as critical by Swissport is discussed with each individual worker. The latter must certify with his signature that he has understood the content of the "Safety Information".

Before the serious incident, Swissport informed workers via a "Safety Information" dated 30 November 2005 of the introduction of a new surface de-icing product by Unique as follows:

The advantages of the new surface de-icing agent:

- *Günstigeres Produkt* (a lower-cost product)
- *Verbesserte Enteiswirkung* (improved de-icing effect)
- *Biologisch abbaubar* (biodegradable)

The disadvantages of the new surface de-icing agent:

- *Aggressiveres Mittel, welches Material angreift* (a more aggressive agent, which attacks material)
- *Starke Stromleitfähigkeit* (high electrical conductivity)

Workers were also made aware of the following points:

- *Strom darf nur zugeschaltet werden, wenn der Stecker eingesteckt ist.* (Power may be switched on only when the plug is inserted.)
- *Der Strom muss von demjenigen zugeschaltet werden, der den Stecker eingesteckt hat (1 Mann-Betrieb).* (Power must be switched on by the person who has inserted the plug (one-man operation).)
- *Der Stecker darf nie auf dem Boden geschleift werden und sollte nicht mit dem Enteisungsmittel in Berührung kommen.* (The plug must never be dragged on the ground and should not come into contact with the de-icing agent.)
- *Falls der Pilot Stromschwankungen oder sonstige Störungen meldet, darf nicht versucht werden durch Rütteln und sonstige Manipulation einen Wackelkontakt zu beheben. (Brand- und Stromschlaggefahr). In diesen Fällen muss der Strom ausgeschaltet werden und die Avireal (Dock) oder Werkstatt (GPU) umgehend informiert werden.* (If a pilot reports power fluctuations or other faults, no attempt must be made to remedy a loose connection by wiggling or other manipulations. (Danger of fire and electric shock). In these cases, power must be switched off and Avireal (dock) or the workshop (GPU) must be informed immediately.)
- *Als weitere Sicherheitsmassnahme wird während der Wintersaison die Stromzuschaltmöglichkeit an den Steckern deaktiviert.* (As a further safety measure, the power switch on the plug is deactivated during the winter season.)

The deactivation mentioned in the final point was completed on 25 January, the day before the serious incident.

1.18 Additional information

In cooperation with Flughafen München GmbH (FMG), the TÜV carried out an analysis of the hazards and risks due to de-icing agents in late autumn 2004. In particular, this was related to the "Clearway F5" de-icing agent, which is comparable with the "AVIFORM L50" de-icing agent used in connection with the serious incident. According to information from FMG employees, accidents have already occurred at Munich Airport and at other commercial airports in connection with the de-icing agent.

The findings of this hazard and risk assessment are therefore of significance for the serious incident. A few of the essential findings are cited below:

Infolge Verwirbelung des Enteisungsmittels, z. Bsp. beim Transport der mobilen Geräte der Bodenstromversorgung oder beim Einrollvorgang der Flugzeuge, kann sich ein leitfähiger Belag auf den Flugzeugsteckern bilden. (As a result of de-icing agent swirling, e.g. during transport of the mobile ground power supply equipment or when aircraft are taxiing, a conductive layer can form on the aircraft plugs.)

Durch diesen leitfähigen Belag kann im Extremfall eine gefährliche Berührungsspannung (gegen die Aussenhaut des Flugzeuges) auf die Oberfläche des Flugzeugsteckers verschleppt werden bzw es kann zu Kriechströmen und Kurzschlüssen im Steckerbereich kommen. (As a result of this conductive layer, in extreme cases a dangerous contact voltage (against the outer skin of the aircraft) may be established on the surface of the aircraft plug, or leakage currents and short-circuits may arise in the plug.)

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Technical aspects

2.1.1 Connection of the external power supply to the aircraft

For reasons of environmental protection and cost, many airlines no longer use the auxiliary power unit (APU) after landing, as it is assumed that the external power supply will be available within a very short time at the fingerdocks. Flight crews are obliged to shut down the engines immediately after coming to a standstill at the dock so that the doors can be opened. This puts pressure on the personnel from the corresponding service provider to make the external power supply available as quickly as possible.

This causes the worker beginning to extend the cable, with the help of the cable lift up device, even before the aircraft comes to a standstill and to approach the expected position of the aircraft nose.

Immediately after the aircraft comes to a standstill, the worker opens the cover in the aircraft fuselage to obtain access to the aircraft-side connector. Since he generally needs two hands to do this, he may be unable to keep hold of the plug on the extended cable. He either places the cable over his shoulder or, as was observed as part of the investigation, places it on the ground.

Two days after the serious incident, the investigation team inspected stand A-57 and observed the cable connection procedure for the external power supply. An aircraft was towed to the stand. The cable was pulled from the dock to the aircraft. In order to open the aircraft-side cover, the worker needed both hands and he therefore placed the cable on the ground. It must be assumed that this procedure was not an isolated case, as the new plug fitted after the incident already exhibited abrasion marks (Annex 9). This allows the conclusion that the cable is not only laid on the ground, but is also dragged around on the ground. If the ground is contaminated, this may cause contamination on the surface of the plug. This creates the conditions which prevailed in the serious incident.

2.1.2 Use of the dock-side aircraft energy supply system

The airport operator is basically responsible for training persons who operate the systems for the external power supply. It produces the corresponding training documentation, but has delegated training to the companies which provide this service.

The training documentation available to the investigation proves that personnel are fully trained. The directives and information which are additionally produced on a regular basis by Unique for the service providers, concerning incidents and events, confirm this impression.

Since the external power supply system is handled by three different service providers on Zurich Airport, it was not possible to establish which service provider was not handling the power supply cable with the necessary care.

2.1.3 Potential hazards with de-icing agents

It is known that most de-icing agents contain components which exhibit a degree of aggressiveness. There are potential hazards due to the fact that metals may be corroded or that electrical leakage currents may occur. Leakage currents may develop into a short-circuit in extreme cases.

The “AVIFORM L50” de-icing agent used in connection with the serious incident was described in an information letter from Unique to the service provider, among other things, as: “*Aggressiveres Mittel, welches Material angreift, mit starker Stromleitfähigkeit“* (aggressive agent which attacks material, with a high degree of electrical conductivity).

The “Clearway F5” de-icing agent investigated by the TÜV (D), in cooperation with Flughafen München GmbH, is also described, amongst other things, as follows:

“Infolge Verwirbelung des Enteisungsmittels, z. Bsp. beim Transport der mobilen Geräte der Bodenstromversorgung oder beim Einrollvorgang der Flugzeuge, kann sich ein leitfähiger Belag auf den Flugzeugsteckern bilden". (As a result of de-icing agent swirling, e.g. during transport of the mobile ground power supply equipment or when aircraft are taxiing, a conductive layer can form on the aircraft plugs.)

The fluid residues inside the plug analysed in the course of the investigation exhibited practically identical elemental composition as the de-icing fluid. On the basis of the chemico-physical analysis it can be assumed that the short-circuit was caused by de-icing fluid which had penetrated the plug.

2.1.4 De-icing of movement areas

According to the removal log, stand A-57 was last de-iced four days before the serious incident. This stand has a heated midfield that as a rule will not be de-iced. On the day of the serious incident, light snowfall had occurred during the morning and in the course of the morning the taxiways which skirted stand A-57 directly but not the stand itself had been de-iced. It is obvious that the Airbus A-319 aircraft which had used stand A-57 just before, as well as the aircraft using the taxiway, had swirled contaminated snow. In addition, service vehicles, with contaminated snow adhering to their tyres from de-iced taxiways or roads, conveyed this snow to stand A-57. It can therefore be assumed that stand A-57 was covered with moister interspersed with de-icing agent.

2.1.5 Contamination of the dock-side plug

There are several possibilities as to how the dock-side plug could have been contaminated with de-icing fluid. The aircraft taxiing to the stand may cause turbulence with their engines and deposit contaminated snow on the plug. Swirl may also be caused by aircraft taxiing past. In this regard, stand A-57 is in an extreme position, as it borders taxiways on two sides.

Another possibility of contamination of the dock-side plug with de-icing fluid lies in inappropriate handling, i.e. placing the cable on the ground or dragging it along the ground.

There are essentially two possibilities as to how the de-icing fluid was able to penetrate into the plug. It can penetrate on the one hand through the very small aperture between the sockets and the connector housing, and on the other through joints in the connector housing.

When and how the de-icing fluid was able to penetrate the plug in the present case must remain open.

2.2 Human and operational aspects

2.2.1 Flight crew

The short-circuit and the resulting explosive flame in the cockpit occurred at a time when the copilot had reached the final points on the parking checklist. The emergency slides in the cabin had therefore already been disarmed. The operational status of the emergency slides did not therefore correspond with that prescribed for an emergency evacuation.

The crew were unable to localise exactly the explosive flame accompanied by thick black smoke; nor were they able to establish its origin. Since the cockpit oxygen line is in the vicinity of the explosive flame, the commander considered the hazard as severe and decided immediately for an emergency evacuation. It must remain open whether he was aware that the emergency slides were no longer armed at this point. In addition, he probably did not realise that the passenger bridge had already been brought up to the aircraft.

The flight attendant in the front cabin heard the commander's evacuation order. He realised immediately that the emergency slides were already disarmed and wanted to ascertain whether the passenger bridge was already docked with the aircraft by looking through the fisheye lens in the forward passenger door. Since he could not establish this, he re-armed the emergency slide and opened the door. When the door opened, he noted that the passenger bridge was already at the aircraft. The package with the emergency slide subsequently fell onto the floor of the passenger bridge and was therefore unable to deploy. The flight attendant's reaction of requesting passengers to leave the aircraft immediately and leave their hand luggage behind (rapid disembarkation) was correct in the situation and appropriate. However, it must be stated that as a result there arose a risk of inadvertent deployment of the emergency slide. This could have been avoided by unlatching the emergency slide package (quick release) and removing it from the area of the forward left door.

The copilot heard the commander giving the evacuation order. According to his statement, the copilot could not recall having received the order from the commander to process the corresponding emergency checklist. In view of the evacuation order, however, he would have had to process this emergency checklist autonomously. The result of this would have been that the copilot would have switched off the aircraft's auxiliary power unit (APU). However, since according to his statement he was primarily preoccupied with fighting the fire, he left the APU running, particularly because he was sure that it could not be the source of the fire.

As a result of the APU not being switched off, the aircraft remained in an operating condition which did not correspond to that applicable to an emergency evacuation. Among other things, with the APU switched off the normal cabin lighting would have gone out and only the emergency lights would have been on. Switching off the APU and the associated electrical switch-over would have been visually and audibly perceptible in the cabin.

Since nothing changed in the cabin, any indications of an abnormal situation were lacking. This may have been a deciding factor why the passengers hesitated to or did not at all obey the rapid disembarkation order.

The flight attendant in the rear section of the cabin also heard the commander's evacuation order. Since, as has been described above, no indications of an abnormal situation were detectable in the cabin, for him the evacuation order did not correspond to the current situation. Nonetheless, he did glance through the fisheye lens in the aft doors, as it would have been his tasks in an emergency evacuation. Since he was also unable to discern anything abnormal here, he omitted to re-arm the emergency slides and to open the doors in order to make available the two rear evacuation routes. This omission did not have any consequences, as all the passengers disembarked the aircraft normally through the forward door.

In this present case, the triggering of an emergency evacuation coincided with the process for a normal passenger disembarkation, which was already well advanced. As a result of this, and by not switching off the APU, there arose uncertainty among the cabin crew about performing an emergency evacuation. The incident demonstrates the importance of a comprehensive evaluation of the situation before initiating an emergency evacuation.

2.2.2 Raising the alarm with the fire brigade

On the commander's order, the copilot raised the alarm with the fire brigade. To do this he used the Zurich Delivery frequency. Normally this call would have to be made on the Zurich Apron frequency. Since the copilot, at the stand, had already switched to the Zurich Delivery frequency in preparation for the next crew, the call was made on this frequency by mistake. This led to uncertainty at Zurich Delivery, leading to a query as to the identity of the caller.

2.2.3 The worker

There are no indications whatsoever that the worker responsible for the external power supply had been working contrary to the existing regulations and procedures. He was following the instruction that connecting and switching on the power must be performed in one-man operation. The serious incident indicates the appropriate nature of the modification which permitted the power to be switched on only from the dock. If the power had been switched on at the plug, the worker concerned might have suffered serious injuries due to the short-circuit.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- On the basis of the chemico-physical analysis it can be assumed that the short-circuit was caused by de-icing fluid which had penetrated the plug.
- A short-circuit had already occurred on 25 November 2005 when the power was switched on. The internal investigation carried out at the time came to the conclusion that de-icing agent must have penetrated into the plug, causing the short-circuit.
- According to information from employees of the Flughafen München GmbH, incidents of the same nature had already occurred at Munich Airport and other commercial airports before the serious incident.

3.1.2 Crew

- The commander decided immediately for an emergency evacuation.
- The copilot did not process his points in the corresponding emergency checklist. Consequently, the aircraft's auxiliary power unit (APU) was not switched off.
- The copilot used the fire extinguisher in the direction of the explosive flame.
- The failure to switch off the APU caused uncertainty among the cabin crew with regard to performing an emergency evacuation.
- The flight attendant in the front section of the aircraft cabin decided to perform the evacuation in the way of a rapid disembarkation.
- The flight attendant in the rear section of the cabin acted only partially in accordance with the procedures specified by the airline for an emergency evacuation.

3.1.3 Service provider

- There are no indications that the worker responsible for connecting the power did not comply with the existing regulations and procedures.

3.1.4 General conditions

- De-icing agents for movement areas contain components which represent potential hazards in terms of corrosion and electrical short-circuits.

3.2 Causes

The serious incident is very probably attributable to the fact that the dock-side plug had been contaminated with de-icing fluid used for airport movement areas, causing a short circuit.

4 Measures taken since the serious incident

4.1 By the airport operator

Immediately after the serious incident, Unique imposed, via NOTAM, various restrictions concerning the availability of the external power supply at the docks. One day after the serious incident, Unique decided to switch off the 400 Hz power supply on all docks until further notice. The external power supply to the docks was restored on 31 January 2006 after insulation measurements had been taken.

A process instruction, issue date 8 March 2006, was published under the title: *"Prüfung der stationären 400 Hz Anlagen nach der Ausbringung von Flächenenteisungsmittel"* (Testing of the stationary 400 Hz equipment after the application of de-icing agent). This process instruction essentially contains the performance of insulation measurements on the 400 Hz connections within a maximum of 24 hours after surface de-icing.

In order to provide the best possible protection for the plugs from external influences (swirl), Unique arranged for the installation on all stands of a protective sleeve in which the plugs are to be stored when they are not in use (see Annex 10).

4.2 By the maintenance company Avireal

Immediately after the serious incident, inspection of all power connections, taking insulation measurements. Corresponding information to the service providers.

4.3 By the service company Swissport

On 31 January 2006, workers were informed as follows by means of a "Safety Information" from the ramp services manager:

"Geschätzte Mitarbeiter

Nach dem jüngsten Vorfall im Zusammenhang mit der Energieversorgung ist es zwingend, dass Ihr die nachfolgenden Anweisungen beim Gebrauch des 400Hz Stromkabels am Dock wie auch bei den GPU ausnahmslos einhaltet:

- *Der Stecker darf nie mit dem Enteisungsmittel in Berührung kommen! Es ist strengstens verboten, den Stecker auf den Boden zu legen oder auf dem Boden nachzuschleifen!*
- *Das Anstromen darf nur im 1 Mann Betrieb erfolgen. Das heisst: Derjenige der den Stecker einsteckt, muss auch den Strom zuschalten. Beim Einschalten darf sich niemand im Gefahrenbereich (3 Meter) des Steckers befinden.*
- *Strom darf nur zugeschaltet werden, wenn der Stecker eingesteckt ist.*
- *Bei Unregelmässigkeiten oder Anzeichen, dass der Stecker dennoch mit Enteisungsmittel in Berührung gekommen ist, muss umgehend der Teamleiter informiert und Avireal (Dock) resp. die Werkstatt BZRU (GPU) aufgeboten werden.*

Besten Dank für die Einhaltung dieser Sicherheitsanweisung."

(Dear colleagues

After the latest incident in connection with the power supply, it is imperative that you comply without exception with the following instructions when using the 400 Hz power cable on the dock and at the GPU:

- The plug must never come into contact with de-icing agent! It is strictly forbidden to place the plug on the ground or to drag it along the ground!
- Connection must take place in one-man operation only. This means: the person who inserts the plug must also switch on the power. When power is switched on, no-one must be within the hazard area (3 metres) of the plug.
- Power may be switched on only when the plug is inserted.
- In the event of irregularities or indications that the plug has in fact come into contact with de-icing agent, the team leader must be informed immediately and Avireal (Dock) or the workshop BZRU (GPU) must be called in respectively.

Thank you for complying with this safety instruction.)

4.4 By the aircraft manufacturers Boeing and Airbus

The basic problems using de-icing fluid for airport movement areas is known to the aircraft manufacturers for quite a while. In a joint letter, dated July 2006 (see Annex 11), they have addressed the negative effects of corrosion in the area of electrical systems and brakes.

Berne, 22 October 2009

Federal
Aircraft Accidetn Board

André Piller, president

Tiziano Ponto, vice-president

Ines Villalaz-Frick, member

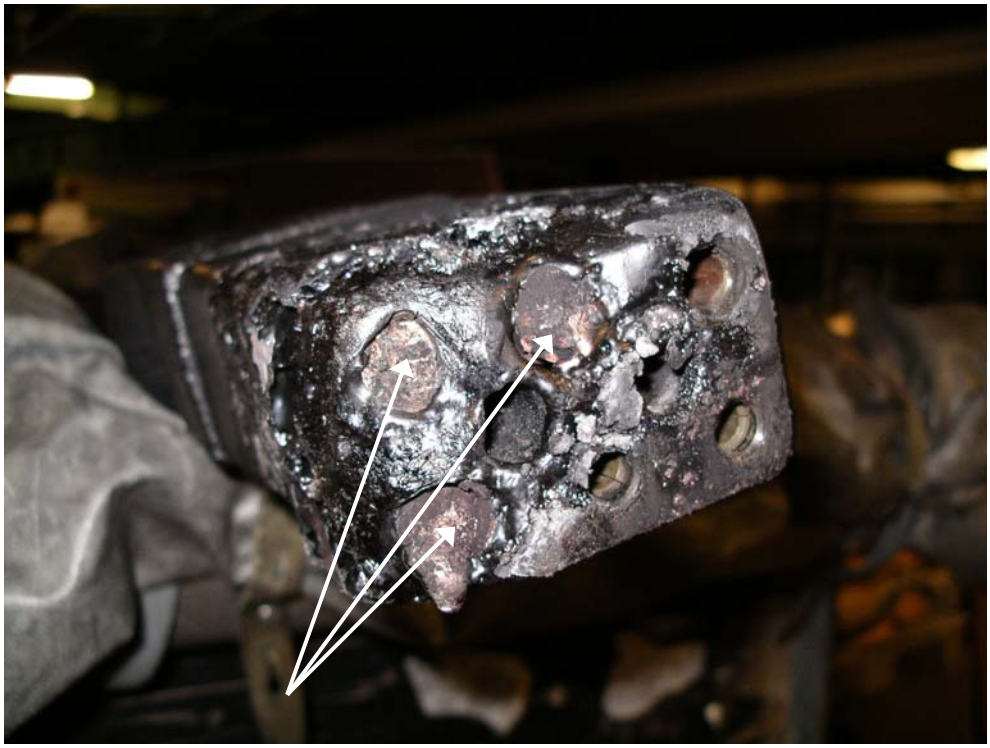
Annexes

Annex 1: Traces of soot on the surface of the fuselage

Annex 2: Crack from the contact pin to the edge of the connector plate

Annex 3: Hole in the fuselage

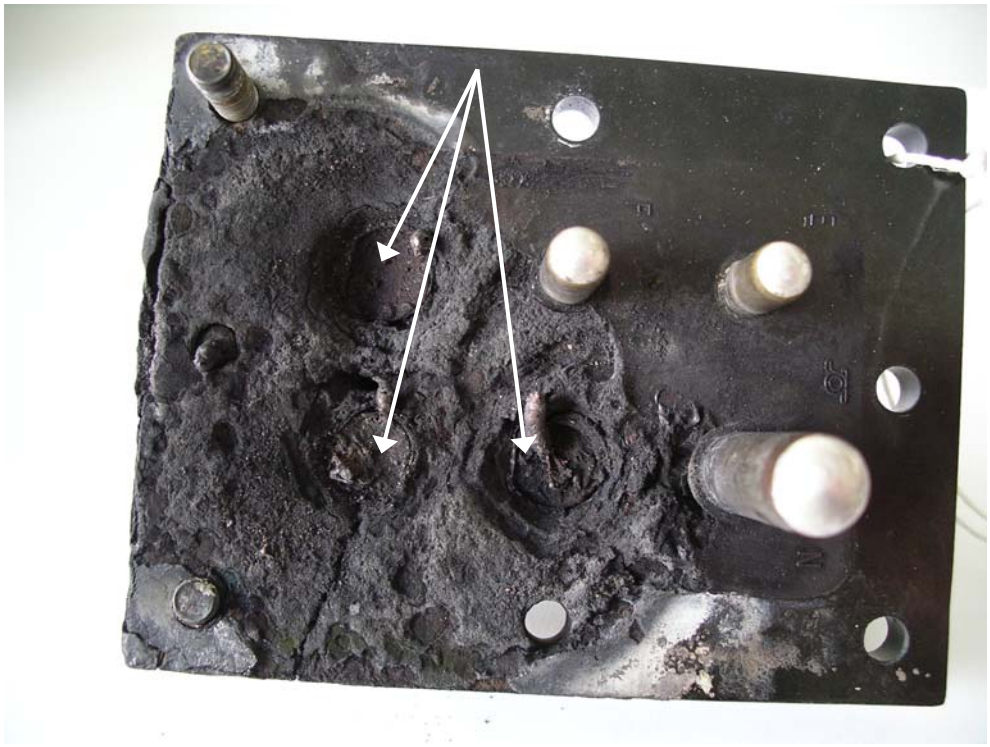
Annex 4: Destroyed dock-side plug



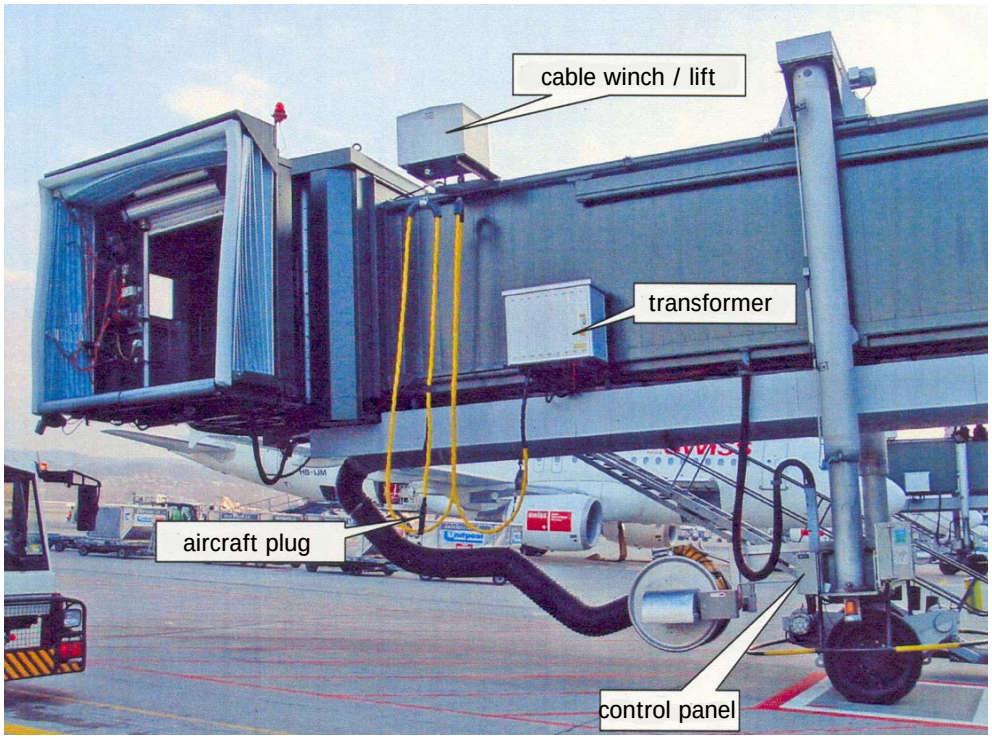
The three molten contact pins of the aircraft-side connector plate

Annex 5: Contact pins on the aircraft-side connector plate

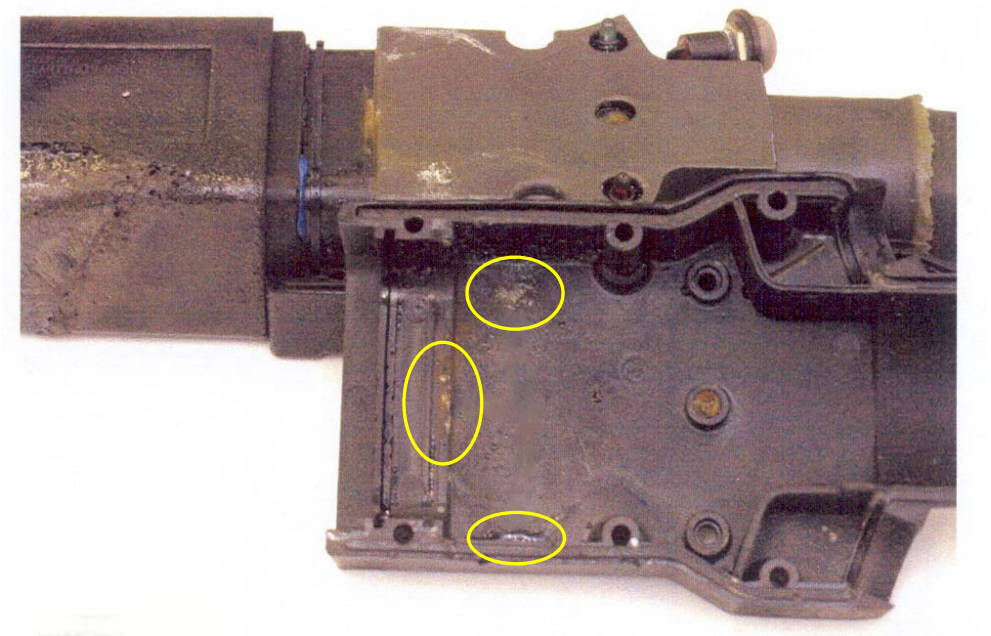
The three phase contact pins have melted away



Annex 6: Cable lift up device



Annex 7: Fluid residues on the dock-side plug



Annex 8: W/I Working Instruction (example 603EG19)

aviReal Operations EOB — UNIQUE — W/I - Arbeitsanweisung

Anlage:	**400 Hz - Installationen in WB 2**	Anweisung Nr.	**603EG19**
Zusatzinfo:	FEV Dock E	Anlage Nr.	600
Lieferant:	Statron, Fladung, Thyssen		
Erstellungsdatum:	26.11.2003	Revision:	25.05.2005
Ersteller:	R. Eigenheer EOPP	Revisor:	R. Eigenheer

Technische Daten:	**Gates E 19, 23, 25, 27, 35, 37, 43, 45, 47, 53**
Sicherheitshinweise:	Eigene Tätigkeit sichern mit dem persönlichen Sicherheitsschloss Vorsicht: Anlage läuft automatisch an
Gültigkeit:	Statische Umformer, Kabeltrommel mit 400 Hz Kabel und Stecker Flugzeugfühler in Kabine (Inspektion 400 Hz Kabel in der Energiekette der Fluggastbrücke macht Unique)

Elektro

Was	Tätigkeit	Intervall in Monaten 1	3	6	12	96	Einstell-werte v
Vorgabezeiten in Stunden (pro Intervall) >>>>>>>>>>>>>>>>>:			60.0		96.0	16.0	
Andienkabel							
Stecker - Gehäuse	Auf Beschädigung und aussergewöhnliche Abnutzung prüfen	KR	x				
Stecker - Kontakte	Sichtkontrolle (ggf. reinigen)	KR	x				
	Auszugskräfte der Kontakte A, B, C, N messen	KR	x				a
	Auszugskräfte der Kontakte E, F messen	KR	x				b
Mikroschalter	Prüfung mit E-Kontakt	KR	x				
LED	Prüfung		x				
Taster	Funktionsprüfung		x				
Kabel	Auf Beschädigung und aussergewöhnliche Abnutzung prüfen -		x				
	durch komplettes Herausziehen des Kabels						
400 Hz Spannungsmessung							
Phase A > N	Volt:		x				
Phase B > N	Volt:		x				
Phase C > N	Volt:		x				
N gegen Erde	Volt:		x				
Kurz - Rundgang (KR)	Gate WB 1 Gate WB 3						

v v <<

Einstellwerte:	
Position	Wert/Hinweis
a	5 - 8 kg
b	4 - 6 kg
c	Metaflux Gleitmetall

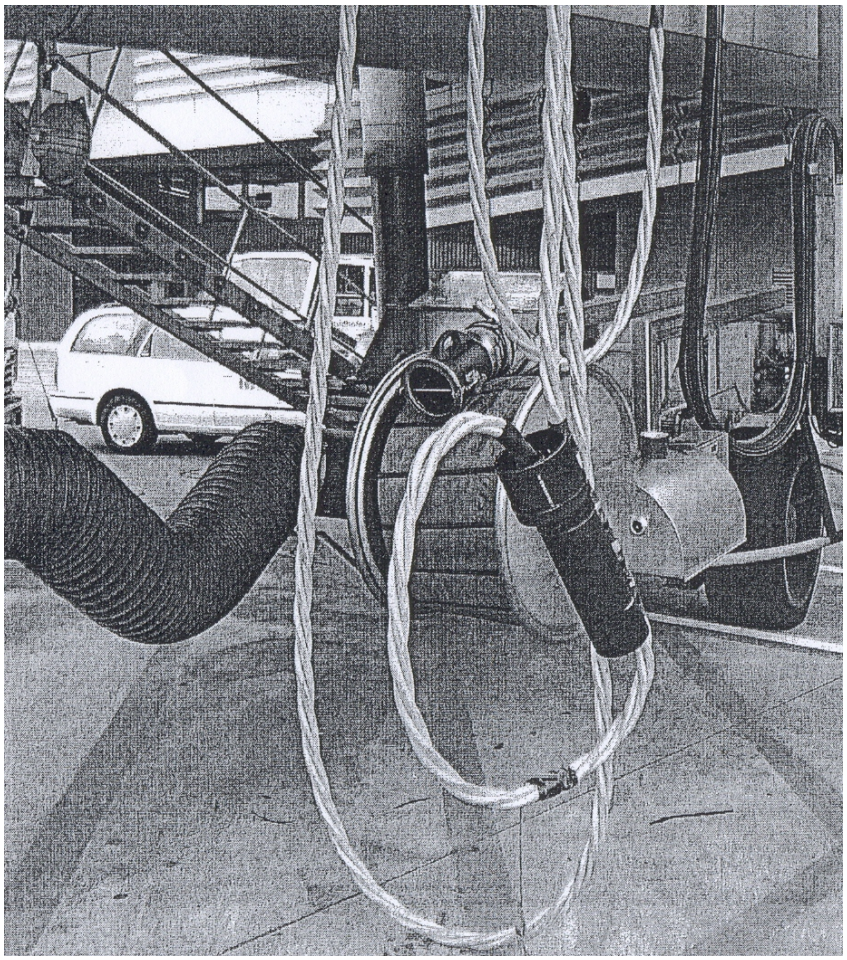
Zusatzdefinitionen:
d = täglich
w = wöchentlich
KR = Kurzrundgang

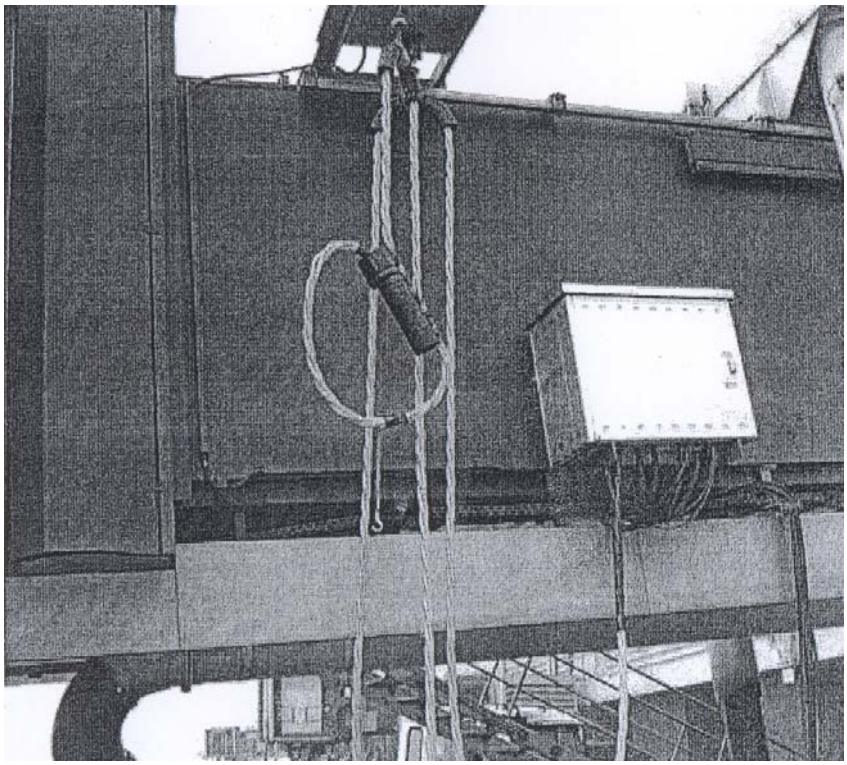
Funktionskontrolle
Ende der Tätigkeiten

19.07.2005 2/2 603EG19

Annex 9: Abrasion marks on the two-day old plug

Annex 10: Protective sleeve for the dock-side plug





Annex 11: Letter by the Aircraft Manufacturers Boeing and Airbus (July 2006)

BOEING

Michael Arriaga, CMfgT
747/767/777 Service Engineer
Mechanical Systems -767 Landing Gear
Tel: +1.425.294.8115
FAX: +1.425.294.2945
email: michael.a.arriaga@boeing.com

AIRBUS

Alun ***WILLIAMS***
Manager General Mechanical Systems
Engineering (EYDCC, B23 1115), Airbus SAS
1 Rond-Point Maurice Bellonte
31707 Blagnac CEDEX, France
e-mail:alun.a.williams@airbus.com
Tel: +33 561 93 32 82

July 2006

General Letter to Airports, Authorities, Operators and Suppliers

Use of Runway De-Icers - Potassium Formates/Acetates Corrosion on Aircraft.

Since 1997 a serious problem of catalytic oxidation has been occurring on aircraft using carbon brakes.

The requirement for the use of carbon brakes originated in various weight-saving initiatives by aircraft manufacturers during which steel brakes were replaced by carbon brakes and new aircraft were delivered with carbon brakes.

In 1997 because of a concurrent initiative by airports, to improve or control their environmental pollution, a change in the use of runway de-icing fluids took place in favour of more environmentally mild products.

This resulted in the use of potassium based products containing potassium formates and/or acetates. These chemicals (organic salts) attack the carbon in the brake and unfortunately create a catalytic oxidation which softens the carbon causing it to flake and crumble undetected and unpredictably over time thus reducing the life and long-term efficiency of the brakes themselves. There is therefore a safety issue involved, namely that of a brake failure during high-speed aborted take-off and the possibility of a brake/wheel fire from hydraulic fluid released during that failure.

In 2002 Transport Canada Civil Aviation issued Aerodrome Safety Circular ASC 2002-015, which describes the situation regarding the severity of potassium formate reaction and advising that airports should not use it. At that time the circular was pointed towards electrical connection and followed a Boeing Advisory form 2001. FAA also had issued a similar advisory at around the same time.

Since then it appears that Formates also attack carbon and potassium acetates also add to the problem. Worst case for carbon is acetates, second worse is formates.

SAE G-12F, among other Industry working groups, have been working for some time to try and reduce these effects from runway de-icers used by airports, which not only reduce aircraft safety but also enormously increase costs (maintenance, cost of ownership and, of course, eventually passenger costs), in fact it is becoming apparent that perhaps hundreds of millions of dollars of industry usable revenue have been lost over the last ten years on this particular issue. Airports, themselves, are also experiencing costs related to the use of these fluids, we understand.

During winter, snowplough activity leaves fairly large amounts of fluid and slush on runways because snowplough drivers lower the plough blade to within half an inch (15 mm.) of the runway surface, leaving the last part to be dealt with by the runway de-icing fluids, even though some airports use a broom wagon to follow the plough and sweep the slush, there will still be heavy elements of spray from what's left and further precipitation just adds to the problem.

Unfortunately this causes a very wet, fluid (potassium) impregnated runway surface. The fluid is sprayed over and under the aircraft landing and taking off, where it causes various types of corrosion.

On aircraft during take-off and landing roll, the spray is often taken onto the undercarriage, particularly the centre parts, where it builds into fairly solid ice because of the reduction of chemical action of the de-ice fluid.

When the aircraft takes off again, the undercarriage legs/wheels are pulled up into the undercarriage bay. At this point the ice on the undercarriage melts and runs down onto the brake units and onto/into the carbon disks. This fluid comprises water and potassium-formates and/or acetates, perhaps both as airports do not all use the same de-icing fluids.

In the same way many aircraft have the additional issues of Cadmium corrosion, aluminium corrosion, corrosion in landing gear joints, and electrical wire bundle degradation, also caused or accelerated by the same fluids, which, again, is a further unaccounted for expense.

In addition, there is the enormous cost associated with premature and severe GSE equipment corrosion attributed to the runway and ramp fluids applied by the airports. These runway fluids are now being found to adversely affect anti-icing fluid applied to aircraft and also to promote the formation of anti-icing fluid residue gel in aerodynamically quiet areas of the aircraft.

As an immediate short-term goal, the co-chair party of the SAE G-12F Catalytic Oxidation Working Group is now approaching all Airports, Airlines and Authorities, De-Icing Fluid Manufacturers, and Carbon Brake Manufacturers, to discuss what can be done, to the **mutual** benefit of all, perhaps by using those fluids, which, on record, are causing less corrosion in all 'areas', finding other fluids - all solutions are welcomed.

Airbus and Boeing believe that, because the issue is wide and varied and the common denominator in every entity's problem appears to be the use of one type of material having an effect on many materials that an Industry meeting would be the best way to begin to promote the discussion. We are therefore requesting a response from all parties with regard to an appropriate time and venue for this meeting and some commitment in helping to find solutions to the issue. With regard to a venue, any organisation willing to provide the use of its facilities would also be appreciated.

Michael Arriaga

Alun Williams