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Swiss Confederation

Büro für Flugunfalluntersuchungen BFU
Bureau d'enquête sur les accidents d'aviation BEAA
Ufficio d'inchiesta sugli infortuni aeronautici UIIA
Uffizi d'inquisiziun per accidents d'aviatica UIAA
Aircraft Accident Investigation Bureau AAIB

Final Report No. 1953 by the Aircraft Accident Investigation Bureau

concerning the incident

to the Boeing 767-300 aircraft, HB-ISE

operated by Belair Airlines under flight number BHP 902

on 21 February 2006

at Zurich Airport

Bundeshaus Nord, CH-3003 Berne

Ursachen

Der Vorfall ist darauf zurückzuführen, dass technische Störungen am Boden dazu führten, dass auf dem Flughafen Zürich bei den herrschenden Wetterbedingungen eine Landung nicht mehr erlaubt war. Dies hatte zur Folge, dass die Flugbesatzung aufgrund des noch zur Verfügung stehenden Treibstoffes einen Anflug und eine Landung nach *low visibility procedures* durchführte, obwohl der Betrieb der Piste 16 auf CAT I beschränkt war.

Zum Vorfall beigetragen hat der Umstand, dass die Information nicht übermittelt wurde, dass die Piste 14 für Anflüge und Landungen nach CAT III nicht zur Verfügung stand.

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the incident which is the subject of the investigation.

In accordance with Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

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

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

Contents

Final Report

Owner	International Lease Finance Corporation, Los Angeles, USA
Operator	Belair Airlines AG, CH-8058 Zurich, Switzerland
Aircraft type	Boeing 767-300
Country of registration	Switzerland
Registration	HB-ISE
Location	Zurich Airport
Date and time	21 February 2006, 08:44 UTC

General

Brief description

On 20 February 2006, at 22:27 UTC, the Belair Airlines B767-300 aircraft, registration HB-ISE, flight number BHP 902, took off from Cancun MMUN (Mexico) on a flight to Zurich LSZH (Switzerland). After an uneventful flight, the crew of flight BHP 902 were instructed to join the GIPOL holding pattern.

Since at the time of landing in Zurich runway 14 was able to operate only in CAT I for technical reasons, approaches and landings were taking place on runway 16 under the low visibility procedure (LVP) because of the prevailing weather conditions.

The fact that runway 14 was available only in CAT I was communicated neither by ATIS nor by radio.

The crew decided to use the fuel intended for the flight to the alternate aerodrome for a longer stay in the holding pattern (commitment to proceed).

During the approach, the display of wind and RVR data on the air traffic control screens failed. As a result, runway 16 had to be downgraded to CAT I, causing the approach clearance to be cancelled.

The crew of BHP 902 then informed the air traffic controller (ATCO) that they would have to start the approach in 10 minutes at the latest, as otherwise they would be forced to declare an emergency because of the amount of fuel remaining.

The ATCO then offered the crew a CAT I approach. The crew pointed out that the weather conditions were not adequate for a continuation of the approach under CAT I conditions. However, they mentioned that taking into account the last RVR values transmitted and the current ground visibility they would begin an approach in five minutes.

BHP 902 was cleared for a CAT I approach on runway 16. At the request of the crew of flight BHP 902, they were given clearance to land. The landing was uneventful.

Investigation

Since this incident appeared to be of significance for improving aviation safety, the AAIB decided to carry out an investigation.

The incident is attributable to the fact that technical faults on the ground meant that a landing was no longer permitted at Zurich Airport under the prevailing weather conditions. The result was that the flight crew, on the basis of the available fuel, carried out an approach and a landing under low visibility procedures, even though operation of runway 16 was restricted to CAT I.

A contributing factor to the incident was the circumstance that no information was communicated concerning the fact that runway 14 was not available for approaches and landings according to CAT III.

1 Factual Information

1.1 Pre-flight history and history of the flight

1.1.1 Pre-flight history

On 18 February 2006, three days before the incident, a short circuit occurred in the Kloten substation of the electrical power supply system. This led to a failure of the general aviation center (GAC) distribution station, which provides the main feed to the transformer station (TS) Hell near to runway 14. The emergency power unit in the TS Hell took over power supply of runway 14 and flight operations were not restricted.

The power failure caused numerous faults on the airport. On the early morning of 19 February 2006 it was ascertained that various doors and gates in the terminals were not working. Alarm D 14 "Betriebsstörung Terminals" was triggered. Conveyor belts and escalators were also affected. It was possible to clear alarm D 14 some two hours after it was triggered.

1.1.2 Flight planning

An operational flight plan (OFP) was available to the flight crew for flight planning about one hour before they left the hotel. This is a standard procedure in the airline, which gives the crew an opportunity to acquaint themselves with the forthcoming flight in good time. This OFP included all relevant flight data such as, for example, information on the aircraft's planned zero fuel weight (ZFW), the planned flight path including all waypoints with the corresponding wind information, average wind over the entire route and the flight path distance from the departure airport to the destination airport.

In particular, this OFP listed the fuel calculations which, on the basis of the JAR OPS regulations (JAR-OPS 1, Subpart D, AMC OPS 1.255) and those of the airline, provide the crew with detailed information about the quantity of fuel required for this flight. In addition, the OFP contained information on the fuel quantity which had been consumed from the start of the flight to the individual waypoints. These fuel calculations were based on the planned take-off weight of the aircraft. The OFP also included a correction factor which informed the crew how much additional fuel would be consumed for each tonne of additional take-off weight.

For flight BHP 902, departing on 20 February 2006, this OFP envisaged the following regarding weight and fuel calculations (figures in tonnes):

OFP		Term	Explanation
ZFW	110.5	zero fuel weight	Planned weight of the aircraft without any fuel
TOF	52.5	take off fuel	Required quantity of fuel at start of take-off
TOW	163.0	take off weight	Planned take-off weight
TRIP	47.6	trip fuel	Required quantity of fuel for the flight from Cancun to Zurich
LW	115.4	landing weight	Planned landing weight
REMF	4.9	remaining fuel	Quantity of fuel still available after landing at the destination airport
BIAS	1025	correction factor	Correction factor relating to engine deterioration (2.5% more fuel)

TAXI[1]	.4	taxi fuel	Required quantity of fuel up to take-off at the departure airport
LSZH	47.6	fuel to destination	Required quantity of fuel from take-off to landing at the destination airport
T20 [2]	1.6	fuel for 20 min	Quantity of fuel for 20 minutes flying time
LFSB	1.4	fuel to alternate	Required fuel from destination airport to alternate airport
CF	.0	company fuel	Additional quantities of fuel specified by the airline
FR [3]	1.9	final reserve	Minimum remaining quantity of fuel which should be available after landing
REQ	52.9	required fuel	Minimum quantity of fuel required for the flight
EXT	...	extra fuel	Extra fuel specified by the crew
ACT	...	actual fuel	Actual total quantity of fuel ordered

As can be seen from the OFP, a minimum fuel quantity of 52.9 tonnes was calculated for flight BHP 902. A value of 264 kg was indicated on the OFP as a correction factor for an increased take-off weight. This means that fuel consumption increases by 264 kg if the take-off weight is increased by 1 tonne.

Since, according to the commander's statement, the ZWF of 110.5 tonnes seemed to the crew to be too low on the basis of the number of passengers reported in the load briefing dated 18 February 2006, they decided to work on the basis of a ZFW of 117 t. For this increased ZFW, they corrected the original fuel quantity envisaged for the flight by 2 tonnes to 54.9 tonnes. In addition, the crew decided to tank 1.1 tonnes extra fuel[4]. In total, this led to a 56 tonne fuelling for the planned flight BHP 902.

By means of the loadsheet, the crew then received the effective ZFW of 120.3 tonnes shortly before departure. This ZFW, further increased because of cargo accepted at short notice, required a further correction of the fuel quantity planned for the flight. However, since this additional quantity of nearly 1 tonne was already covered by the 1.1 tonnes of extra fuel, the crew decided against a further correction.

1.1.3 History of the flight

On 20 February 2006, at 22:27 UTC, the Belair Airlines B767-300 aircraft, registration HB-ISE, flight number BHP 902, took off from Cancun MMUN (Mexico) on a flight to Zurich LSZH (Switzerland).

1 Covers 30 min use of APU, engine start and 15 min taxi time

2 20 min flying time based upon planned trip fuel consumption

3 30 min flying time at holding speed at 1500 ft AAL under ISA conditions at estimated LW

4 extra fuel is an amount taken at the CMD's discretion

On 21 February 2006 at 06:00 UTC, runway 14 at Zurich airport became operational for approaches under CAT I conditions. From 06:24 UTC, because of a worsening weather situation, low visibility procedures (LVP) were applied to runways 14/16. It is a prerequisite for LVP operation that the air traffic controller (ATCO) in the control tower switches an emergency power unit in parallel with the mains supply for the active runway. At 06:29 UTC it was found that the emergency power unit for runway 14 in the transformer station TS Hell could not be connected. It could not be synchronised with the mains supply. Consequently it was not possible to use runway 14 in LVP operation. At 07:12 UTC, therefore, a runway change to runway 16 was carried out.

The fact that runway 14 was therefore available only for CAT I operation was neither communicated via ATIS nor by radio.

After an uneventful flight, flight BHP 902 reached waypoint MELKO at 07:48 UTC. In accordance with normal procedures, the crew checked the quantity of fuel consumed and determined the remaining quantity of fuel. At this time, according to the crew's flight plan documents, the indicated fuel was 5.2 tonnes. This fuel quantity was 1100 kg above the calculated minimum quantity which was required according to the OFP to complete the flight to Zurich and a possible diversion to Basle. It also included the prescribed minimum quantity which must still be available after landing (the final reserve – FR). The expected landing weight was about 10 tonnes higher than the weight used as a basis in the OFP. This would have resulted in an FR of 2.1 tonnes instead of 1.9 tonnes. Hence the actual quantity of 5.2 tonnes was effectively only 900 kg over the required minimum quantity.

At 07:59:15 UTC, the crew of BHP 902 made contact with Zurich Area Control Centre (radar lower sector west). It received an instruction from the ATCO to fly to waypoint GIPOL and to join the corresponding holding pattern. The crew received from the ATCO an expected approach time of 08:36 UTC.

On the basis of this approach time and the Zurich weather report in force for this period, the crew decided to remain in the holding pattern and to land in Zurich (commitment to proceed). This was in accordance with the airline's corresponding procedures. As a result, the fuel quantity planned for the flight to the alternate airport of Basle was available to the crew for a longer period in the holding pattern.

At 08:06:34 UTC, the frequency change to the approach ATC unit (Zurich arrival sector west - APW) took place. At 08:07:03 UTC, APW requested the crew of BHP 902 to proceed to the GIPOL holding pattern to hold and notified them of an expected ILS approach on runway 16.

At 08:18:53 UTC, the approach time was corrected as follows by the ATCO: *"Good news for you, new approach time is now three two"*.

At 08:25:31 UTC, the ATCO instructed the crew of flight BHP 902 to leave the holding pattern and to turn onto a heading of 060°. At the same time he informed the crew that they would be guided by radar vectors onto the runway 16 ILS. Shortly afterwards, flight BHP 902 received the instruction to maintain a speed of 200 KIAS and at the same time they were informed of a runway visual range (RVR) of 400 metres for runway 16.

At 08:27:17 UTC, the crew received the information that they still had a flight path of 35 NM before landing. At 08:27:42 UTC, they received clearance to descend to 6000 ft QNH and at 8:29:20 UTC they were instructed to contact approach control (Zurich final - FIN).

At 08:30:27 UTC, flight BHP 902 received clearance to descend to 4000 ft QNH and was notified of an RVR of 450 metres for the touchdown zone and an RVR of 900 metres for the midpoint.

At 08:30 UTC, the emergency power supply for runway 16 in the transformer station TS North was also connected manually to that for runway 14. To do this, the TS Hell had to be switched off for approximately 2 minutes.

At 08:31 UTC, the display of wind and RVR values failed on the INCH (internal information system) screens. As an immediate measure, the DOM immediately contacted the system manager (SYMA) and asked how long the outage would last. Since he did not receive any reliable information, he decided to downgrade operation of the ILS 16 to CAT I and instructed the coordinator approach (CAP) to abort approaches under CAT II/III conditions. In addition, he arranged for the installation of a temporary anemometer, which was stored in the tower. He also called back his colleague from his break.

At 08:31:56 UTC, the approach clearance for flight BHP 902 was cancelled by the ATCO and the crew were instructed to climb back to 5000 ft QNH. The ATCO justified the discontinuation of the approach with reference to the failure of the RVR data, which were no longer available to him on his screen.

The ATCO's instruction to climb back up to 5000 ft QNH led to a query from the crew, because at this time the aircraft was descending to the cleared altitude of 4000 ft QNH and was currently passing 5500 ft QNH. After a corresponding clarification at 08:32:27 UTC, they stopped their descent at 5000 ft QNH.

The crew were then asked whether they were in a position to turn left and fly back to waypoint GIPOL. They confirmed this and asked how long the expected delay would last. The ATCO informed the crew that they would be notified as soon as further details were available.

At 08:33:35 UTC, the crew were instructed by the ATCO to climb to 7000 ft QNH, corresponding to the minimum holding altitude in the GIPOL holding pattern. The crew replied that they were unable to obey this instruction: *"...negative we have to stay at five thousand we're short of fuel"*. The ATCO then allowed the aircraft to fly a full circuit in its current position (see Annex 1).

At 08:34:25 UTC, the crew of flight BHP 902 informed the ATCO that they would have to start the approach in 10 minutes at the latest, as otherwise they would have to declare an emergency. At this time, according to the crew's statement, they still had approximately three tonnes of fuel available.

Then, at 08:35:31 UTC, the ATCO offered the crew an approach under CAT I conditions and at the same time informed them of a visibility of 300 metres and a cloud ceiling of 160 ft. He informed the crew that he had neither a wind nor an RVR display. The crew answered that these values were insufficient. They further informed him that they would, however, start their approach in five minutes: *"Äh... it's not enough for us but we'll still start the approach äh... in äh... five minutes even with that ... with that RVR and that visibility*".

At 08:36:36 UTC, the ATCO informed the crew of flight BHP 902 that their approach would be coordinated with the tower and they subsequently received a heading instruction of 200°. A little later, the ATCO mentioned to flight BHP 902: *"it's still freezing fog with vertical visibility 160 ft according ATIS"*.

At 08:37:13 UTC, the ATCO informed the crew that they still had 18 NM to go to the runway threshold. At 08:38:39 UTC, flight BHP 902 received the following

clearance: *"Belair nine zero two descend to four thousand feet turn left heading one eight zero cleared ILS one six".*

To the ATCO's question during the approach as to whether the crew would divert to Stuttgart in the event of a go-around, the latter replied: *"we have no fuel for diversion at the moment, we have to land"*.

At 08:40:00 UTC, the crew reported that they were established on the ILS 16. The ATCO then remarked again that this was a CAT I ILS approach for runway 16 and instructed the crew to make contact with the tower.

After the frequency change to the tower, the crew of BHP 902 enquired about visibility, as they needed 400 m visibility for a CAT I approach. The ATCO provided them with wind information 310° at 2 knots and visibility of 300 metres. He also informed the crew of BHP 902 that ten minutes before an RVR of 400 to 500 metres had been measured but that at the moment no current values were available.

At 08:43:04 UTC, flight BHP 902 requested landing clearance ("*request landing clearance"*), which was given at 08:43:08 UTC.

Subsequent to the immediate measures he had taken, the DOM contacted the weather observer in the Oberglatt weather building. The latter informed him that he had the current RVR values and was able to transmit these manually. However, this did not work. The DOM again contacted the weather observer and asked him for the current RVR for runway 16. This value was stated as 500 m and was immediately forwarded to the crew of BHP 902. At this time, the aircraft was about to land.

The landing of flight BHP 902 then took place uneventfully. After the engines had been shut down at the assigned stand, there was still 2.1 t of fuel in the tanks according to the crew's statement.

At 08:40 UTC, an entry was made in the TWR operations log to the effect that the runway 16 emergency power supply had also been connected to that of runway 14. The daily operations manager (DOM) then decided to bring runway 14 back into use. While doing so, it was found that the remote control system for the runway 14 lights was not working. The DOM decided to continue using runway 16.

The message that the remote control system was not working was communicated to Airfield Maintenance by the TWR at 08:45 UTC. As an immediate measure, an Airfield Maintenance employee was delegated to the TS Hell in order to regulate the illumination level manually based on instructions from the TWR. According to the TWR operations log, runway 14 was brought back into service at 09:13 UTC.

As a result of the downgrading of runway 16 from CAT III to CAT I, four aircraft had to fly to their alternate airport (Basle, Stuttgart and Munich).

1.2 Injuries to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly injured or uninjured	9	237	

1.3 Damage to aircraft

There was no damage.

1.4 Other damage

There was no damage to third parties.

1.5 Personnel information

1.5.1 Commander

Person	Swiss citizen, born 1964
Licence	Airline transport pilot licence ATPL (A) according to JAR, issued by the Federal Office for Civil Aviation (FOCA), valid till 31.05.2010
Ratings	Type rating B757/767 PIC RTI (VFR/IFR) NIT (A) IFR (A)
Last proficiency check (OPC)	13.09.2005
Last line check (LC)	31.12.2005
Medical fitness certificate	Class 1, valid till 26.03.2006 No restrictions
Last medical examination	26.08.2005
Total flying experience on B757/767 during the last 90 days	7383 hours 3098 hours 116 hours

1.5.2 Copilot

Person	Swiss citizen, born 1969
Licence	Airline transport pilot licence ATPL (A) according to JAR, issued by the Federal Office for Civil Aviation (FOCA), valid till 22.09.2010
Ratings	Type rating B757/767 COPI RTI (VFR/IFR) NIT (A) IFR (A)
Last proficiency check	13.09.2005
Last line check	10.11.2005
Medical fitness certificate	Class 1, valid till 24.11.2006 Restriction: wearer of spectacles
Last medical examination	07.11.2005
Total flying experience on B757/767 during the last 90 days	3391 hours 681 hours 170 hours

1.5.3 Air traffic controllers

Air traffic controller A	
Function	Daily Operation Manager (DOM)
Person	Swiss citizen, born 1966
Licence	for air traffic controllers, issued by the Federal Office for Civil Aviation on 28 October 1992, valid till 5 October 2006.
Air traffic controller B	
Function	Approach controller West (APW)
Person	Swiss citizen, born 1981
Licence	For air traffic controllers, issued by the Federal Office for Civil Aviation on 3 August 2004, valid till 3 August 2006.
Air traffic controller C	
Function	Approach controller FINAL (FINAL)
Person	Swiss citizen, born 1956
Licence	For air traffic controllers, issued by the Federal Office for Civil Aviation on 27 August 1984, valid till 30 June 2006.
Air traffic controller D	
Function	Aerodrome Controller (ADC)
Person	Swiss citizen, born 1965
Licence	For air traffic controllers, issued by the Federal Office for Civil Aviation on 28 October 1992, valid till 6 October 2006.

1.6 Aircraft information

1.6.1 General

Type	Boeing B767-300
Characteristics	Twin-jet commercial aircraft
Seats	252 (42 C und 210 Y)
Maximum take-off mass	185 065 kg
Year of construction	1997
Serial number	27600
Engines	2 Pratt & Whitney PW 4060
Certification	Cat. IIIB LVTO RVR 125 m RVSM RNP 5 Dangerous goods
Airworthiness certificate	issued on 01.07.2002

1.6.2 Mass and centre of gravity

The mass and centre of gravity were within the prescribed limits.

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.6 was provided by MeteoSwiss and that in section 1.7.7 by Skyguide.

1.7.2 General weather situation

Zum Zeitpunkt des Vorfalls lag die Schweiz zwischen einem Hochdruckgebiet über Skandinavien und einem Tiefdruckgebiet über dem Golf von Lion. Im Mittelland herrschte eine leichte Bise vor.

At the time of the incident, Switzerland was situated between a high-pressure area over Scandinavia and a low-pressure area over the Gulf of Lion. There was a slight 'bise' wind in the Swiss Plateau.

1.7.3 Forecasts and warnings

Long Range TAF's

LSZH 201000Z 201812 VRB03KT 9999 SCT020 BKN050 TEMPO 1824 4500 BR SCT040 TEMPO 0206 3000 MIFG FEW030=

LSZH 202100Z 210624 VRB03KT 0500 FG VV003 BECMG 0710 05005KT 3000 BR BKN005 BECMG 1012 5000 SCT015 BECMG 1215 9999=

Short TAF's

LSZH 202100Z 202207 VRB03KT 6000 SCT070 BECMG 2202 1500BCFG NSC BECMG 0204 0500 FG VV003 PROB40 TEMPO 0307 0200 VV001=

LSZH 210000Z 210110 VRB03KT 8000 BKN070 BECMG 0103 3000 MIFG BECMG 0305 0800 FZFG PROB40 TEMPO 0508 0200 VV001 BECMG 0810 3000 BR FEW005 SCT070=

1.7.4 Measured and observed values

METAR Zurich (destination aerodrome)

LSZH 210720Z 33004KT 0300 R14/0400V0550N R16/0375N R28/P2000N R34/0500V0900D FZFG VV001 M01/M01 Q1009 TEMPO 0200=

LSZH 210750Z 34004KT 0300 R14/0350N R16/0375N R28/0600V1200U R34/0375V0550N FZFG VV001 M01/M01 Q1009 TEMPO 0200=

LSZH 210820Z VRB02KT 0300 R14/0400N R16/0325V0550N R28/0350V0700N R34/0500V1000U FZFG VV001 M00/M01 Q1009 BECMG 0800=

LSZH 210850Z 29003KT 0300 R14/0500D R16/0450V0550N R28/0600V1000D R34/0500N FZFG VV001 M00/M00 Q1010 BECMG 0800=

METAR Basel (alternate aerodrome)

LFSB 210700Z 18003KT 5000 FEW054 SCT088 01/M00 Q1008 NOSIG=

LFSB 210730Z 18006KT 5000 FEW054 SCT088 01/00 Q1009 NOSIG=

LFSB 210800Z 17005KT 5000 FEW054 SCT098 01/00 Q1009 NOSIG=

LFSB 210830Z 18005KT 6000 FEW054 SCT098 02/01 Q1009 NOSIG=

LFSB 210900Z 19003KT 160V240 6000 FEW054 SCT098 03/02 Q1009 NOSIG=

1.7.5 RVR values

Die RVR Daten wurden auf einem automatischen System (SMART) aufgezeichnet und logiert. Dieses generierte jede Minute einen Log Eintrag im METAR Format, welcher nur maschinell gemessene Daten enthält (siehe Anlage 2). Die Analyse der Logdatei vom 21.2.2006 ergibt einen Ausfall der RVR Werte während zweier Minuten für alle Pisten (0831 bis 0832 UTC), danach noch weitere zwei Minuten (bis 0834 UTC) für die Piste 14.

The RVR data were recorded and logged on an automatic system (SMART). Once a minute, this generated a log entry in the METAR format, which contains only data measured by machine (see Annex 2). Analysis of the logfile for 21.2.2006 shows a failure of the RVR values for two minutes for all runways (08:31 to 08:32 UTC), and then for a further two minutes (till 08:34 UTC) for runway 14.

1.7.6 Weather conditions at Zurich airport

On the basis of the listed information, it is possible to conclude that the weather conditions at the time of the incident at Zurich airport were as follows:

Cloud:	fog, vertical visibility 100 ft
Weather:	freezing fog
Visibility:	300 m, runway visual range (RVR) runway 16: 500-550m
Wind:	variable wind at 2 kt
Temp./dewpoint:	0 °C / 0 °C
Atmospheric pressure:	LSZH 1010 hPa, LSZA 1011 hPa, LSGG 1009 hPa
Position of the sun:	azimuth 134°, elevation 20°
Hazards:	visibility reduced by fog

1.7.7 ATIS reports LSZH

During the period relevant to the incident, the following ATIS messages were broadcast:

ATIS LSZH INFO MIKE dated 21 February 2006

THIS IS ZURICH INFORMATION MIKE
LANDING RUNWAY 16 ILS APPROACH, DEPARTURE RUNWAY 28
METREPORT ZURICH 0750
WIND 320 DEGREES 4 KNOTS
VISIBILITY 3 HUNDRED METRES
RVR RUNWAY 14 350 METRES, RVR RUNWAY 16 375 METRES, RVR RUNWAY 28 6 HUNDRED METRES
FREEZING FOG
VERTICAL VISIBILITY 160 FEET
TEMPERATURE MINUS 1, DEWPOINT MINUS 1
QNH 1009
TREND TEMPORARY VISIBILITY 2 HUNDRED METRES
TRANSITION LEVEL 75
LOW VISIBILITY PROCEDURES IN OPERATION
ZURICH INFORMATION MIKE

ATIS ZURICH INFO NOVEMBER dated 21 February 2006
THIS IS ZURICH INFORMATION NOVEMBER
LANDING RUNWAY 16 ILS APPROACH, DEPARTURE RUNWAY 28
MET REPORT ZURICH 0820
WIND 330 DEGREES 3 KNOTS
VISIBILITY 3 HUNDRED METRES
RVR RUNWAY 14 4 HUNDRED METRES, RVR RUNWAY 16 325 METRES,
RVR RUNWAY 28 350 METRES
FREEZING FOG
VERTICAL VISIBILITY 160 FEET
TEMPERATURE MINUS 0, DEWPOINT MINUS 1
QNH 1009
TREND BECOMING VISIBILITY 8 HUNDRED METRES
TRANSITION LEVEL 75
LOW VISIBILITY PROCEDURES IN OPERATION
ZURICH INFORMATION NOVEMBER

1.8 Aids to navigation

DVOR/DME Kloten (KLO) and ILS DME 16 were used as navigation aids. The ILS DME 16 system is CAT IIIB qualified.

DVOR KLO is an omnidirectional radio range which functions on the Doppler principle. It is equipped with distance measuring equipment (DME).

1.9 Communications

1.9.1 General

An audio copy and the corresponding transcript of the radio communications between the crew and the air traffic control units were available to the investigation. Comprehensibility was good and the recording was complete.

All radio conversations between the various air traffic control units and the crew of flight BHP 902 were conducted in English. There are no indications of any misunderstandings between the air traffic control units and the crew.

1.9.2 Air traffic control units involved

Workstation/function	Abbreviation	Frequency
Swiss Radar Lower Sector West	RE-W	135.675 MHz
Zurich Arrival Sector West	APW	118.000 MHz
Zurich Final	FIN	125.325 MHz
Zurich Aerodrome Control	ADC	118.100 MHz
Daily Ops Manager Tower	DOM	

1.10 Aerodrome information

1.10.1 General

Zurich Airport is located in the north-east of 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 Runway equipment

Runways 16 and 14 are equipped with a Category IIIB instrument landing system (ILS) and are therefore suitable for precision approaches. At the time of the incident, runway 28 allowed non-precision approaches based on VOR/DME KLO.

Runway 16 and 14 are equipped with an airfield lighting system complying with ICAO standards for continuous operation under all weather conditions. A distinction is made between lighting systems with high intensity (LIH – light intensity high) and low intensity (LIL – light intensity low).

The high-intensity runway centre line lights and the high-intensity runway edge lights are important for landings in poor visibility. The intensity of this lighting system can be set to 1%, 3%, 10%, 30% and 100%.

The runway centre line lighting system is laid in the ground and heated. The lamps are installed at 15 m intervals. They are white up to 900 m before the end of the runway. Between 900 m and 300 m before the end of the runway they are alternately white and red, and over the last 300 m they are red only. The emission angle is set vertically to 3°.

The runway edge lights are positioned at 30 m intervals on both sides and are approximately 1 m outside the useable runway surface. The lights are white and over the last 600 m before the end of the runway they are amber.

1.10.3 Airport power supply

The power supply at Zurich airport is split into 3 sectors (10-28, 14-32 and 16-34). The feed for sector 10-28 (Flughafenkopf – KS FK) is from the Balsberg substation, the feed for sector 14-32 (General Aviation Center – KS GA) is from the Kloten substation and the feed for sector 16-34 (Balsberg – KS BL) is from the Balsberg substation (see Annex 3).

From the KS Flughafenkopf, power is routed to transformer stations FS (Flugsicherung - air traffic control), FA (Fingerdocks A and E) and OS (Ost - East). To cope with a power failure, Flughafenkopf is equipped with an emergency power supply system. In the event of a mains failure, this supplies power to the following infrastructure:

Flugsicherungsgebäude A2, Dockleitsystem Fido A und Fido E, Standplatzbeleuchtung incl. Midfield, Piste 10/28, Aproncenterline incl. Midfield, Strassentunnel, Verregnung, Strassenbeleuchtung und VR-Anlagen landseitiger Verkehr.
(air navigation services company building A2, dock control system Fido A and Fido E, stand lighting incl. Midfield, runway 10/28, apron centre line incl. midfield, road tunnel, rainage, road lighting and VR equipment of landside traffic).

Power is routed from the KS General Aviation Centre to the transformer station Hell (TS HE). This is located in the vicinity of the runway 14 threshold. It provides power for the infrastructure of runway 14/32. The TS HE has two emergency power units which each consists of a diesel engine and a generator. The use of the emergency power units is described in greater detail in section 1.10.4.

In the event of a mains failure, the emergency power supply feeds the following infrastructure:

Piste 14/32, Gleitwegsender 14, Localizer 14 und 32, Mittelmarker 14/32 und 16/34, Meteobeobachtung Oberglatt, Tor 120 und 121.
(runway 14/32, glidepath transmitter 14, Localizer 14 and 32, centre markers 14/32 and 16/34, Oberglatt weather observation, gate 120 and 121).

Current is fed from the KS Balsberg to the transformer stations North (TS NO) and Werkhof (TS WH). The TS NO is located near the fire brigade satellite between runways 14 and 16. It provides power for the infrastructure of runway 16/34. The TS NO is equipped with two emergency power units which each consists of a diesel engine and a generator. The use of the emergency power units is described in greater detail in section 1.10.4. In the event of a mains failure, the emergency power supply feeds the following infrastructure:

Piste 16/34, Empfangstation, Gleitwegsender 16 und 34, Localizer 16 und 34; D-VOR, Feuerwehrsatellit Nord, Schiessanlage Cheibenwinkel, Verregnung.
(runway 16/34, reception, glidepath transmitter 16 and 34, localizer 16 and 34; D-VOR, fire brigade satellite North, Cheibenwinkel shooting range, rainage).

The TS WH transformer station also has an emergency power unit which supplies power to the following infrastructure in the event of a mains failure:

Werkhof, Berufsfeuerwehr und Sanität, Treibstofflieferanten, Asylunterkunft Rohr, Standplätze Jenische, Tor 130.
(maintenance area, fire brigade and paramedics, fuel suppliers, asylum accommodation Rohr, Jenische stands, gate 130).

In order to achieve redundancy in power supply, cross-feeds exist between the sectors as well as between some of the individual transformer stations. There are also cross-feed options between individual transformer stations for the emergency power supply.

Checks are carried out on the power supply installations by the Unique technical maintenance department every two months. The last check took place during the night of 26 to 27 January 2006.

1.10.4 Power supply to the infrastructure for runways 14 and 16

According to information from the airport operator Unique, the power supply for runways 14 and 16 is organized as follows:

CAT I operation

Requirement: the energy supply must be available within 15 seconds in the event of a failure in the power supply system.

Implementation: in the event of a failure of the feeding energy supply, the emergency power diesel generators switch on automatically and connect to the lighting system within 13 seconds. The system then runs in isolated mode[5]. If the supply network is reinstated over a longer period (approximately 5 minutes), then synchronisation with the network takes place automatically. Afterwards, the emergency power units disconnect from the mains.

[5] In isolated mode, the power supply is completely isolated from the mains supply.

CAT II/III operation

Requirement: the energy supply must be available within one second in the event of a failure in the power supply system.

Implementation: When Cat II/III weather situations arise, one emergency power unit per active runway is connected in parallel with the mains supply – this is controlled by the tower. In the event of a fault, the lighting system is immediately switched to isolated mode and the second emergency power unit is run up, synchronised and connected to the isolated system within 13 seconds.

If the supply network is reinstated over a longer period, the system is synchronized back to the mains and reconnected. The second emergency power diesel is switched off automatically.

1.11 Flight recorders

The aircraft was equipped with a digital flight data recorder (DFDR) manufactured by Honeywell (formerly Allied Signal). It was possible to analyse the recordings which showed no irregularities.

In addition, the aircraft was equipped with a cockpit voice recorder (CVR), type "Fairchild Model A100", which provides a recording of the previous 30 minutes. The recordings for the flight concerned were no longer available or rather had been overwritten.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

Not applicable.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

Not applicable.

1.17 Organisational and management information

1.17.1 The operator Belair Airlines

1.17.1.1 General

In 1997 a new Swissair charter subsidiary was founded, appearing under the old brand name Balair. Two Boeing 757-200 aircraft were operated for various tour operators on medium-haul and short-haul flights. Balair also had two Boeing 767-300 aircraft for long-haul flights. In October 2001, Balair was also affected by the crisis involving the SAir group.

In the autumn of 2001, it was clear to the management of the main tour operator that the end of the Balair charter company was linked to the end of the SAir Group. After consultation with the parent company, this tour operator founded

the new Belair Airlines charter company, which was entered in the trade register on 16 October 2001.

Belair began operation on 3 November 2001. Today, its fleet consists of three aircraft, two B757-200 and the B767-300 involved in the incident. Since then, the two B757 aircraft are mainly used for flights to holiday destinations in the Mediterranean and in North Africa. The B767 is used for long-haul flights.

In cooperation with the REGA, the Swiss air rescue organisation, one Belair B757 has been converted to enable it to be used as a rescue aircraft in the event of catastrophes. Belair is thus in partnership with REGA in the area of repatriation flights.

1.17.1.2 Procedures

The regulations which are relevant to the incident are laid down within the airline in the operation manual A (OM A) and in the operation manual C (OM C).

OM A section 8.3 para. 7.5 states the following under commitment to proceed:

Situations may arise in which the application of the rules in para above[6] is no longer possible or could lead to an increased operational risk with no gain in safety. In this case, the CMD has to make the choice to divert to the alternate or to continue to (or hold over) the destination.

He must take into account:

- *The remaining fuel;*
- *The weather at the intended landing aerodrome (actual, trend, seasonable aspects);*
- *The traffic situation (peak hours, familiarity with the aerodrome/approach procedures, single/multiple runway layout, etc);*

So as to land with not less than final reserve fuel.

Among other things, OM A section 8.1, para. 6.2.1, defines the precision approach as follows:

CAT I

A Cat I operation is a precision instrument approach and landing using ILS with

- *a decision height not lower than 200 ft and*
- *a visibility / RVR not less than 550 m or 1800 ft*

During the approach of BHP 902 on runway 16 under CAT I conditions, no RVR value was available and visibility was indicated as 300 m.

Section 8.4, under all weather operation (AWO), states the following, among other things, in para. 2.4.3 commencement and continuation of approach:

The CMD may commence an instrument approach regardless of the reported RVR / visibility but the approach may not be continued beyond the outer marker or equivalent position, if the reported RVR / visibility is less than the applicable minimum.

If, after passing the outer marker or equivalent position, the reported RVR / visibility falls below the applicable minimum, the CMD may continue the approach.

[6] The term "rules in para above" relates to the planning requirements (OM A, section 7 Policies and procedures for fuel management), which are based on fuel calculations including an alternate airport.

Throughout the entire approach of BHP 902 until reaching the outer marker or equivalent position, no RVR was transmitted and visibility was reported as 300 m.

1.17.2 The airport operator Unique

1.17.2.1 General

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

On 1 June 2001 the new operating licence came into effect 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 were important for the airport, including the baggage sorting installation, from different SAir Group companies.

As the infrastructure owner and the operator, Unique is obliged under its licence to guarantee operation of the public Zurich Airport. Under its own responsibility it exercises all functions which are essential for the maintenance and smooth running of the operation.

1.17.2.2 Maintenance of the runway infrastructure

Unique's Airfield Maintenance division is responsible for maintaining the runway infrastructure. Among other things, the electrical energy supply system and the runway and taxiway lighting system are periodically checked in accordance with a defined maintenance plan.

In particular, the emergency power supply is checked under different conditions, e.g. LVP operation, at night every two months.

1.17.3 The air navigation services company Skyguide

1.17.3.1 General

Radio Schweiz AG was founded in 1922 to meet requirements in the area of telegraphy and international telephony. In 1931, further developments in systems and procedures led to the introduction of actual air traffic control. In 1988, Radio Schweiz AG changed its name, first to Swisscontrol and finally, after the amalgamation of military and civil air traffic control services to Skyguide, on 1 January 2001.

On behalf of the Swiss Confederation, Skyguide is responsible for the safe, efficient and economical handling of air traffic. Its mandate includes civil and military air traffic control, the telecommunications service, the aviation information service and the technical service for installation, operation and maintenance of the air traffic control systems.

Skyguide employs some 1400 people at twelve locations. Two thirds of these are employed in air traffic control and about a quarter in the Technical Service.

1.17.3.2 Operating regulations and procedures

The ATM Manual Switzerland, Section 9, *aerodrome control* contains the following, among other things:

Operational downgrading

- *The flight crew shall be informed without delay of any deficiency in the operation of the ILS or aerodrome lighting system.*
- *The downgrading of the operational status does not prevent the flight crew from making an ILS CAT II/III approach, or LVD, under their own responsibility.*

Operational minima for IFR flights

- *It is the sole responsibility of the pilot to comply with the prescribed operational minima (ceiling, visibility and RVR).*
- *You are only responsible for providing pilots with the current or last measured visibility/ceiling/RVR values. You may issue landing or take-off clearance, regardless of the visibility and/or ceiling conditions.*

Equipment downgrade tables

During operation conducted in Low Visibility Conditions, the flight crew of any affected aircraft shall be immediately advised of the following equipment downgrading:

CAT II/III Approaches

Malfunction	*Downgrade to*
Failure of RVR assessment system; or *Failure of display/transmissometer at both TDZ and Mid-point positions*	*CAT I*
Failure of secondary power supply for the aerodrome lighting system	*CAT I*
Wind information indicator not available	*CAT I, unless information available from other sources*

1.17.4 The weather service MeteoSwiss

1.17.4.1 General

The Federal Office for Meteorology and Climatology has been in constant evolution since the beginnings of the national observation network in the 19th century. With the introduction of extended services, it assumed the name MeteoSwiss in 1996.

The MeteoSwiss national weather service performs key tasks for the population, the government and the economy. In addition to providing general weather forecasts, MeteoSwiss warns the cantonal emergency services when storm winds, heavy precipitation and thunderstorms threaten. This is done via protected information channels, which are operational round the clock.

In 2006, MeteoSwiss had approximately 270 employees at the following locations: Zurich, Zurich Airport, Geneva, Payerne and Locarno-Monti. MeteoSwiss works with partners such as universities and research institutes, as well as with experts in the private sector. It is involved in international bodies on weather and the climate and it is Switzerland's official representative in the WMO (World Meteorological Organisation) in Geneva.

1.17.4.2 The Oberglatt meteorological building

Power for the Oberglatt meteorological building, close to the end of runway 16, is supplied from transformer station TS Hell. Among other things, power is supplied to the sensors for environmental data (transmissometers, temperature, atmospheric pressure and wind) erected in the field. The environmental data are conditioned in two so-called MOXA boxes and transmitted over a LAN to the Air Navigation Center (ANC).

Normally, the sensors and MOXA boxes have an uninterruptible power supply (UPS), i.e. in the event of a failure in the power supply from the TS Hell, these have battery back-up.

In the Oberglatt meteorological building, there are two types of socket, standard sockets for the normal power supply and UPS sockets for the uninterruptible supply.

When the system was upgraded to INCH, the MOXA boxes were connected to a standard socket on the occasion of a test installation, as no more UPS socket points were available. Skyguide was responsible for this work.

On 21 February 2006, at 08:30 UTC, the entire TS Hell transformer station was switched off for approximately 2 minutes. This caused an interruption in the power supply to the two MOXA boxes. As a result of the failure of data transfer via the LAN to the servers in the ANC, the latter were blocked because of a software error.

Although the MOXA boxes were again providing data after two minutes, the servers remained blocked. It was only possible to provide the air traffic controllers with data once the servers were restarted.

1.18 Additional information

1.18.1 OFP calculations

As part of the investigation, comparative calculations were made by the aircraft manufacturer in order to verify the OFP calculations for flight BHP 902. On the one hand, an analogous calculation was carried out for the expected ZFW of 110.5 tonnes and on the other hand such a calculation was carried out for the actual ZFW of 120.3 tonnes.

With regard to the calculations with a ZFW of 110.5 tonnes, the manufacturer stated the following:

- *Although we do not normally use the listed fuel categories for flight plan, the planned fuel for the ZFW of 110.5 is consistent with our calculations.*
- *With regard to the footnotes, the quantities listed for taxi, T20, and FR segments appears reasonable given the descriptions of those segments.*

The table below shows the data for the OFP for flight BHP 902 in comparison with the corrections made by the crew and the manufacturer's calculations:

	OFP	according to crew	according to manufacturer
ZFW	110.5	120	120.3
TOF	52.5	56	55.2
TOW	163.0	176	175.7
Trip	47.6	49.6	49.6
LW	115.4		125.8
REMF	4.9		5.6

Taxi	.4		0.4
LSZH	47.6		49.6
T20	1.6		1.8
LFSB	1.4		1.7
CF	.0		
FR	1.9		2.1
REQ	52.9	54.9	55.6
EXT	...	1.1	
ACT	...	56	

From the comparative calculation by the aircraft manufacturer, it is apparent that with the fuel quantity of 56 tonnes (ACT) tanked for flight BHP 902 the crew did take onboard the minimum fuel quantity of 55.6 tonnes (REQ) as required by the regulations in force.

1.18.2 The commitment to proceed procedure

The commitment to proceed procedure published by the airline is based on the regulations of the JAR-OPS (Joint Aviation Requirements). The JAR-OPS 1 (Commercial Air Transportation (Aeroplanes)), section 1 – Requirements, Subpart D (Operational Procedures) states the following under JAR-OPS 1.375 *In-flight fuel management (b)*:

A commander shall ensure that the amount of usable fuel remaining in flight is not less than the fuel required to proceed to an aerodrome where a safe landing can be made, with final reserve fuel remaining.

Moreover, reference is made to Appendix 1 to JAR-OPS 1.375, which among other things states the following:

(b) In-flight fuel management

(1) If, as a result of an in-flight fuel check, the expected fuel remaining on arrival at the destination is less than the required alternate fuel plus final reserve fuel, the commander must take into account the traffic and the operational conditions prevailing at the destination aerodrome, along the diversion route to an alternate aerodrome and at the destination alternate aerodrome, when deciding whether to proceed to the destination aerodrome or to divert, so as to land with not less than final reserve fuel.

The procedure published by the airline for a commitment to proceed is in accordance with this regulation.

1.18.3 Information concerning dissemination and content of ATIS messages

The competent Skyguide employee commented as follows on the question of why the downgrading of runway 14 to CAT I was not communicated: *"Wenn die im ATIS publizierte Landepiste uneingeschränkt zur Verfügung steht und keine operationelle Notwendigkeit für Anflüge auf die andere Piste besteht, wird kein "DOWNGRADE TO CAT I" publiziert, weder im ATIS noch im NOTAM."* (When the landing runway published in the ATIS is available without any restriction and there is no operational necessity for approaches on the other runway, "DOWNGRADE TO CAT I" is neither published in the ATIS nor in the NOTAM).

1.18.4 Information concerning the content of ATIS messages

According to statements by Skyguide, it relies for the information disseminated via ATIS on the guidelines which are summarised as follows in the AIP under General 3.3.3.5:

The English broadcast contains the following information:

a) name of aerodrome and information designator;
b) arrival and/or departure indicator;
c) runway(s) in use;
d) type of approach(es) to be expected;
e) type of report (METAR or SPECI, including TREND);
f) time of observation
g) surface wind direction and speed, including significant variations and, if surface wind sensors related specially to the sections of runway(s) in use are available and the information is required by operators; the indication of the runway and the section of the runway to which the information refers;
h) visibility and, when applicable, RVR;
i) present weather;
j) cloud below 1500 m (5000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available;
k) air temperature;
l) dew point;
m) altimeter setting(s);
n) any available information on significant meteorological phenomena in the approach, take-off and climb out areas including wind shear information on recent weather of operational significance;
o) transition level;
p) other essential operational information (LVP in operation, changes in the operational status of navigation aids, visual aids, taxiways, etc);
q) significant runway surface conditions and, if appropriate, braking action;
r) holding delay, if appropriate;
s) as applicable, SIGMET and/or AIRMET information

With regard to the present investigation, the point mentioned under p) is of particular importance.

By way of comparison concerning the content of ATIS information, it is worth mentioning here the principles as laid down, for example, in Germany in the BA-FVK[7] (Betriebsanodnungen Flugverkehrskontrolldienst, Kapitel Flugdatenbearbeitung Punkt 1172 vom 01.05.2005):

Die ATIS hat folgende Informationen in der angegebenen Reihenfolge zu enthalten (The ATIS must contain the following information in the indicated sequence):

a) Name des Flugplatzes,
b) das Wort "Information" und der Kennbuchstabe (z.B. Alfa, Bravo),
c) Zeit der Beobachtung,
d) Art des zu erwartenden Anflugs,
e) Betriebspiste(n),
f) ungewöhnlicher Zustand der Pistenoberfläche und wenn verfügbar Bremswirkung,
g) An- und Abflugverzögerungen von 20 Minuten und mehr,

[7] The BA-FVK corresponds to the ATM Manual Switzerland in force in Switzerland

h) Übergangsfläche (TL),
i) weitere besondere Hinweise (z.B. Einschränkung(en) in der Benutzbarkeit der Piste(n) sowie Einschränkung(en) in der Benutzbarkeit der Anflughilfen usw.),
j) Bodenwindrichtung und –stärke und wesentliche Änderungen dazu,
k) Sicht und Pistensichtweite,
l) gegenwärtiges Wetter,
m) Wolken unterhalb 10000 Fuss oder unterhalb der höchsten Sektormindesthöhe - der höhere Wert ist massgebend - Wolkenarten,
n) Temperatur,
o) Taupunkt,
p) QNH in vollen Hectopascalstufen - ggf auch in Zoll inches,
q) wichtige Wettererscheinungen im An - und Abflugbereich des Flughafens wenn verfügbar,
r) Trend,
s) das Wort "Information" mit Wiederholung des Kennbuchstabens und das Wort "out".

With regard to the present investigation, the point mentioned under i) is of particular importance:

i) *weitere besondere Hinweise (z.B. Einschränkung(en) in der Benutzbarkeit der Piste(n) sowie Einschränkung(en) in der Benutzbarkeit der Anflughilfen usw.)*

(other special remarks (e.g. restriction(s) on the serviceability of the runway(s) plus restriction(s) on the serviceability of approach aids, etc.)

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Technical aspects

2.1.1 Aircraft HB-ISE

There is no indication that aircraft HB-ISE had any defects or technical restrictions which had an effect on the origin and development of the incident.

2.1.2 Electrical power supply at the airport

Thanks to the various infeed and cross-feed options, and the various emergency power units, the power supply to the airport infrastructure has a high degree of redundancy.

The short circuit on 18 February 2006, three days before the incident, resulted in the busbar in transformer station TS Hell being isolated from the mains supply. The emergency power unit took over the power supply automatically, as intended. Both generators were started correctly and connected to the busbar.

Once the mains power supply was available again, the two generators disconnected from the busbar. In the disconnection sequence, contacts are opened in the generator relay and pre-tensioned by a motor, so that they close by spring force when they are next used. On 18 February 2006, the pre-tensioning sequence was not completed, and as a result an auxiliary contact did not close. Consequently, the generator relay was not ready for subsequent use.

On 21 February 2006, when it was attempted to put the emergency power unit in the TS Hell into service from the tower because of the planned LVP operation, the lead generator could not be connected to the busbar and therefore not be paralleled with the main supply.

Pre-selection of the generator intended for parallel operation takes place manually in the TS Hell. It is not possible to switch over to the remaining generator from the tower.

The failure to close the auxiliary contact in the generator relay occurred by chance and was not related to the short circuit on 18 February. This fault could have occurred during a future mains failure or after carrying out a periodic check.

2.2 Human and operational aspects

2.2.1 Flight crew

2.2.1.1 Flight planning

At the hotel, the flight crew received an OFP with a planned ZFW of 110.5 tonnes. On the basis of the reported number of passengers in the load briefing dated 18 February 2006, the crew corrected the ZFW to 117 tonnes. By means of the loadsheet, they then received the effective ZFW of 120.3 tonnes shortly before departure. This ZFW, which was even higher than the ZFW of 117 tonnes planned by the crew, required approximately 1 tonne of additional fuel. However, since this quantity was already covered by the 1.1 tonnes of extra fuel already planned, the crew decided against a further correction.

The question must be posed as to how appropriate it was:

- to give up planned extra fuel, which was taken onboard by the crew to cover "unforeseen events", even before the engines have been started.
- not to request a new OFP, which would have provided more reliable information with regard to flight monitoring, among other things regarding the quantity of fuel consumed at each individual waypoint and regarding planned flight levels along the flight path. In addition, a new OFP would also have corrected the final reserve fuel from 1.9 tonnes to 2.1 tonnes (see section 1.1.3 and table in section 1.18.1).

2.2.1.2 History of the flight

At the waypoint MELKO, at 07:48 UTC, the crew checked the quantities of fuel consumed and fuel still available. According to the flight plan documents, flight BHP 902 still had 5.2 tonnes onboard. This corresponded to an additional quantity of 900 kg compared with the fuel required to complete the flight with the required reserves and the expected landing weight.

According to the commander's statement, the crew were aware that with that additional fuel they were able to join the GIPOL holding pattern for about 10 minutes. According to the OFP, 1.4 tonnes of fuel would have been required for a landing at the alternate airport of Basle. Since BHP 902 was in the GIPOL holding pattern, i.e. in terms of distance it was between the destination airport and the alternate airport, the crew calculated only approximately 1 tonne of fuel for an alternate landing and therefore allowed themselves an additional reserve of about 5 minutes to remain in the GIPOL holding pattern.

When in the GIPOL holding pattern, the crew had to decide between the two following possibilities:

- an alternate landing in Basle. Basle with good weather but only one runway.
- waiting in the holding pattern, consuming the fuel for an alternate landing in Basle and flying to Zurich by applying the so-called commitment to proceed. Zurich with weather conditions which demanded an approach under CAT II/III conditions. On the basis of the information which was available to the crew of BHP 902, however, two runways with CAT III capability were available.

The crew chose the second option. They did not know that runway 14 in Zurich was not CAT III-capable at this time and that consequently only one runway was actually available in the prevailing weather conditions.

It is worth mentioning that between the operational downgrading of the ILS 14 from CAT III to CAT I or the time at which runway 16 was brought into use and the initial radio contact by the crew with Zurich area control centre, more than 47 minutes elapsed. Thus sufficient time would have been available to communicate this information in an ATIS message or by radio. Such information might possibly have influenced the decision of the crew of BHP 902.

It is comprehensible that the crew decided in favour of a commitment to proceed on the basis of the information available to them. The responsibility for such a decision lies with the commander, according to the airline's policies.

However, this case also shows that a commitment to proceed, especially under challenging weather conditions such as low visibility conditions, constitutes a procedure which additionally restricts the flight crew's room for manoeuvre.

When the approach clearance on runway 16 was cancelled by the air traffic controller and flight BHP 902 received the instruction to climb to 7000 ft, the crew were forced to mention their remaining fuel quantity: *"...negative we have to stay at five thousand we're short of fuel".*

At the time of the subsequent approach clearance on runway 16, according to the commander's statement, the crew were aware that the reported visibility of 300 m did not meet the requirements for a CAT I approach. Nor were these requirements met at any time during the approach. Thus the crew should have initiated a go-around at the latest when overflying the outer marker or equivalent position (see section 1.17.1.2). Given the quantity of fuel still available, the crew had no option other than to continue the approach and land.

After the engines had been shut down at the assigned stand, there was still 2.1 tonnes of fuel in the tanks, according to the crew's statement. This quantity was 200 kg above the final reserve fuel according to the OFP. With reference to the landing weight calculated with the actual ZFW of 120.3 tonnes, the quantity of fuel still available corresponded to the final reserve fuel.

2.2.2 Air traffic controllers

2.2.2.1 Operations

When daily operation began at 06:00 UTC, runway 14 was put into service under CAT I conditions. The subsequent deterioration in weather conditions led to the application of the "low visibility procedure" (LVP), as prescribed in the air navigation services company's procedures. It was accordingly implemented by the air traffic controller.

Since it was not possible to connect the emergency power unit for runway 14 for LVP operation, the daily operation manager (DOM) decided to bring runway 16 into service. This decision was appropriate in the situation.

In order to bring runway 14 back into service, the transformer station TS Hell was switched off at 08:30 UTC. One minute later, the RVR and wind displays failed on the INCH screens. The DOM took appropriate immediate measures to rectify this situation.

Switching of the emergency power supply may have unforeseeable repercussions, up to and including failure of entire systems, due to the complexity of systems networking. It is therefore questionable whether it was appropriate to carry out this switching whilst aircraft were approaching according to the low visibility procedure.

After a successful connection of the runway 16 emergency power unit to runway 14, the latter runway was authorised by the airport operator and the DOM planned to bring it back into operation. When it was brought into operation, it became obvious that the approach and runway lights could not be regulated. The DOM therefore decided to keep runway 16 in operation. This situation was appropriate in the situation.

2.2.2.2 Communication of information

Since it was not possible to connect the emergency power unit for runway 14 for LVP operation, the daily ops manager (DOM) decided to bring runway 16 into service. However, the fact that runway 14 was available only for operation under CAT I conditions was not made known. The Skyguide employee who was responsible made the following comments in this regard: *"Wenn die im ATIS publizierte Landepiste uneingeschränkt zur Verfügung steht und keine operationelle Notwendigkeit für Anflüge auf die andere Piste besteht, wird kein "DOWNGRADE TO CAT I" publiziert, weder im ATIS noch im NOTAM."* (When the landing runway published in the ATIS is available without any restriction and there is no operational necessity for approaches on the other runway, "DOWNGRADE TO CAT I" is neither published in the ATIS nor in the NOTAM). This justification is insufficient. The present case shows that it can never be excluded that approaches will have to be made at short notice on a different runway.

Moreover, this statement does not correspond to the spirit of the regulations as laid down, among other things, in the ATM Manual Switzerland, Section 9, *aerodrome control* concerning downgrading of a runway from CAT II/III to CAT I conditions: "*During operations conducted in Low Visibility Conditions, the flight crew of any affected aircraft shall be immediately advised of the following equipment downgrading…"* It is a one-sided interpretation to assume that this refers only to the runway currently in use and it pays too little attention to the information requirements of all those concerned.

Nor is this statement consistent with the regulations on which elements an ATIS message should include with reference to the availability of runway and approach aids. With regard to ATIS information, Skyguide relies on the information given in the AIP Switzerland under General 3.3.3.5 (section 1.18.4). Under point p) "*Other essential operational information (LVP in operation, changes in the operational status of navigation aids, visual aids, taxiways, etc);"* by analogy with point i) of the BA-FVK in Germany: other special remarks (e.g. restriction(s) on the serviceability of the runway(s) plus restriction(s) on the serviceability of approach aids, etc.); it is pointed out that operational restrictions concerning the serviceability of runways must be indicated. In both cases no mention is made as to whether this comment refers only to the runway in use.

2.2.3 Maintenance work in the Oberglatt meteorological building

According to the system concept, the MOXA boxes in the Oberglatt meteorological building which are required for data transfer should have been connected to UPS (uninterruptible power supply) sockets.

When the system was upgraded from Infonet to INCH in the autumn of 2005, the MOXA boxes were connected to a standard socket on the occasion of a test installation by Skyguide, as no more UPS socket points were available.

This inappropriate power supply to the MOXA boxes was not documented by Skyguide. Consequently, the MOXA boxes subsequently remained connected to the wrong sockets.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- Aircraft HB-ISE was rated for CAT III approaches.
- There is no indication that the incident was affected by technical restrictions or defects on aircraft HB-ISE.
- After the power failure on 18 February 2006, an auxiliary contact in a generator relay did not close.
- This meant that the emergency power unit in the transformer station TS Hell could not be brought into operation correctly from the control tower.
- In order to activate the runway 14 emergency power supply, the TS Hell unit had to be switched off for approximately two minutes.
- As a result of the interruption in power, the display of RVR and wind values failed on all the INCH screens.
- This failure was the result of an incorrect power supply to the devices used to transfer data to the INCH screens. The devices were connected to a standard power socket rather than a UPS socket.
- The RVR and wind values were available again in the Oberglatt meteorological building after two minutes.
- According to the TWR operations log, the display of RVR and wind values on the INCH screens was not available for approximately 40 minutes. During this period, CAT I operation only was possible.

3.1.2 Flight crew

- The flight crew were authorised to make CAT III approaches.
- The flight crew planned flight BHP 902 on the basis of an OFP which showed a ZFW which was about 10 tonnes lower than the actual ZFW.
- A new OFP with the current ZFW was not requested.
- The flight crew had no information concerning the fact that at the time of the approach to Zurich, runway 14 had been downgraded to CAT I.
- The crew decided to use the fuel intended for a flight to the alternate aerodrome for a longer stay in the holding pattern (commitment to proceed).
- The flight crew continued the CAT I approach on runway 16 even though the necessary weather conditions were not met.
- The final reserve fuel remaining after the flight was not below the prescribed minimum quantity.

3.1.3 Air traffic controllers

- The repeated runway changes were implemented by the DOM in good time and in accordance with the regulations in force.
- Flight crews were not informed of the lack of CAT III capability (operational downgrading) of runway 14.
- The downgrading of runway 16 to CAT I operation was communicated without delay to the flight crews concerned.

3.2 Causes

The incident is attributable to the fact that technical faults on the ground meant that a landing was no longer permitted at Zurich Airport under the prevailing weather conditions. The result was that the flight crew, on the basis of the available fuel, carried out an approach and a landing under low visibility procedures, even though operation of runway 16 was restricted to CAT I.

A contributing factor to the incident was the circumstance that no information was communicated concerning the fact that runway 14 was not available for approaches and landings according to CAT III.

4 Safety recommendations

4.1 Safety deficit

On the morning of 21 February 2006, a Belair Airlines B767 made an ILS approach on runway 16 according to low visibility procedures.

Whilst in the GIPOL holding pattern the flight crew decided to consume the fuel for a flight to the alternate airport of Basle for a longer stay in the holding pattern and to land in Zurich (commitment to proceed).

The flight crew's decision basis was: the alternate airport of Basle, with only one runway but with good weather, or the destination airport of Zurich, with low visibility conditions but two runways with CAT IIIB capability.

The flight crew did not know that at this time runway 14 only had CAT I capability for technical reasons, because the emergency power unit could not be connected. This fact was communicated neither by radio nor in an ATIS.

According to the Aeronautical Information Publication (AIP) Switzerland, a flight crew can in principle assume for their approach planning that two runways with capability for CAT IIIB precision approaches are available in Zurich. The downgrading of one of the two approach systems should have been made known immediately to the flight crew, because this information changed the basis on which the above-mentioned decision was taken.

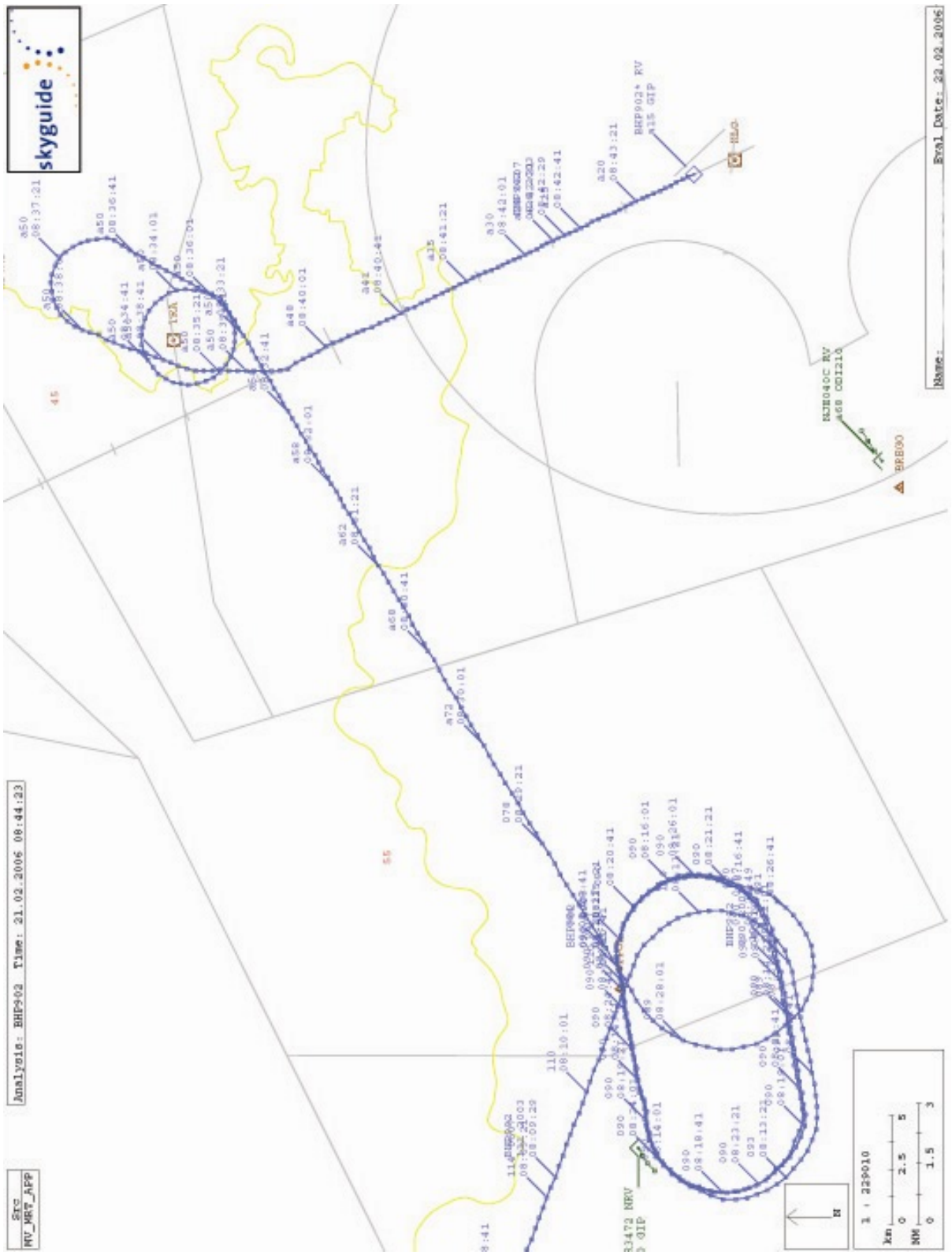
During the approach to Zurich, the displays of wind and RVR values failed in the tower. This led to a downgrading of runway 16 to CAT I operation. On the basis of the remaining quantity of fuel, the flight crew made an approach and landing on runway 16. However, the prevailing weather conditions were not appropriate to permit the continuation of the approach and the subsequent landing.

4.2 Safety recommendation No. 390

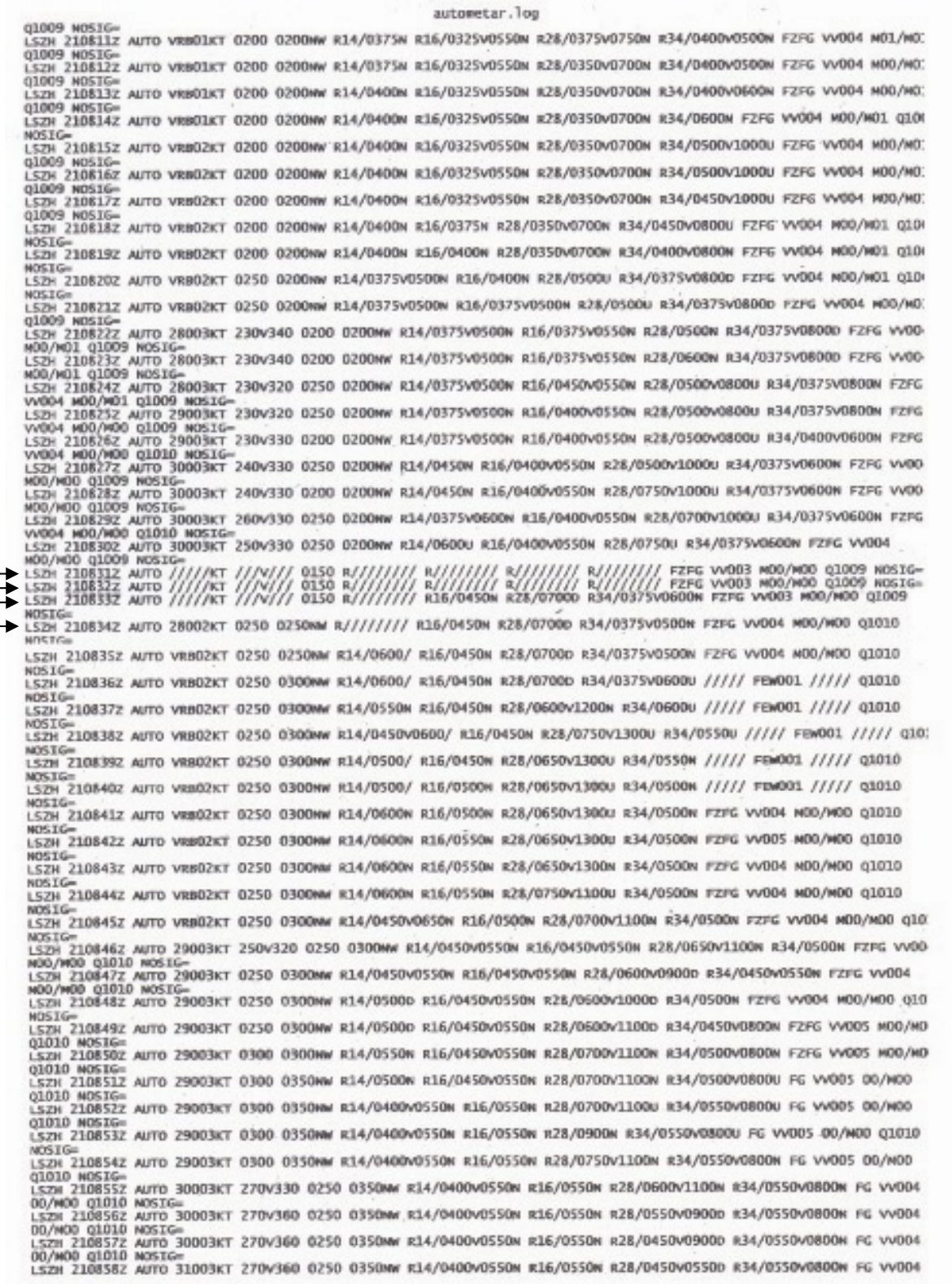
The Federal Office for Civil Aviation should arrange for even short-term downgradings of runways to be communicated via ATIS or by radio, even when they are not in use at the time.

Berne, 5 July 2007 Aircraft Accident Investigation Bureau

Annex 1: Flight path BHP 902



Annex 2: RVR measurement record



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Annex 3: Airport power supply