



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

Final Report No. 1956

by the

Federal Aircraft Accident Board

concerning the serious incident

to the SAAB 2000 aircraft, HB-IZZ

operated by Darwin Airline under flight number DWT 018

on 17 November 2005

at Lugano Airport, municipality of Agno/TI

This final report has been prepared of the Federal Aircraft Accident Board according to art. 22 – 24 of the Ordinance relating to the Investigation of Aircraft Accidents and Serious Incidents (VFU/SR 748.126.3), based on the Investigation Report by the Air Accident Investigation Bureau on 22 August 2007.

General information on this report

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 serious incident, Central European Time (CET) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is: $LT = CET = UTC + 1 \text{ hour}$.

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

Contents

General	5
Brief description	5
Investigation	5
1 Factual Information	6
1.1 Pre-flight history and history of the flight	6
1.1.1 Pre-flight history	6
1.1.2 History of the flight	6
1.2 Injuries to persons	7
1.3 Damage to aircraft	7
1.4 Other damage	7
1.5 Personnel information	8
1.5.1 Commander	8
1.5.2 Copilot	8
1.5.3 Flight attendant A	9
1.5.4 Flight attendant B	9
1.6 Aircraft information	9
1.6.1 General	9
1.6.2 Mass and centre of gravity	10
1.6.3 Communication	10
1.6.4 Description of the variable pitch propellers	10
1.6.5 Findings after the serious incident	11
1.6.6 Design of the emergency exits	11
1.7 Meteorological information	11
1.7.1 General	11
1.7.2 General weather situation	11
1.7.3 Forecasts and warnings	11
1.7.4 Measured and observed values	11
1.7.5 Weather conditions at Lugano airport	12
1.8 Aids to navigation	12
1.9 Communications	12
1.9.1 General	12
1.9.2 Communication between flight crew and air traffic controller	12
1.9.3 Communication between air traffic controller, airport authority and fire brigade	12
1.10 Aerodrome information	13
1.10.1 General	13
1.10.2 The airport fire brigade	13
1.11 Flight recorders	14
1.12 Wreckage and impact information	14
1.13 Medical and pathological information	14
1.14 Fire	14
1.15 Survival aspects	14
1.16 Tests and research	14

1.17	Organizational and management information	14
1.17.1	The airline	14
1.17.1.1	General	14
1.17.1.2	Airline procedures	14
1.17.1.3	Aircraft manufacturer's procedures	17
1.17.1.4	Procedures of the Federal Office for Civil Aviation	18
1.17.1.5	The airport fire brigade	18
1.18	Additional information	19
1.19	Useful or effective investigation techniques	19
2	Analysis	20
2.1	Technical aspects	20
2.2	Human and operational aspects	20
2.2.1	Flight crew	20
2.2.2	Cabin crew	21
2.2.3	Airline procedures	22
2.2.4	Airport fire brigade	23
3	Conclusions	25
3.1	Findings	25
3.1.1	Technical aspects	25
3.1.2	Crew	25
3.1.3	The airline	25
3.1.4	Airport fire brigade	26
3.2	Causes	26
4	Safety recommendations and measures taken since the serious incident	27
4.1	Safety recommendations	27
4.2	Measures taken since the serious incident	27
4.2.1	Measures by the propeller manufacturer, Dowty	27
4.2.2	Measures by the operator, Darwin Airline	27
	Annex 1: Emergency Exits	28
	Annex 2: Lugano Airport	29
	Annex 3: AIP Lugano	30
	Annex 4: Lugano Airport Alarm Plan	31
	Annex 5: Position of smoke sensor and air nozzle in the lavatory	32

Final Report

Owner	Darwin Airline, Lugano Airport, CH-6982 Agno, Switzerland
Operator	Darwin Airline, Lugano Airport, CH-6982 Agno, Switzerland
Aircraft type	SAAB 2000, Saab Aircraft AB
Country of registration	Switzerland
Registration	HB-IZZ
Location	Lugano Airport
Date and time	17 November 2005, 17:22 UTC

General

Brief description

On 17 November 2005, at 17:22 UTC, the Darwin Airline Saab 2000 aircraft, registration HB-IZZ, flight number DWT 018, took off on a scheduled flight from Lugano to Geneva. All preparations in the cockpit took a normal course and at 17:21:10 UTC the crew of flight DWT 018 received clearance to take off from runway 01.

During the take-off acceleration phase, at a speed of approximately 60 kt, the aural warning sounded and the FWD LAVATORY SMOKE warning appeared. Both pilots noticed this warning at the same time. The commander decided without delay to abort the take-off. The aircraft came to a standstill on runway 01 after a rolling distance of about 480 m.

The commander then asked the flight attendant in the front section of the cabin (working station 1) whether there was smoke in the lavatory. The flight attendant replied that there was smoke in the cabin, upon which the commander immediately ordered an emergency evacuation.

One passenger received slight injuries to the foot during this emergency evacuation.

Investigation

The investigation was opened on 17 November 2005 in cooperation with the Ticino cantonal police.

The serious incident is attributable to the fact that a smoke warning in the lavatory was triggered by contaminated air from the air-conditioning system; the crew aborted the take-off and immediately carried out an evacuation of the aircraft.

1 Factual Information

1.1 Pre-flight history and history of the flight

1.1.1 Pre-flight history

The Darwin Airline Saab 2000, registration HB-IZZ, was released for service after a daily check at 22:50 UTC on 16.11.2005.

On 17.11.2005 at 05:21 UTC, HB-IZZ took off on the first scheduled flight of the day. Five further flights, all uneventful, followed.

1.1.2 History of the flight

On 17 November 2005 at 17:13:19 UTC, the crew of flight DWT 018 requested take-off clearance for a scheduled flight according to instrument flight rules (IFR) from Lugano (LSZA) to Geneva (LSGG).

At 17:13:28 UTC, the crew received clearance to start the engines and were assigned the following departure procedure: *"Ginevra, OMETO SEVEN WHISKEY departure, one zero zero initially, squawk zero four zero two"*.

Once all the preparations had been concluded, at 17:17:19 UTC the crew of DWT 018 requested taxi clearance, which was given to them without delay up to the holding point OSCAR. At 17:17:41 UTC, they received further clearance to taxi onto the runway and to the take-off position.

Subsequently the cockpit voice recorder (CVR) recordings indicate conversations which concern the impending departure as well as some with private content.

At 17:21:10 UTC, the crew of flight DWT 018 received take-off clearance. On this flight, the copilot was intended to be pilot flying (PF) and the commander to be pilot not flying (PNF). According to the airline's policy, however, take-off must always be carried out by the commander; this was the situation in this case.

The commander then initiated the take-off. According to the statements of both pilots, at 17:21:33 UTC, at a speed of approximately 60 kt, an aural warning sounded and the copilot almost simultaneously reported the FWD LAVATORY SMOKE¹ warning as follows: *"abortion, forward lavatory smoke"*. According to the commander's statement, he too saw this warning.

The commander immediately started to abort the take off. At 17:21:37 UTC, the copilot reported: *"warning is cancelled"* and just one second later the copilot reported to aerodrome control (tower) that they had aborted the take-off. The air traffic controller (ATCO) confirmed this message with: *"roger"*. At 17:21:40 UTC, the FWD LAVATORY SMOKE warning went out again. At 17:21:44 UTC, the copilot reported: *"warning is gone, ehh!"* The aircraft came to a standstill at 17:21:49 UTC after a rolling distance of about 480 m.

At the same time, the commander used the onboard telephone to contact the flight attendant at working station 1 and asked him at 17:21:51 UTC to check the lavatory: *"eh, eh... guardami un attimino il cesso, per favore!"*. At 17:21:54 UTC, the flight attendant immediately replied: *"c'è fumo in cabina, eh!"*.

¹ The Saab 2000 aircraft can optionally be equipped with two lavatories (front and rear). The Darwin Airline aircraft are all equipped with only one lavatory (front).

The commander then said immediately to the copilot: *"OK!... perform malfunction checklist, emergency evacuation, perform malfunction checklist... eh..."*. From the CVR it is apparent that the copilot very probably then executed his points of the ON GROUND EMERGENCY procedure (cf. section 1.17.1.2).

During take-off, the flight attendant in the front section of the cabin (working station 1) noticed a light mist, at approximately the overwing emergency exits. He also noticed a smell of smoke. He was just about to press the emergency call button when he noticed that the take-off had been aborted.

The flight attendant in the rear section of the cabin (working station 2) felt the aborted take-off as a slight deceleration and opened his seat belt to establish the reason for braking. According to his statement, the flight attendant noticed smoke in the cabin.

At 17:22:19 UTC, the commander gave the following order via the public address (PA) system: *"cabin crew prepare... emergency evacuation, emergency evacuation!"*.

At 17:22:38 UTC, the ATCO asked: *"Darwin zero one eight, do you need assistance?"* At 17:22:42 UTC, the commander answered as follows: *"Affirm, Darwin zero one eight is performing emergency evacuation, now!"*. The ATCO replied at 17:22:46 UTC with *"roger"* and raised the alarm with the fire brigade at 17:22:54 UTC.

After the commander's order, the two flight attendants immediately initiated an emergency evacuation. The passengers left the aircraft through the front main door and the rear service door. As they did so, they had to jump onto the runway from a height of 1.62 m in the case of the front door and 1.78 m in the case of the rear door. The overwing emergency exits were not opened. One passenger slightly injured his foot jumping from the aircraft onto the runway.

The passengers were assembled on the ground by the crew and taken to the Hangar North.

At 17:27:54 UTC, five minutes after receiving the alarm, the fire brigade reported from the aircraft location and informed that people had already moved away and that no-one else was on the aircraft.

1.2 Injuries to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly injured or uninjured	4	40	

1.3 Damage to aircraft

There was no material damage to the aircraft.

1.4 Other damage

Not applicable.

1.5 Personnel information

1.5.1	Commander	
	Person	Swiss citizen, born 1974
	Licence	Airline transport pilot licence ATPL (A), according to JAR, first issued by the Federal Office for Civil Aviation (FOCA) on 07.06.2002
	Ratings	Type rating SAAB 2000 as pilot in command, valid till 11.01.2006 Instrument flying IFR (A), valid till 11.01.2006 International radiotelephony for visual and instrument flight RTI (VFR/IFR) Night flying NIT (A)
	Last operator proficiency check (OPC)	23.06.2005
	Last licence proficiency check (LPC)	11.01.2005
	Medical fitness certificate	Class 1, valid till 11.09.2006, no restrictions
	Last medical examination	03.08.2005
	Total flying experience	4223 hours
	of which as copilot	2749 hours
	on the accident type	3550 hours
	during the last 90 days	177 hours
	Commencement of pilot training	1997
1.5.2	Copilot	
	Person	German citizen, born 1965
	Licence	Airline transport pilot licence ATPL (A), according to JAR, first issued by the Federal Office for Civil Aviation (FOCA) on 10.12.2002
	Ratings	Type rating SAAB 2000 as copilot, valid till 30.08.2006 Instrument flying IFR (A), valid till 30.08.2006 International radiotelephony for visual and instrument flight RTI (VFR/IFR) Night flying NIT (A)
	Last proficiency check	11.08.2005
	Last line check	30.06.2005
	Medical fitness certificate	Class 1, valid till 12.08.2006, no restrictions
	Last medical examination	27.07.2005

Total flying experience	2959 hours
on the accident type	2700 hours
during the last 90 days	182 hours
Commencement of pilot training	1998

1.5.3 Flight attendant A

Person	Italian citizen, born 1976
Function	FA working station 1 (front section of the cabin)
Courses	Periodic courses on CRM ² , DG ³ , SEC ⁴ , ESET ⁵ , Inc. & Acc. Rev. ⁶ . and Quality System, issued by Darwin Airline
Last Operator Line Check (OLC)	21.03.2005

1.5.4 Flight attendant B

Person	Italian citizen, born 1972
Function	FA working station 2 (rear section of the cabin)
Courses	Periodic courses on CRM, DG, SEC, ESET, Inc. & Acc. Rev. and Quality System, issued by Darwin Airline
Last Operator Line Check (OLC)	29.08.2005

1.6 Aircraft information

1.6.1 General

Type	SAAB 2000
Characteristics	Commercial aircraft with two turboprop engines
Seats	50
Maximum take-off mass	22 999 kg
Wingspan	24.76 m
Length	27.28 m
Height	7.72 m
Year of construction	1997
Serial number	048

² Crew Resource Management

³ Dangerous Goods

⁴ Security Training

⁵ Emergency Safety

⁶ Incident & Accident Review

Engines	Allison Engine Company Inc. AE 2100A
Power per engine	4152 SHP (4212 PS, 3096 kW)
Propellers	Dowty Rotol Ltd. (C)R 381/6-123-F/5
Servicing	A4 check on 11.10.2005 weekly check on 16.11.2005 daily check on 16.11.2005
Certification	VFR day and night IFR Cat IIIa B-RNAV (RNP 5)
Airframe flying hours	18 531:54 hours
Registration certificate	No. 3, issued by the FOCA on 24.10.2005
Airworthiness certificate	No. 2, issued by the FOCA on 24.10.2005

1.6.2 Mass and centre of gravity

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

1.6.3 Communication

The following systems were available to the pilots for communication:

- VHF COM system
- pilots' interphone
- flight deck/cabin interphone
- public address system

1.6.4 Description of the variable pitch propellers

The Dowty propeller mounted on the Saab 2000's Allison AE 2100A engines is a so called constant speed propeller, i.e. the pitch of the propeller blades is varied with the aim of achieving a constant speed. This variation is brought about by hydraulic pressure on a piston which is located in the hollow shaft on which the propeller is mounted. In one end position the propeller is in the feather stop position and in the other it is in the full reverse stop position. The hydraulic pressure is controlled via the pitch control unit (PCU) fitted to the gearbox; the PCU is regulated by the engine's FADEC (full authority digital engine control).

If the hydraulic pressure on the front of the piston is greater than on the rear, then the propeller blades adjust themselves to increase the pitch, i.e. towards the feather stop position. If the hydraulic pressure on the rear of the piston is greater than on the front, the propeller blades then adjust themselves to reduce the pitch, i.e. towards the full reverse stop position. These two hydraulic pressures are transferred from the PCU by means of two concentric tubes in the hollow shaft on the front and rear of the piston.

The cylinder in which the piston moves is filled with gear oil. The area in which the blades are actuated is partly filled with grease. Cases have occurred in which gear oil is forced inwards in this area at increased pressure. This oil then penetrated the roots of the blades and caused an imbalance of the propeller. To prevent this, the manufacturer installed a pressure relief valve.

1.6.5 Findings after the serious incident

Clarifications after the incident revealed that because of a defective seal, gear oil from the adjusting mechanism was able to penetrate the propeller area in which the propeller blades are actuated.

The pressure relief valve then opened and gearbox oil got to the outside of the propeller. The oil flowed into the spinner and from there was flung into the environment. Some of the oil was sucked back in through the engine air inlet and in this way passed through the compressor into the bleed air, and from there through the air-conditioning pack into the cabin in the form of odour, mist and smoke.

1.6.6 Design of the emergency exits

The Saab 2000 aircraft type has four emergency exits for passengers: in the front of the aircraft a passenger door to the left and in the rear of the aircraft a service/emergency door to the right. An emergency exit is installed over each wing (cf. Annex 1).

According to construction regulations JAR 25.810 this aircraft type does not need emergency slides. Among other things, these regulations read as follows:

“(a) Each non-over-wing land plane emergency exit more than 6 ft (1.80 m) from the ground with the aeroplane on the ground and the landing gear extended and each non-over-wing type A exit must have an approved means to assist the occupants in descending to the ground.

(1) The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent; (...)”

As can be seen in Annex 1, the threshold of the front passenger door is 1.62 m above the ground. The rear service/emergency door has a threshold height of 1.78 m.

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.5 was provided by MeteoSwiss.

1.7.2 General weather situation

Am Rande eines Tiefs über der Ostsee floss mit einer starken nordwestlichen Höhenströmung nur mässig feuchte Polarluft von der Nordsee gegen die Alpen. Im Süden sorgte der Nordföhn für schönes Wetter.

At the edge of a depression over the East Sea, moderately humid polar air was flowing from the North Sea towards the Alps, with a strong north-westerly high-altitude current. In the south, the north “Föhn” wind brought fine weather.

1.7.3 Forecasts and warnings

TAF from Lugano Airport (LSZA) for the period of the serious incident.

LSZA 171702 36012KT CAVOK

1.7.4 Measured and observed values

METAR from Lugano Airport (LSZA) for the period of the serious incident.

LSZA 171720 36008KT CAVOK 09/M07 Q1008 NOSIG

LSZA 171750 36008KT CAVOK 09/M06 Q1009 NOSIG

1.7.5 Weather conditions at Lugano airport

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

Cloud	3-4/8 at 13 000 ft AMSL
Visibility	about 30 km
Wind	north wind at 8-10 kt
Temperature/dewpoint	9 °C / -7 °C
Atmospheric pressure	QNH LSZA 1008 hPa, QNH LSZH 1014 hPa
Position of the sun	Azimuth 259°, elevation -16°
Hazards	none detectable
Sunset	16:27 UTC

1.8 Aids to navigation

Not applicable.

1.9 Communications

1.9.1 General

The communications of the individual units were recorded on various media. In addition to the conversations recorded by the CVR (cockpit voice recorder), a transcript of the recorded radio conversations between the flight crew and the air traffic controllers, plus a recording of the radio conversations between the air traffic controller, the airport authority and the head of the fire brigade were also available.

1.9.2 Communication between flight crew and air traffic controller

The flight crew and the air traffic controller (ATCO) communicated on the aerodrome control tower (ADC) frequency of 120.25 MHz. Communication took place in English at the beginning and in Italian at the end. When the crew informed the air traffic controller as follows at 17:21:38 UTC: *"Take off abortion, Darwin zero one eight"*, the latter answered with: *"roger"*. One minute later, the ATCO asked the flight crew if they needed assistance. The crew replied immediately: *"Affirm, Darwin zero one eight is performing emergency evacuation, now"*. The ATCO again confirmed this with: *"roger"*. The ATCO raised the alarm with the fire brigade at 17:22:54 UTC.

1.9.3 Communication between air traffic controller, airport authority and fire brigade

The conversations between the air traffic controller, the head of the fire brigade and the airport authority took place on the 162.625 MHz frequency. After the fire brigade was alarmed by the ATCO at 17:22:54 UTC, the head of the fire brigade asked for the reason for the alarm at 17:23:38 UTC. The ATCO replied that the passengers would be disembarking because fire had broken out in the aircraft's lavatory.

At 17:24:07 UTC, the commander of the fire brigade declared the intervention as a sudden test alarm. At 17:26:26 UTC, the airport authority asked the ATCO for permission to drive onto the runway. This permission was granted immediately. At 17:27:54 UTC, five minutes after the alarm had been raised, the commander of the fire brigade reported from the aircraft location that there was no fire, that

no-one was inside the aircraft and that the fire brigade would now check the cargo compartments.

When the airport authority asked the fire brigade commander at 17:31:45 UTC whether the Securitas alarm centre (CERTAS) should forward the alarm in accordance with the alarm plan, the latter replied that the alarm should be treated as a genuine alarm. He himself had received the alarm as a genuine alarm and acted accordingly.

At 17:36:25 UTC, the head of the fire brigade reported that he had informed the REGA that it was an exercise. Shortly afterwards, he withdrew with his team and vehicles. At 17:37:24 UTC, he confirmed to the airport authority in response to an enquiry: "*Si, confermo che è un esercizio non c'è niente sull'apparecchio, non c'è fumo né niente*" (Yes I confirm that it is an exercise, there is nothing on the aircraft, there is no smoke or anything).

At 17:41:59 UTC, the airport authority reported to the head of the fire brigade after a conversation with the commander of flight DWT 018 that it had not been an exercise.

1.10 Aerodrome information

1.10.1 General

Lugano Airport is located in the Veduggio valley, four kilometres west of the city of Lugano (see Annex 2). The airport is open for IFR and VFR flights and for private, business and scheduled air traffic. The airport reference point (ARP) has coordinates N 46° 00' 13" / E 008° 54' 37" and is located at an elevation of 915 ft AMSL.

The airport has a concrete runway with the following dimensions (see Annex 3):

Runway	Dimensions	Elevation of runway thresholds
01/19	1350 x 30 m	896/915 ft AMSL

1.10.2 The airport fire brigade

According to the AIP⁷ Switzerland, in terms of rescue and fire fighting services Lugano Airport belongs to airport category 6. These categories are defined in Annex 14 of the ICAO⁸. According to this definition, (chapter 9, para 9.2.3 ff), a category 6 airport must meet the following criteria, among others:

Rescue and fire fighting services must be guaranteed for aircraft over a total length of 28 m up to but not including 39 m and a fuselage diameter of 5 m. Moreover, two vehicles are required for rescue and fire fighting services and a minimum available quantity of water of 11 800 litres is required for performance stage A and 7900 litres for performance stage B.

At the time of the serious incident, Lugano Airport had three rescue and fire fighting vehicles, with a total water capacity of 13 300 litres. In accordance with the AIP, Lugano Airport also has two rescue boats, each with an inflatable life raft for 40 persons.

⁷ AIP – Aeronautical Information Publication;

⁸ ICAO – International Civil Aviation Organisation

The ICAO also requires the rescue and fire fighting personnel to be trained appropriately and to be capable of deployment within three minutes of an alarm at any point on the airport.

The airport fire brigade had an alarm plan (see Annex 4), which was approved by the Federal Office for Civil Aviation (FOCA).

1.11 Flight recorders

The aircraft was equipped with an FDR and a CVR. The available data were serviceable.

1.12 Wreckage and impact information

The aircraft came to a standstill on concrete runway 01, after a rolling distance of approximately 480 m.

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 Organizational and management information

1.17.1 The airline

1.17.1.1 General

Darwin Airline is a young Swiss airline based in canton Ticino. It is based at Lugano Airport and was founded in August 2003.

Darwin Airline has had an operating licence from the Federal Office for Civil Aviation since July 2004. On 28 July 2004, Darwin commenced scheduled operations with its maiden flight from Lugano to Geneva.

Several European destinations are currently being served. The Darwin Airline team consists of approximately 100 employees.

The Darwin Airline fleet consists of four Saab 2000 aircraft which were previously in use with Crossair or Swiss International Airlines respectively.

1.17.1.2 Airline procedures

Among other things, the following is stated in the airline's Operation Manual (OM) A, in section 8.0.5.13 *Malfunctions on Ground*:

"Whenever a malfunction occurs in an aeroplane on ground the CMD shall take proper corrective action. This responsibility starts upon boarding the aeroplane until disembarking after flight."

Minor problems shall be handled with the aeroplane checklists and in close co-operation with maintenance.

If the malfunction is serious or whenever there is a risk of fire on ground emergency procedures shall be applied. The applicable checklists and callouts are published in the respective OM Part B and must be known by heart.

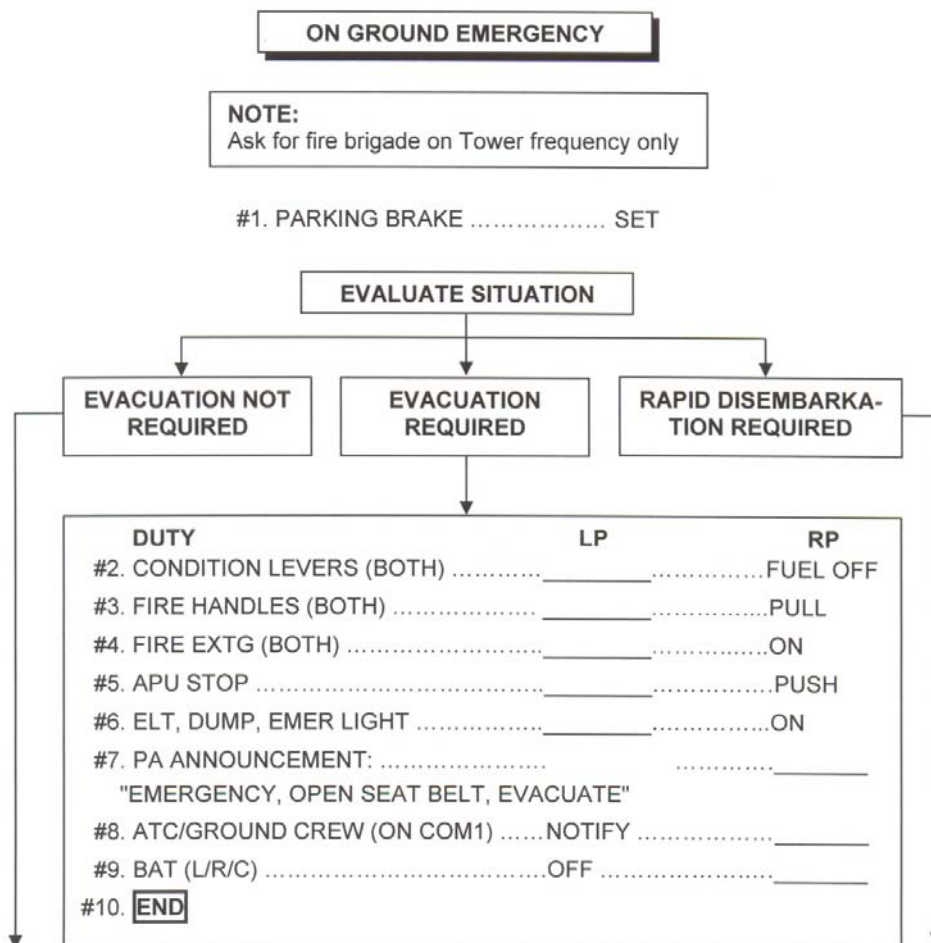
Keep passengers on board: if the situation is under control and disembarkation is not required.

Rapid disembarkation: in this case a malfunction exists but no immediate safety threat and the CMD decides a precautionary disembarkation using normal exit procedures.

Emergency evacuation: there is an immediate safety hazard and the aeroplane must be evacuated. This procedure involves a high potential of passenger injuries."

In the case of the present serious incident, the commander decided for an emergency evacuation.

According to the OM B, a situation analysis must be carried out before a decision is taken on an emergency evacuation. Under the heading ON GROUND EMERGENCY, the following is prescribed for this decision-making process, among other things (M122, EICAS 6.0):



The commander's decision in favour of an emergency evacuation was taken spontaneously.

According to the commander's statement, he himself had switched on the emergency locator transmitter (ELT). According to the airline's procedures, the copilot should have switched it on.

Twenty-five seconds after the commander had ordered the malfunction checklist, he used the public address (PA) in the passenger cabin to inform the cabin crew as follows: *"Cabin crew prepare emergency ... emergency evacuation, emergency evacuation!"*

The *"cabin crew prepare emergency"* command does not exist in the airline's Cabin Safety Procedure Manual (CSPM).

Among other things, section 4.5 *Emergency Evacuation Procedures* of the CSPM states:

4.5.1 Initiation of Evacuation

.....

"Generally, the CMD will initiate an evacuation.

For initiation it is of utmost importance that the aeroplane is no longer moving and the engines have been shut down. This must be verified if the occurrence arises in connection with Take-Off, Landing or Taxiing.

.....

The commands which are possible in an emergency situation on the ground and which can be given via the PA to the cabin crew are the following:

"Cabin Crew at station". For the cabin crew, according to the CSPM, this means:

Proceed immediately to your assigned station: if you are already there, stay where you are;

- *Check outside conditions;*
- *Be alert (the situation might require a rapid disembarkation/evacuation, for example during "Fuelling with passengers on board, after rejected Take-Off" etc.*
- *Wait for further instructions*

"Cabin Crew, rapid disembarkation". For the cabin crew, according to the CSPM, this means, among other things:

- *S/C or C/C1 checks outside condition, open door and extends the stairs;*
- *S/C or C/C1 makes announcement (see above). Order passengers to leave the aeroplane immediately via main door and to leave all carry-on baggage behind;*
- *Ensure a quick disembarkation*

"Emergency open seat belt evacuate". For the cabin crew, according to the CSPM (4.7.1), among other things this means that the following orders must be given (shout the following orders):

2 C/Cs on board: *"Emergency - open seat belt
open overwing exit – get out, foot first – hurry – come here – come this way – assist on ground!"*

1 C/C on board: *"Emergency – open seat belt
open overwing exits and rear door – get out, foot first – hurry – come here – come this way – assist on ground!"*

In case the main door and/or service door is usable, after the overwing exit commands, tell the passengers near by:

- *"Come here!"*
- *"Jump out, run forward!"*

In case the main door and/or service door is blocked, after the overwing exit commands, tell the remaining passengers:

- *"Go to the overwing exits!"*

During the serious incident, 2 C/Cs were onboard. The main door and service door were available and the overwing exits were not opened. All the passengers left the aircraft either through the main door or through the service door.

"Cabin Crew, operation normal". For the cabin crew, this means that the commander has decided not to carry out an emergency evacuation and that operation will continue in accordance with normal procedures.

In the CSPM, under 4.6 *Initiation of Evacuation*, there is a flow diagram, according to which the "cabin crew at station" command is given from the cockpit. Following this command, the cabin crew must determine the situation outside the aircraft (*check outside condition*) and make a corresponding report to the cockpit. The flight crew, on the basis of their situation analysis, then decides whether to carry out an evacuation or not.

If the decision on an evacuation is taken, the order *"Emergency, open seat belt, evacuate"* is given. If the flight crew decides not to carry out an evacuation, the order *"Cabin Crew, Operation Normal"* is given.

In contrast to the flight crews' OM B and section 4.5.5 of the CSPM, the third possibility, a rapid disembarkation, is not mentioned in this flow diagram.

1.17.1.3 Aircraft manufacturer's procedures

In the procedures of the Saab 2000 aircraft manufacturer there is no published procedure for a so-called ON GROUND EMERGENCY, as the airline defined it in its OM B. With regard to an evacuation, the manufacturer has published the following tasks to be performed by heart by the pilots under the heading EMERGENCY EVACUATION (SAAB 2000, MALFUNCTION CHECKLIST, -M6-):

LEFT PILOT'S DUTY:

Parking brake..... SET
"Evacuation" ORDER
Tower/Ground Crew NOTIFY
BAT switches (three) OFF
End of procedure

*RIGHT PILOTS' DUTY**COND LEVERS (both)..... FUEL OFF**ELT, DUMP, EMER LIGHT..... ON**Fire Handles (both)..... PULL**FIRE EXTG (both)..... ON**APU..... STOP**End of procedure*

The tasks specified by the airline in the ON GROUND EMERGENCY procedure and to be performed by heart by the pilots are identical to the tasks required by the manufacturer in the case of the EMERGENCY EVACUATION procedure. However, they differ in the sequence in which they have to be carried out.

It must be stated that the manufacturer, unlike the airline, has not published a procedure for a so-called RAPID DISEMBARKATION.

1.17.1.4 Procedures of the Federal Office for Civil Aviation

In principle, the Federal Office for Civil Aviation (FOCA) adheres to the procedures of the United Kingdom Civil Aviation Authority (CAA) with regard to the evaluation of checklists. In particular, this relates to CAP 676 (Guidance on the Design, Presentation and Use of Emergency and Abnormal Checklists) and CAP 708 (Guidance on the Design, Presentation and Use of Electronic Checklists).

According to statements by the FOCA on 9 March 2006, no deviations from the malfunction and emergency checklists published by the manufacturer are accepted for the issue of an operating licence.

In the case of the normal checklist, changes are accepted only if they are not of a substantial nature and are approved by the manufacturer in the form of a written, so-called "no technical objection" (NTO).

The malfunction and emergency checklists applied in the present serious incident were not identical to those of the aircraft manufacturer. They were accepted by the FOCA in their present form on the occasion of the operating licence in July 2004.

In this context, the FOCA, which issued the airline with the operating licence along with the corresponding checklists, explained that it might well be possible that airlines which had received their operating licence before 2006 would have deviations in their checklists. At the time of issue of the operating licence in 2004, only the minimum equipment list (MEL) and the configuration deviation list (CDL) were meticulously checked, because of a shortage of personnel.

1.17.1.5 The airport fire brigade

The deployment of the airport fire brigade is defined in an alarm plan for the airport (see Annex 4). The alarm plan distinguishes between the following seven different alarm types:

- *Allarme semplice* (simple alarm)
- *Allarme standard* (standard alarm)
- *Allarme incidente in zona impervia* (alarm in the event of an incident in an area difficult to access)
- *Allarme incidente nel lago* (alarm in the event of an accident on the lake)

- *Allarme incidente in territorio italiano* (alarm in the event of an accident on Italian territory)
- *Allarme inquinamento* (contamination alarm)
- *Allarme fuoco hangars e stabili* (fire alarm for hangar and building)

In addition, the alarm plan shows which agencies have to be informed for the respective alarm types.

In the case of the serious incident, the alarm was raised by the ATCO at 17:22:54 UTC after confirmation from the aircraft commander that it was an emergency situation.

This alarm was raised as an *allarme semplice* (simple alarm).

At 17:27:54 UTC, five minutes after the alarm was raised, the fire brigade commander reported from the location of the aircraft and described the situation at that time.

1.18 Additional information

A similar incident occurred in July 2005. A Darwin Airline Saab 2000 aircraft, registration HB-IZG and flight number DWT 500, took off from Lugano on a flight to London City via Berne. After an uneventful flight, the master caution L GEN FAULT appeared in the cockpit during the final approach to London City at about 500 ft AGL. The crew decided to continue the approach and started the auxiliary power unit (APU). After landing, whilst turning onto the taxiway, the master warning L ENG OIL TEMP HI appeared. The commander switched off the left air-conditioning pack and the left bleed air immediately, to prevent smoke penetrating into the air-conditioning unit.

In such a case, the checklist specifies that the engine must be shut down. The commander decided to let the engine run, as he still had to make a right turn to taxi into the parking position. Since the copilot expressed doubts about this procedure, the commander checked the oil temperature and oil quantity. The temperature was in the red range and the oil quantity was in the green range.

The fire warning LH ENG FIRE now appeared immediately before the aircraft stopped at the stand. The commander straightaway informed the copilot that he would carry out the points of the corresponding malfunction checklist which were to be executed by heart. Shortly after the crew had released the fire extinguisher for the left engine, smoke appeared in the cockpit. The copilot informed the tower about the fire warning and the latter raised the alarm with the fire brigade. The commander, who initially wanted to carry out a rapid disembarkation, now decided on an emergency evacuation. The fire brigade and ground personnel supported the emergency evacuation which had been ordered. No-one was injured.

Since this incident did not take place on Swiss territory, the corresponding foreign investigation authority was responsible for it.

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Technical aspects

The hydraulic pressure for controlling the propeller caused a seal on the adjusting piston, which was very probably already damaged, to be pushed out. As a result, gearbox oil was able to penetrate the propeller housing at increased pressure. Subsequently, the installed pressure relief valve opened and gearbox oil was able to get from the propeller housing onto the exterior surface. The oil flowed into the spinner and from there was flung into the environment. Some of the oil was sucked back in through the engine air inlet and in this way passed through the engine compressor into the bleed air, and from there through the air-conditioning pack into the cabin, where it was perceived as smoke.

It must be assumed that this light smoke, as it was perceived in the cabin, was also responsible for briefly triggering the smoke alarm in the lavatory. The air-conditioning pack air nozzle is in the immediate vicinity of the smoke sensor (see Annex 5).

It is impossible to determine definitively whether smoke was actually present in the lavatory after the aborted take-off. In view of the time sequence, it must be assumed that the flight attendant did not check the lavatory. According to his statement, the copilot touched the outside of the lavatory door with his hand and found that it was cold. He then left the aircraft.

2.2 Human and operational aspects

2.2.1 Flight crew

At 17:21:10 UTC, flight DWT 018 was cleared for take-off. During the acceleration phase, at a speed of approximately 60 kt, the aural warning sounded at 17:21:33 UTC. At the same time, the copilot reported that the FWD LAVATORY SMOKE warning was being displayed. The commander immediately aborted the take-off and almost simultaneously the copilot reported that the red warning display had extinguished.

The copilot then immediately reported to the tower that the take-off had been aborted.

At 17:21:49 UTC, the commander used the onboard telephone to ask the flight attendant to check the front lavatory. When the flight attendant immediately replied that there was smoke in the cabin, the commander decided without delay on an evacuation, speaking to the copilot as follows: *... "perform malfunction checklist, emergency evacuation, perform malfunction checklist ... eh ..."*

The order by the commander was not complete, because he did not define the case for which the malfunction checklist should be applied. On the basis of the CVR recordings it can be assumed that the copilot nevertheless applied the ON GROUND EMERGENCY procedure, as defined in the airline's procedures.

The announcement made only some 20 seconds later by the commander via the public address (PA): *"Cabin crew prepare emergency ... emergency evacuation, emergency evacuation!"* confirms the assumption that the commander wanted the malfunction checklist for ON GROUND EMERGENCY to be carried out.

The order given to the cabin crew via the PA did not correspond to that prescribed for such a case in the airline's procedures. According CSPM chapter 4.6. (initiation of evacuation) the commander should have given the order "*Cabin crew at station*" immediately after the aircraft came to a standstill in order to prepare the cabin crew for the impending evacuation.

According to the current state of knowledge in the area of crew resource management, after the aircraft has stopped and the parking brake has been set the flight crew should first inform the cabin crew by means of the instruction "*Cabin crew at stations*" and in this way prepare them for further measures. It is then customary for the flight crew, under the leadership of the captain, to take the time for a joint situation assessment. A decision based on this assessment and supported by both pilots is then communicated and implemented as part of the procedure. This situation assessment may be shortened somewhat only in specific predefined cases such as structural failure, explosive fire or in water. Even in these cases a joint assessment by the flight crew must take place to compensate for individual perceptions under stress.

The incomplete command given by the commander, as described above, as well as the chronological sequence of the commands issued permits the conclusion that action was taken hastily. This may also have led to the situation analysis which had been commenced not being completed.

The FWD LAVATORY SMOKE warning was extinguished six seconds after it appeared, before the aircraft came to a standstill. This was also reported by the co-pilot. This circumstance may possibly have influenced the subsequent decision-making process. It must therefore remain open whether the commander was consciously aware of the warning being extinguished.

The serious incident demonstrates the importance of a comprehensive assessment of the situation before initiating an emergency evacuation.

2.2.2 Cabin crew

The flight attendant in the aft section of the cabin (working station 2) felt the aborted take-off as a slight deceleration and opened his seat belt to establish the reason for braking. This behaviour involved certain risks. An instruction from the cockpit, such as, for example: "*Cabin crew at station*" as is prescribed in the airline's procedures for such a case, would have ensured clarity in this case.

Immediately after the aircraft came to a standstill, the commander instructed the flight attendant at working station 1 to take a look inside the front lavatory, at 17:21:51 UTC: "*eh, eh, guardami un attimino il cesso, per favore!*". The answer came immediately (17:21:54 UTC) with the comment that there was smoke in the cabin: "*c'è fumo in cabina, eh!*" and brought the commander to the spontaneous decision to initiate an emergency evacuation.

The commander's order at 17:22:19 UTC: "*Cabin crew prepare ... emergency evacuation, emergency evacuation!*" was understood by the two flight attendants as an order for an emergency evacuation, even though it was not issued correctly. According to the airline's procedures, the wording of the command should have been: "*Emergency – open seat belt – evacuate*".

The flight attendants initiated the emergency evacuation immediately; their task was made more difficult by the fact that the passengers, according to the statement of the flight attendant at working station 2, did not want to leave their hand luggage behind. The passengers left the aircraft through the front and rear doors (cf. section 1.6.6). The overwing emergency exits remained closed.

According to the statement by the flight attendant at working station 2, before the flight he had personally instructed the passengers sitting next to the overwing emergency exits about the operation of these emergency exits. However, the overwing exits were not opened.

In section 4.7.1.1 of the CSPM, with reference to the overwing emergency exits, the evacuation order is described as follows, among other things:

*2 C/Cs on board: "Emergency - open seat belt
open overwing exits – get out, foot first – hurry – come
here – come this way – assist on ground!"*

It can be assumed that this evacuation order was called out by the flight attendants. Corresponding recordings are not present.

In principle, it should be stated that use of the two overwing emergency exits would have been appropriate for an evacuation. It could have reduced the risk of injury in the case of an aircraft such as the Saab 2000, which does not have emergency slides for evacuation purposes. The front door is 1.62 m and the rear door 1.78 m above the ground (cf. Annex 1). However, the trailing edge of the wings is only 1.32 m above the ground, even with the flaps retracted.

2.2.3 Airline procedures

The airline procedures for the pilots in the OM A and OM B distinguish between a rapid disembarkation and an emergency evacuation in the event of an emergency situation.

The cabin crew CSPM also describes rapid disembarkation in section 4.5.5. However, rapid disembarkation is not described in section 4.6 and only emergency evacuation is mentioned. Hence the flow diagram in the CSPM is not identical to the ON GROUND EMERGENCY publication for pilots in the OM B.

In order to preclude misunderstandings in emergency situations it is imperative that the airline's procedures are identical for both the cockpit crew and the cabin crew and that no questions are left open.

The airline's malfunction checklist concerning ON GROUND EMERGENCY does not correspond with the aircraft manufacturer's. According to the airline's statement, the malfunction checklist used by Swiss, Crossair respectively, who had previously operated the aircraft, was adopted. No amendments were made to the corresponding checklists by the airline.

It can be assumed that the airline itself was not aware that the malfunction checklist for an emergency evacuation did not correspond to the aircraft manufacturer's. Consequently, the airline was also unable to produce a "no technical objection" (NTO) from the manufacturer which would have permitted the deviations in the malfunction checklist.

The FOCA has explained that only the minimum equipment list (MEL) and the configuration deviation list (CDL) were meticulously checked, because of a shortage of personnel. The FOCA would also have had an opportunity to perform this in cooperation with the manufacturer.

Section 4.5.1 *Initiation of Evacuation* of the CSPM states the following, among other things:

... it is of utmost importance that the aeroplane is no longer moving and the engines have been shut down....

In the case of a propeller aircraft such as the SAAB 2000, it is not sufficient to shut down the engines. It is important that the propellers are no longer rotating when an evacuation takes place. Measurements have shown that after shutting down the engines there is still a period of approximately 50 seconds before the propellers stop rotating. This fact is not mentioned explicitly in the documentation. A corresponding note in the cabin crew documentation (CSPM) would help take this circumstance into account.

2.2.4 Airport fire brigade

The air traffic controller (ATCO) raised the alarm with the airport fire brigade at 17:22:54 UTC, after the crew had replied in the affirmative on the radio to the ATCO's enquiry about whether they needed assistance.

Just one minute later, the commander of the fire brigade asked about the reason for the alarm. This permits the conclusion that the fire brigade commander was busy with other tasks at the time the alarm was triggered.

The investigation has shown that the fire brigade on principle also has to carry out other tasks. These include, for example, loading and unloading baggage, refuelling aircraft, guiding aircraft to the stands and maintaining the airport buildings.

At the time of the serious incident, according to the fire brigade commander's statement, the fire brigade team were fully occupied with such tasks. There was no-one from the fire brigade in the fire station.

This type of organization corresponds with standard practice accepted by the federal civil aviation authority for medium sized airports like Bern-Belp, Sion, Altenrhein and Lugano.

Irrespective of the assigned duties of the members of the fire brigade, the stipulations of Annex 14 of the ICAO, which state that on a category 6 airport the rescue and fire fighting services must be at any point on the airport within three minutes of them receiving the alarm, remain mandatory.

The alarm was raised at 17:22:54 UTC. At 17:24:07 UTC, more than one minute later, the commander of the fire brigade declared the intervention as a sudden test alarm on the joint coordination frequency of the tower, fire brigade and airport authority. There was no foundation whatsoever for declaring this alarm as a "sudden test alarm".

At 17:27:54 UTC, the fire brigade commander reported on the coordination frequency that they could not see any fire, that no passengers were still present and that they would now check the cargo compartments: "*Okay, per informazione, l'apparecchio non c'è fuoco, non c'è nessuna persona all'interno dove c'è i sedili e le persone allontanate, adesso controlliamo il vano cargo, poi ti avvisiamo.*" At this point, five minutes had already elapsed since the alarm was raised.

At 17:36:25 UTC, the commander of the airport fire brigade confirmed to the airport authority that he had informed the REGA that it was an exercise. For its part, the REGA had apparently then complained that they should at least have been informed when the alarm was raised that it was an exercise. The fire brigade commander then informed the airport authority that he would now be withdrawing all his personnel.

At 17:37:24 UTC, he again explicitly confirmed to the airport authority that it was an exercise. Only at 17:41:59 UTC, when the airport authority had spoken with the commander of flight DWT 018, was it made clear to the fire brigade commander that it was not an exercise.

In principle, it should be irrelevant for a fire brigade intervention after an alarm has been raised whether it is a matter of a genuine emergency or an exercise.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- A defective seal on the adjusting piston allowed gearbox oil to penetrate the propeller housing and finally make its way to the exterior.
- This oil was sucked back in through the engine air inlet and in this way passed into the bleed air and through the air-conditioning pack into the cabin, where it was perceived as smoke.
- This smoke triggered the lavatory smoke warning for seven seconds.

3.1.2 Crew

- The decision on an emergency evacuation was made by the commander seven seconds after the aircraft came to a standstill.
- The commander's order to the copilot regarding the malfunction checklist was not complete.
- The wording of the commander's order to the cabin crew for the emergency evacuation did not correspond to the airline's procedures.
- The emergency evacuation was initiated without delay by the two flight attendants.
- The overwing emergency exits were not opened.

3.1.3 The airline

- The procedures regarding rapid disembarkation are formulated differently in the CSPM and in the OM B.
- The malfunction checklist does not correspond to that of the aircraft manufacturer with regard to emergency evacuation.
- No corresponding "no technical objections" (NTOs) exist for the procedures which differ from those of the aircraft manufacturer.

3.1.4 Airport fire brigade

- With regard to rescue and fire fighting services, the equipment of the airport fire brigade corresponded to the ICAO regulations for a category 6 airport.
- At the time the alarm was raised, fire brigade team were busy with other tasks and no-one from the fire brigade was in the fire station. This type of organization corresponds with standard practice accepted by the federal civil aviation authority for medium sized airports like Lugano.
- For the first 20 minutes after the alarm was raised the fire brigade commander was of the opinion that it was an exercise and reported it as such to other agencies.

3.2 Causes

The serious incident is attributable to the fact that a smoke warning in the lavatory was triggered by contaminated air from the air-conditioning system; the crew aborted the take-off and immediately carried out an evacuation of the aircraft.

4 Safety recommendations and measures taken since the serious incident

4.1 Safety recommendations

None

4.2 Measures taken since the serious incident

4.2.1 Measures by the propeller manufacturer, Dowty

According to a service bulletin from the propeller manufacturer, the roots of the blades are now sealed with an aluminium washer rather than a plastic washer. This prevents oil from penetrating the roots of the blades causing imbalance, even at high oil pressure.

The pressure relief valve is being removed, as it is no longer necessary.

During operation of the propellers modified in accordance with the above-mentioned service bulletin, no further incidents have been observed.

4.2.2 Measures by the operator, Darwin Airline

Because of the serious incident in Lugano, the airline decided as follows according to a letter dated 8 January 2007 (translated from German):

"However, as an immediate measure it has been decided to deepen decision-making before a possible evacuation. The crew can decide according to the checklist between a normal disembarkation, a rapid disembarkation and an emergency evacuation. The latter should be applied only in an absolute emergency, i.e. Heavy Structural Damage, Open Fire or In Water. Appropriate training must be provided regarding the deliberations necessary for this.

The following key points on this subject have therefore been set down in the current ESET:

- The CRM block contains the topic: *"Smoke: risk and crew reaction in different flight phases"*;
- The case and the above-mentioned decision-making process are dealt with under Accident Review: Major emphasis is placed on the proven "cabin crew at station" model and hence the importance of crew communication and time management is explained.
- With regard to fire fighting, different forms of smoke (smell/colour) are highlighted in practical exercises by burning different materials – oil, de-ice fluid, plastics, cable/circuit boards, fillings) and extinguishing them."

Berne, 27 May 2010

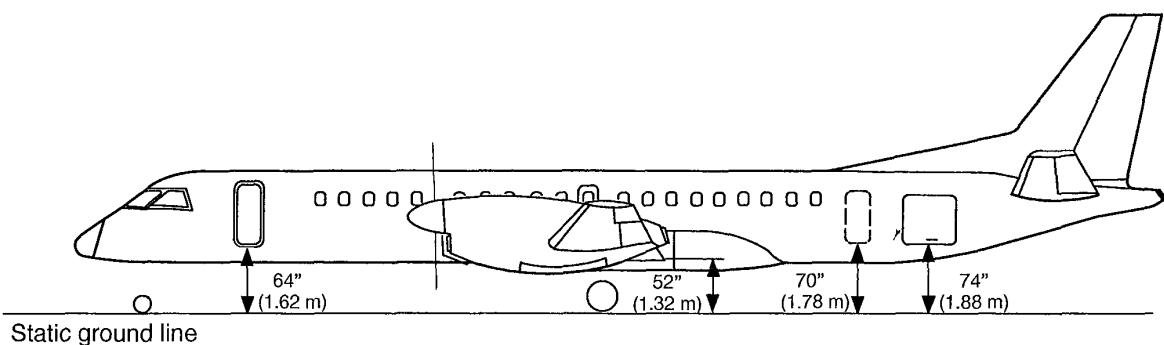
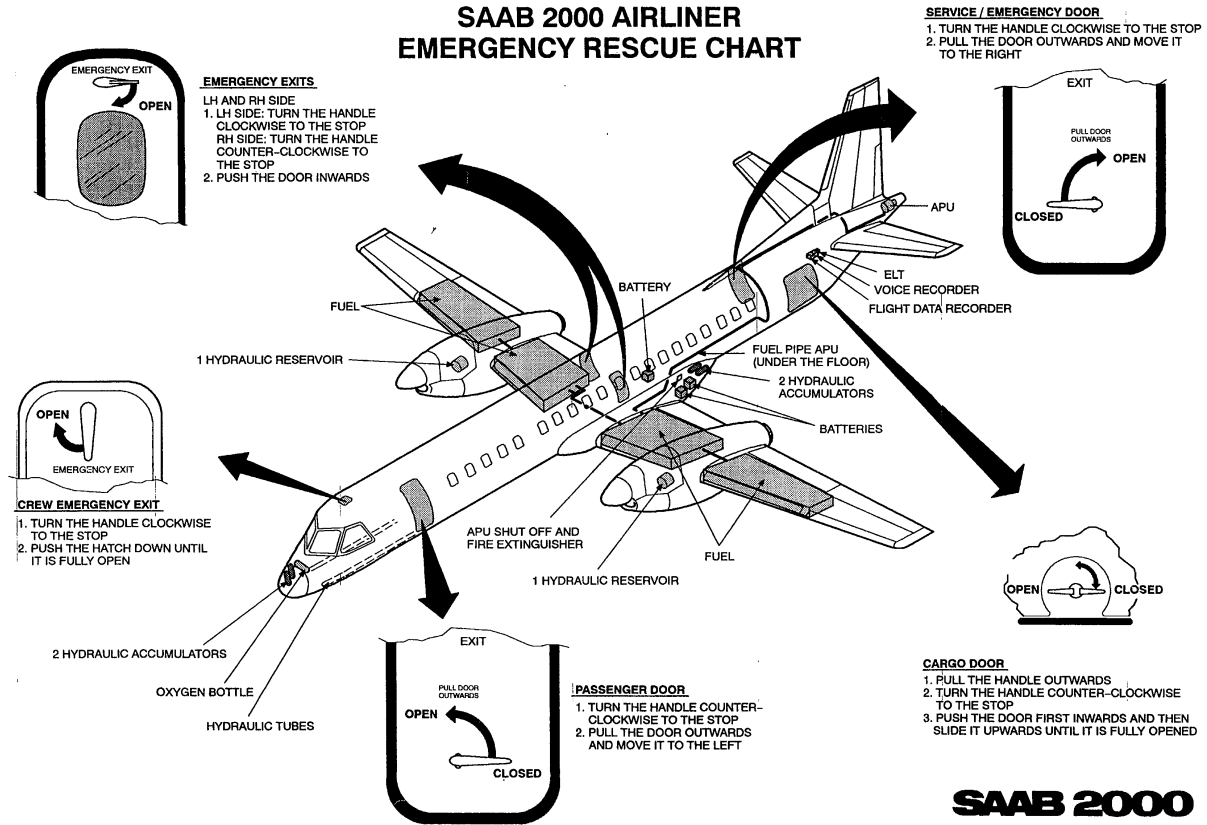
Federal Aircraft Accident Board

André Piller, President

Tiziano Ponti, Vicepresident

Ines Villalaz-Frick, Member

Annex 1: Emergency Exits



Annex 2: Lugano Airport



Airport and runway

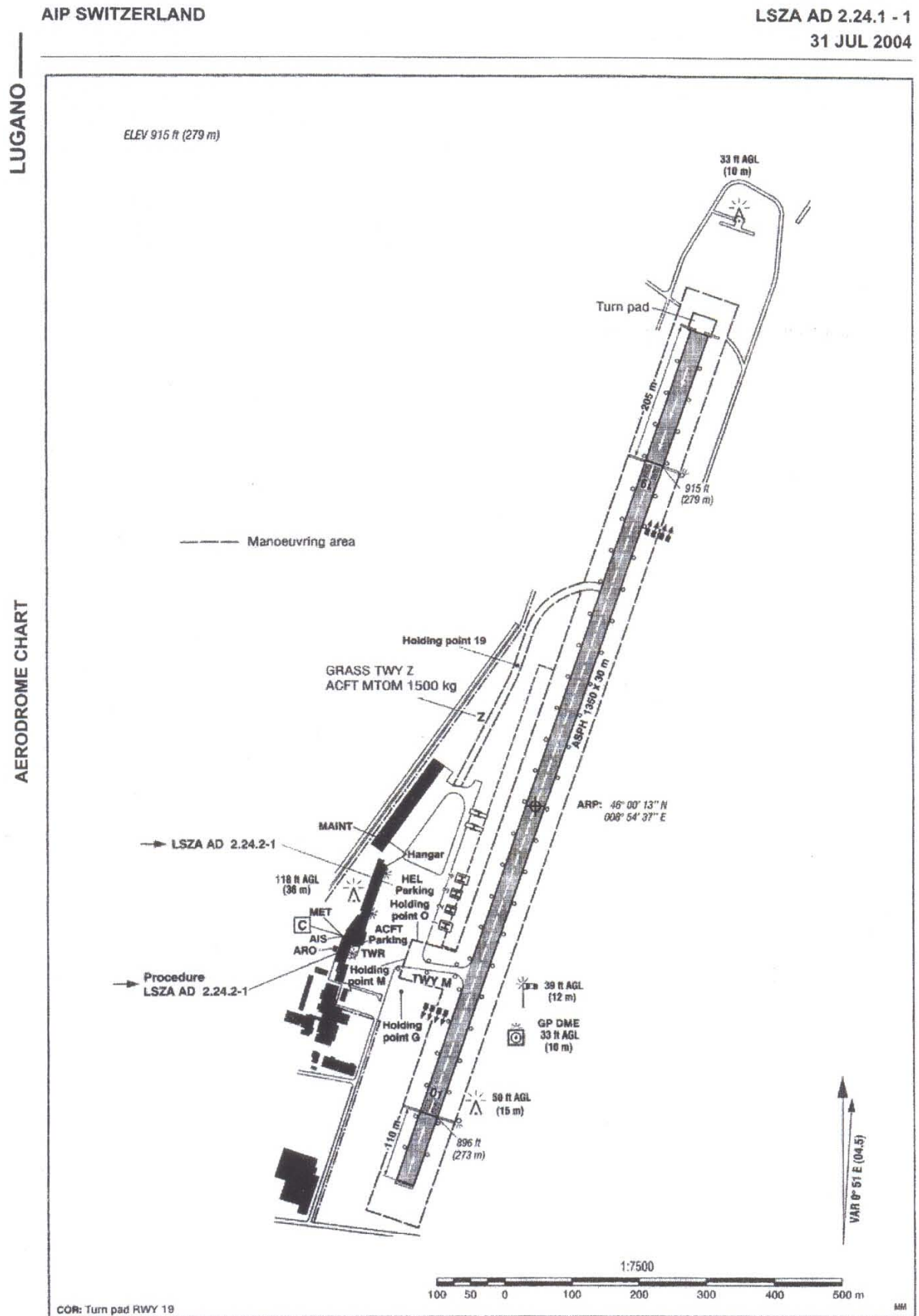


View north



View south

Annex 3: AIP Lugano



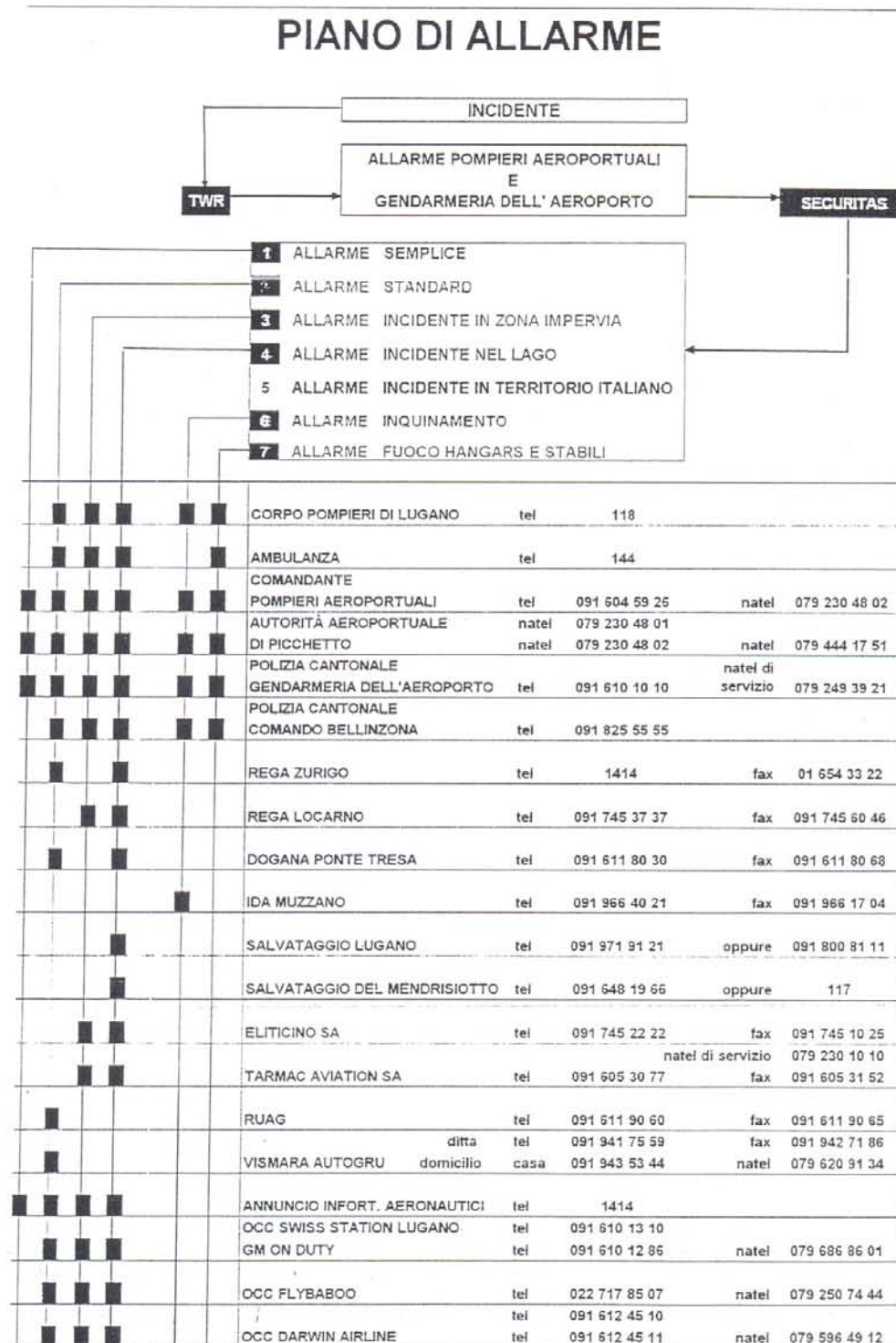
SKYGUIDE, CH-8058 ZURICH-AIRPORT

AMDT 07 2004

Annex 4: Lugano Airport Alarm Plan



22.04.05

ALLEGATO A: PIANO DI ALLARME

Annex 5: Position of smoke sensor and air nozzle in the lavatory



Smoke sensor

Fresh air nozzle