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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report no. 2189 by the Swiss Accident Investigation Board SAIB

concerning the serious incident – Airprox

involving the Saab 2000 aircraft,
under radio call sign DWT 9401

and the Cessna Citation C510 aircraft,
under radio call sign MXY 451

on 16 December 2011

1 NM south-west of PINIK, Lugano CTR

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General information on this report

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

In accordance with Art 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident and serious 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 Summer Time (CEST) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is:
LT = CET = UTC + 1 hour.

Contents

Final Report

Synopsis

Aircraft 1	
Owner	Darwin Airline SA, 6934 Bioggio, Switzerland
Operator	Darwin Airline SA, 6934 Bioggio, Switzerland
Manufacturer	Saab-Scania AB, Stockholm, Sweden
Aircraft type	Saab 2000
Country of registration	Switzerland
Registration	HB-IZZ
Flight number	DWT 9401
Radio callsign	Darwin niner four zero one
Flight rules	IFR
Type of operation	Ferry flight
Departure point	Geneva, LSGG
Destination point	Lugano, LSZA
Aircraft 2	
Owner	MyJet / S.T.C. Aviation, I-16152 Genova, Italy
Operator	MyJet / S.T.C. Aviation, I-16152 Genova, Italy
Manufacturer	Cessna Aircraft Company, Wichita, Kansas, USA
Aircraft type	Cessna Citation C-510 Mustang
Country of registration	Italy
Registration	I-STCD
Flight number	MXY 451
Radio callsign	Myjet four five one
Flight rules	IFR
Type of operation	Commercial flight
Departure point	Biggin Hill, EGKB
Destination point	Lugano, LSZA
Location	1 NM south-west of PINIK, Italian territory
Date and time	16 December 2011, 14:45 UTC
ATS unit	Lugano aerodrome control
Airspace	Class D
Minimum separation of the aircraft	0.1 NM horizontally and 500 ft vertically
Applicable minimum separation	1000 ft vertically
AIRPROX category	ICAO Category B, considerable risk of collision

Investigation

The serious incident occurred on 16 December 2011 at approx. 14:45 UTC. The notification was received on 19 December 2011 at 11:30 UTC by the Swiss Accident Investigation Board, Aviation Division (SAIB-AV). The investigation was opened on 23 December 2011 at 10:45 UTC.

The serious incident occurred over Italian national territory. The SAIB reported the serious incident to the Italian authorities. The country appointed an authorised representative and delegated the investigation of the serious incident to Switzerland.

The final report is published by the SAIB-AV.

Summary

On 16 December 2011 the Saab 2000 commercial aircraft, flight number DWT 9401, was on a ferry flight from Geneva to Lugano. The crew joined the PINIK holding pattern and received clearance from the Lugano aerodrome air traffic control officer to descend to 6000 feet, based on QNH 995. Shortly afterwards, the C510 Mustang executive aircraft, flight number MXY 451, which was on a commercial flight from Biggin Hill to Lugano, reported to Lugano aerodrome control and received clearance to descend to flight level 70. At 14:44:16 UTC, the traffic alert and collision avoidance system (TCAS) in the cockpit of DWT 9401 generated the preventive advisory *"monitor vertical speed"*, while the traffic advisory system (TAS) in the cockpit of MXY 451 indicated an opposing aircraft to the crew visually and acoustically. The two aircraft crossed in opposite directions at a lateral distance of 0.1 NM and an altitude difference of 500 ft. Instrument meteorological conditions prevailed. Subsequently both aircraft landed uneventfully one after the other at Lugano-Agno airport.

Causes

The serious incident is attributable to the fact that the air traffic control officer gave clearance to descend to an aircraft in the area of the transition level (TL); given the prevailing atmospheric pressure this led to a dangerous convergence with another aircraft, which involved a significant risk of collision.

The following factors made it more difficult to identify the incorrect clearance and defuse the situation:

- The air traffic control officer was working alone.
- The altitude readings on the radar display below TL/TA are based on Zurich airport and were wrong for the airport Lugano that hampered the overview.

Safety recommendations

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

According to the provisions of Annex 13 of the ICAO, all safety recommendations listed in this report are intended for the supervisory authority of the competent state, which has to decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, establishment or individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

In the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents (OIAASI), the Swiss legislation provides for the following regulation regarding implementation:

"Art. 32 Safety recommendations

1 DETEC, on the basis of the safety recommendations in the SAIB reports and in the foreign reports, addresses implementation orders or recommendations to the FOCA.

2 The FOCA informs DETEC periodically about the implementation of the orders or recommendations pronounced.

3 DETEC informs the SAIB at least twice a year on the state of implementation by the FOCA."

1 Factual information

1.1 Prehistory and history of the serious incident

1.1.1 General

The recordings of the radiotelephony, radar data and the stored data from the traffic alert and collision avoidance system (TCAS) on board aircraft HB-IZZ as well as the statements of crew members and air traffic control officers were used for the following description of the prehistory and history of the serious incident. On both aircraft the commander was pilot flying (PF) and the copilot was pilot not flying (PNF). Both flights took place under instrument flight rules.

Air traffic control was conducted from the Lugano Tower aerodrome control centre's aerodrome control (ADC) workstation.

1.1.2 Prehistory

Two workstations, aerodrome control (ADC) and ground control (GRO) / coordinator (COORD), were usually occupied during the day at the Lugano aerodrome control centre. At the time of the serious incident, one air traffic control officer was briefly not present in the tower due to illness.

Approach control for Lugano airport is provided by the *Milano Control* air traffic control centre.

1.1.3 History of the serious incident

On the afternoon of 16 December 2011, the Saab 2000 commercial aircraft, flight number DWT 9401, was on a ferry flight from Geneva to Lugano. The crew made contact with Lugano aerodrome control at 14:36:08 UTC and requested to join the holding pattern over waypoint PINIK in order to check the weather conditions before the planned approach. At 14:36:39 UTC, the ADC air traffic control officer (ATCO) issued the following descend clearance: *"Roger, descend to six thousand feet on QNH nine nine five, PINIK limit"*.

Shortly afterwards, the crew of the Cessna 510 executive aircraft, flight number MXY 451, which was on a commercial flight from Biggin Hill to Lugano, made contact with Lugano Tower at 14:37:32 UTC: *"Lugano, good afternoon, Myjet four five one, level one five zero, approaching ODINA"*. The ATCO issued clearance for a standard instrument approach *ODINA 6L,* which is routed via waypoints ODINA and LUGAN to PINIK, and instructed them to descend to and then maintain flight level (FL) 100 (see Annex 1).

At 14:38:08 UTC, the ATCO asked the crew of DWT 9401 for their altitude; they responded as follows: *"Passing now six thousand three hundred feet, Darwin niner four zero one"*. At 14:38:21 UTC the crew of DWT 9401 reported that they would be ready for the Lugano approach after a further holding over PINIK. Immediately afterwards, at 14:38:25 UTC, the ATCO cleared MXY 451 to continue its descent, assuming a transition flight level of FL 70: *"Mike x-ray yankee four five one descend to flight level seven zero, ODINA six lima arrival".* The crew confirmed these instructions.

The prevailing atmospheric pressure in Lugano at this time was 995 hectopascals (hPa); the transition level was accordingly FL 75.

At 14:39:03 UTC the crew of DWT 9401 requested the current Lugano weather; the ATCO replied as follows: *"Darwin niner four zero one, roger, wind three six zero degrees, two knots almost calm, visibility six kilometres, rain, few one thousand feet, scattered one thousand eight hundred feet, overcast three thousand*

five hundred feet, temperature four, dewpoint two, the QNH nine nine five, NOSIG." The crew confirmed this weather report, reported shortly afterwards that they were ready for the approach and requested the following approach clearance: *"Darwin niner four zero one, PINIK holding outbound, request LOC Lima circling Charlie".* The ATCO then cleared them for the requested approach, which initially follows the runway 01 localiser and then with a circling approach to runway 19 (see Annex 2).

At 14:41:32 UTC when over waypoint LUGAN the crew of MXY 451 reported that they were descending to flight level 70; this was confirmed by the ATCO as follows: *"Roger, mike x-ray yankee four five one, clearance limit PINIK, seven zero"*.

While MXY 451 reached and maintained flight level 70, the crew of DWT 9401 received traffic information on their traffic alert and collision avoidance system (TCAS) concerning the opposing MXY 451, which was flying slightly higher. Approximately eight seconds later, the TCAS on DWT 9401 generated the preventive resolution advisory (RA) *"monitor vertical speed"*. For the crew this meant they were to monitor their vertical speed, and led to them maintaining their altitude of 6000 ft. The crew of DWT 9401 then reported at 14:44:16 UTC to air traffic control: *"Darwin niner four zero one, TCAS RA"*. The commander later testified that he was ready at any time, if necessary, to switch off the autopilot and to initiate an immediate descent.

The air traffic control officer noticed on his radar screen that an altitude of 6200 ft was displayed for MXY 451 and at 14:44:27 UTC instructed the crew as follows to maintain FL 70: *"Mike x-ray yankee four five one, Lugano, you have to maintain seven zero, I say again seven zero, do not descend below."*

The two aircraft crossed at 14:44:35 UTC with a lateral distance of 0.1 NM and an altitude difference of 500 ft. DWT 9401 was at an altitude of 6000 ft QNH, while MXY 451 was flying at flight level 70; at the prevailing atmospheric pressure of 995 hPa this corresponded to an altitude of approximately 6500 ft QNH. Both aircraft were in cloud and the crews had no visual contact with each other.

Aircraft MXY 451 was equipped with a traffic advisory system (TAS). Like the TCAS, the TAS issues acoustic TAs. Unlike a TCAS II, however, the TAS cannot generate resolution advisories. The crew of MXY 451 had received traffic information from their TAS regarding the opposing Saab 2000, which was flying 500 ft lower. On the basis of this information the commander of MXY 451 then decided on an avoidance manoeuvre. He stated: *"Having established that the converging traffic was not sufficiently separated and being aware of the absence of traffic in the area above us, I decided to reestablish the separation by climbing."* This avoidance manoeuvre started at 14:44:51 UTC, shortly after the two aircraft crossed. MXY 451 climbed approximately 700 feet and later descended to FL 70 again.

The preventative resolution advisory (RA) in DWT 9401 ended at 14:44:57 UTC.

At 14:45:22 UTC the crew of MXY 451 reported their avoidance manoeuvre to the ATCO as follows: *"Okay, Lugano, ah we have a TCAS avoidance from a traffic five hundred below, and ah we are right position, and right altitude, so zero seven zero"*.

Shortly afterwards, the aerodrome air traffic control officer asked the crew of MXY 451 about the altitude indicated in the cockpit, because an altitude of 6200 ft was indicated on his radar display. The crew of MXY 451 replied at 14:46:24 UTC that all three altimeters indicated a flight level of FL 70: *"...we have zero seven zero and, ah, I confirm you ...over three altimeters".*

The radar indicator (distance from touchdown indicator – DFTI) in the Lugano control tower indicated DWT 9401 at 5700 ft and MXY 451 at 6200 ft respectively at the time of the serious incident. These indicated altitudes were based on the Zurich airport QNH of 984 hPa.

After the serious incident, both aircraft continued their approach to Lugano and landed uneventfully on runway 19.

1.1.4 Location of the serious incident

Geographical position	1 NM south-west of waypoint PINIK, CTR Lugano
Date and time	16 December 2011, 14:45 UTC
Lighting conditions	Rainy weather, mid-afternoon
Height above sea level or flight level	Approx. 6000 ft AMSL

1.2 Personnel information

1.2.1 Crew of DWT 9401

1.2.1.1 Commander

Person	Italian citizen, born 1965
Licence	Airline transport pilot licence aeroplane – ATPL(A) according to Joint Aviation Requirements (JAR) EASA, first issued by the Italian Civil Aviation Authority (*ente nationale per l'aviazione civile* – ENAC) on 17 November 2008
Ratings	Type rating Saab 2000 as pilot in command, valid till 13 May 2012 International radiotelephony for flight according to visual and instrument flight rules RTI (VFR/IFR) Language proficiency English level 4, valid till 22 March 2013
Instrument flight rating	Instrument rating aeroplane IR(A) valid till 13 May 2012
Last proficiency check	Line check on 19 November 2011 Operator proficiency check (OPC) on 23 November 2011
Training on TCAS	Refresher on 23 November 2011
Medical fitness certificate	Class 1 / 2, no restrictions issued on 5 December 2011, valid till 25 June 2012

1.2.1.1.1 Flying experience

Total	12 888:45 hours
on the type involved in the incident	344:59 hours
during the last 90 days	147:30 hours
of which on the incident type	147:30 hours
as commander	8485:25 hours

1.2.1.1.2 Duty times

Start of duty in the 48 hours before the serious incident	14 December 2011, 15:25 UTC 15 December 2011, 05:25 UTC 16 December 2011, 05:25 UTC
End of duty in the 48 hours before the serious incident	14 December 2011, 19:32 UTC 15 December 2011, 09:26 UTC
Flight duty times in the 48 hours before the serious incident	14 December 2011, 4:07 hours 15 December 2011, 4:01 hours
Rest times in the 48 hours before the serious incident	14/15 December 2011, 9:53 hours 15/16 December 2011, 19:59 hours
Flight duty time at the time of the serious incident	9:20 hours

1.2.1.2 Copilot

Person	Swiss citizen, born 1984
Licence	Commercial pilot licence – CPL(A) according to Joint Aviation Requirements (JAR) EASA, first issued by the Federal Office of Civil Aviation (FOCA) on 6 November 2008
Ratings	Type rating Saab 2000 as copilot, valid till 22 December 2012 International radiotelephony for flight according to visual and instrument flight rules RTI (VFR/IFR) Language proficiency English level 4, valid till 11 July 2014 Flight instructor SEP land, valid till 2 April 2012
Instrument flight rating	Instrument flight Saab 2000 aircraft Category III, valid till 22 December 2012
Last proficiency check	Line check on 20 February 2011 OPC on 23 November 2011
Training on TCAS	Refresher on 2 December 2011
Medical fitness certificate	Class 1 / 2, no restrictions issued on 6 October 2011, valid till 21 October 2012

1.2.1.2.1 Flying experience

Total	1525:14 hours
on the type involved in the incident	434:06 hours
during the last 90 days	94:45 hours
of which on the incident type	94:45 hours

1.2.1.2.2 Duty times

Start of duty in the 48 hours before the serious incident	14 December 2011, 15:25 UTC 15 December 2011, 05:25 UTC 16 December 2011, 05:25 UTC
End of duty in the 48 hours before the serious incident	14 December 2011, 19:32 UTC 15 December 2011, 09:26 UTC
Flight duty times in the 48 hours before the serious incident	14 December 2011, 4:07 hours 15 December 2011, 4:01 hours
Rest times in the 48 hours before the serious incident	14/15 December 2011, 9:53 hours 15/16 December 2011, 19:59 hours
Flight duty time at the time of the serious incident	9:20 hours

1.2.2 Crew of MXY 451

1.2.2.1 Commander

Person	Italian citizen, born 1965
Licence	Airline transport pilot licence aeroplane – ATPL(A) according to Joint Aviation Requirements (JAR) EASA, first issued by the Italian Civil Aviation Authority (*ente nationale per l'aviazione civile* – ENAC)
Ratings	Type rating C510 as pilot in command, valid till 30 April 2012 Language proficiency Italian level 6, English level 4, valid till 3 February 2014
Instrument flight rating	Instrument rating aeroplane IR(A) valid till 30 April 2012
Last proficiency check	OPC on 24 October 2011
Medical fitness certificate	Class 1, restrictions: *"must wear corrective lenses in flight"* valid till 11 January 2012

1.2.2.1.1 Flying experience

Total	4000 hours
on the type involved in the incident	1600 hours
during the last 90 days	100 hours
of which on the incident type	80 hours
as commander	3600 hours

1.2.2.1.2 Duty times

Start of duty in the 48 hours before the serious incident	14 December 2011, off duty 15 December 2011, 07:45 UTC 16 December 2011, 09:00 UTC
End of duty in the 48 hours before the serious incident	14 December 2011, off duty 15 December 2011, 18:20 UTC
Flight duty times in the 48 hours before the serious incident	14 December 2011, off duty 15 December 2011, 10:45 hours
Rest times in the 48 hours before the serious incident	14/15 December 2011, off duty 15/16 December 2011, 14:40 hours
Flight duty time at the time of the serious incident	5:45 hours

1.2.2.2 Copilot

Person	Italian citizen, born 1977
Licence	Commercial pilot licence – CPL(A) according to Joint Aviation Requirements (JAR), first issued by the Italian Civil Aviation Authority (*ente nationale per l'aviazione civile* – ENAC) on 11 January 2008, valid till 20 August 2017
Ratings	Type rating C510, valid till 30 April 2013 Radiotelephony privileges English Language proficiency English level 5, valid till 22 November 2017
Instrument flight rating	Instrument rating aeroplane IR(A) valid till 30 April 2013
Last proficiency check	OPC on 24 October 2011
Training on TCAS	Simulator training on aircraft type B737-600/900 in January 2007
Medical fitness certificate	Class 1 / 2, no restrictions, valid till 19 April 2013

1.2.2.2.1 Flying experience

Total	1750 hours
on the type involved in the incident	648 hours
during the last 90 days	142 hours
of which on the incident type	142 hours

1.2.2.2.2 Duty times

Start of duty in the 48 hours before the serious incident	14 December 2011, 12:30 UTC 15 December 2011, 07:45 UTC 16 December 2011, 09:15 UTC
End of duty in the 48 hours before the serious incident	14 December 2011, 21:45 UTC 15 December 2011, 18:20 UTC
Flight duty times in the 48 hours before the serious incident	14 December 2011, 9:15 hours 15 December 2011, 10:35 hours
Rest times in the 48 hours before the serious incident	14/15 December 2011, 10:00 hours 15/16 December 2011, 14:55 hours
Flight duty time at the time of the serious incident	5:30 hours

1.2.3 Air traffic control personnel

1.2.3.1 ADC air traffic control officer

Function	Aerodrome control
Person	Swiss citizen, born 1961
Work days before the day of the incident	14 December 2011, off duty 15 December 2011, 14:00 – 21:00 UTC
Start of duty on the day of the incident	12:00 UTC
Licence	Licence for air traffic control officer, based on European Community Directive 2006/23, first issued by the Federal Office of Civil Aviation (FOCA) on 20 August 1987, valid till 4 July 2012 English Level 4, valid till 4 February 2012
Medical fitness certificate	Class 3, restrictions: VNL (shall have available corrective lenses), valid till 4 July 2012

1.3 Aircraft information

1.3.1 DWT 9401 aircraft

Registration	HB-IZZ
Aircraft type	Saab 2000
Characteristics	Twin-engined turboprop commercial aircraft
Manufacturer	Saab-Scania AB, Stockholm, Sweden
Year of manufacture	1997
Owner	Darwin Airline SA, 6934 Bioggio, Switzerland
Operator	Darwin Airline SA, 6934 Bioggio, Switzerland
Relevant equipment	Traffic alert and collision avoidance system (TCAS) II

1.3.2 MXY 451 aircraft

Registration	I-STCD
Aircraft type	Cessna Citation C510 Mustang
Characteristics	Twin-jet executive aircraft
Manufacturer	Cessna Aircraft Company, Wichita, Kansas, USA
Year of manufacture	2010
Owner	MyJet / S.T.C. Aviation, I-16152 Genova, Italy
Operator	MyJet / S.T.C. Aviation, I-16152 Genova, Italy
Relevant equipment	Traffic advisory system (TAS)

1.4 Meteorological information

1.4.1 General meteorological situation

The Alps were in the open warm sector of a storm low centred over Northern Germany. In the mid-afternoon an active cold front reached the north side of the Alps.

1.4.2 Weather in Lugano and environs

Ahead of the cold front, a band of humid air some 300 km wide was causing dense cloud on both sides of the Alpine ridge. Falling pressure intensified the pressure gradient to the north and accelerated the air in the lower air strata. The constant influx of humid air into the valleys of the southern side of the Alps resulted in compact cloud cover from noon onwards.

At 15:00 UTC, trapped cold air and precipitation cooling led to a regional zero degree isotherm at 1300 m AMSL, corresponding to 4000 ft AMSL, tending to descend. At 12:00 UTC the temperature profile over Milan-Linate indicated the zero degree isotherm at 5700 ft AMSL.

1.4.3 Weather at the time and location of the serious incident

According to the Milano-Linate radio probe, the two aircraft were in cloud at the time of the serious incident. The temperature at their flight altitude was approximately 0 °C. The wind was blowing from 210 degrees at a speed of 36 knots. The air pressure in Lugano reduced using the ICAO standard atmosphere was 995 hPa.

1.4.4 Lugano airport weather reports

In the period from 14:20 UTC up to the time of the serious incident, the following meteorological aviation routine weather report (METAR) was valid for Lugano airport:

161420Z 01004KT 7000 RA FEW010 SCT018 OVC038 05/03 Q0996 NOSIG

In clear text, this means:

On 16 December 2011, shortly before the 14:20 UTC issue time of the aerodrome weather report, the following weather conditions were observed at Lugano airport:

Wind	From 010 degrees at 4 knots
Meteorological visibility	7 km
Weather	Rain
Cloud	1 - 2/8 at 1000 ft AAL 3 - 4/8 at 1800 ft AAL 8/8 at 3800 ft AAL
Temperature	5 °C
Dewpoint	3 °C
Atmospheric pressure	996 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Land weather forecast	No significant changes expected in the two hours following the weather observation.

1.4.5 Astronomical information

Position of the sun	Azimuth: *225*°	Elevation: *7*°
Lighting conditions	Rainy weather, mid-afternoon	

1.4.6 Additional information

In Zurich-Kloten the air pressure reduced according to the ICAO standard atmosphere was 984 hPa.

For nine days before the serious incident the QNH in Lugano had been between 1013 and 1025 hPa as a result of high-pressure conditions. On the day of the serious incident, the QNH fell to 995 hPa within a few hours.

1.5 Air traffic control radar equipment

1.5.1 Radar display in the Lugano control tower

1.5.1.1 General

Like other comparable regional airports in Switzerland, the Lugano control tower has a radar display. It is configured as a distance from touchdown indicator (DFTI) and installed on the ground (GRO) workstation, approximately two metres away from the ADC workstation (see Annexes 3 and 4).

Use of the DFTI for air traffic control officers in the Lugano control tower is regulated in the air traffic management manual (ATMM) II Lugano and allows the use of the radar display only in the following cases:

- Determining the distance of an approaching aircraft from the start of the runway
- Reviewing the estimated overflight times of incoming aircraft
- Support for pilots in emergency situations

1.5.1.2 Excerpt from the air traffic management manual

The Lugano air traffic management manual (ATMM) II states the following in section 5 under para. 3.8 Use of Radar:

"You may use radar to provide Distance from Touchdown Indication (DFTI) according ATMM CH, section 9, § 9.2.

Additionally it may be used to verify estimates.

In case of an emergency, the controller shall use all information provided by radar to assist the pilots as far as possible.

Fallback is not available on TASD Lugano. Following the change to MRTS, regional airports using radar data maintain all the redundancies of the main mode MV-ARTAS but do not have the fallback radar data."

1.5.1.3 Altitude information

The DTFI radar display in the Lugano control tower obtains all its data from the ARTAS[1] central radar computer via the MV-NT[2] at skyguide in Wangen near Dübendorf. The altitude information supplied by the secondary radar and aircraft transponders is always based on the standard pressure of 1013.25 hPa. In order that the display on the radar screen corresponds to the current pressure and the resulting transition level (TL), these values are converted automatically. In the present case, this conversion was based on the Zurich-Kloten atmospheric pressure and TL. Thus the aircraft altitudes respectively the flight levels that are displayed on the DFTI in Lugano are based on the atmospheric pressure and the transition level of Zurich.

values displayed on the DFTI in Lugano corresponded to the atmospheric pressure and TL for Zurich and not those for Lugano.

In the case of this serious incident, the atmospheric pressure was 995 hPa in Lugano but 984 hPa in Zurich-Kloten, corresponding to a pressure difference of 11 hPa. The difference in height per hPa is approximately 27 ft; the deviation of the altitude display on the radar display in Lugano from the effective altitude was therefore approximately 300 ft. According to skyguide, the MV-NT was not designed for multiple QNH zones, so for the radar display the QNH and TL (transition level) for Zurich alone were decisive.

DWT 4901, which was flying at 6000 ft, was therefore displayed to the ATCO at 5700 ft on the DFTI; MXY 451, which was flying at FL 70 or the equivalent of approximately 6500 ft, was displayed at 6200 ft.

1.6 Communications

Communication between air traffic control and the two flight crews was conducted without any problems.

1.7 Aerodrome information

1.7.1 General

Lugano-Agno airport is located in Southern Switzerland, approximately four kilometres west of the city of Lugano.

The runway dimensions are as follows:

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

[1] Abbreviation for air traffic management surveillance tracker and server

[2] Designation of the French manufacturer Thales: *machine virtuelle – nouvelle téchnologie*

1.7.2 Runway equipment

Runway 01 has an instrument landing system designated as an instrument guidance system (IGS), because it does not meet the international standards for a conventional instrument landing system (ILS). The IGS has a glide path angle of 6.65 degrees, whereas the standard value is between 2.5 and 3.5 degrees. Approaches on runway 19 take place via a localiser approach on runway 01 followed by a circuit approach, circling Charlie or circling Foxtrot.

1.8 Atmospheric pressure and transition level

1.8.1 General

In a terminal manoeuvring area or control area, the altitude for IFR flights is expressed as follows:

- In flight levels (FL) with a standard altimeter setting of 1013.25 hPa if the aircraft is at the transition level or higher, or if it passes the transition level when climbing.
- At altitudes above sea level according to the current QNH if it is at the transition level or lower, or if it passes the transition level when descending.

1.8.2 Transition level

The transition level (TL) is determined on the basis of the current barometric pressure (QNH). In Lugano, it is FL 70 or less for a QNH of 1013.25 hPa or more, and FL 75 or higher for a QNH of less than 1013.25 hPa. The QNH and TL are displayed on an information screen at the ATCO workstation in the control tower (see Figure 1) and broadcast on the frequency of the airport terminal information system (ATIS). At the time of the serious incident, the QNH in Lugano was 995 hPa; the TL was therefore FL 75.

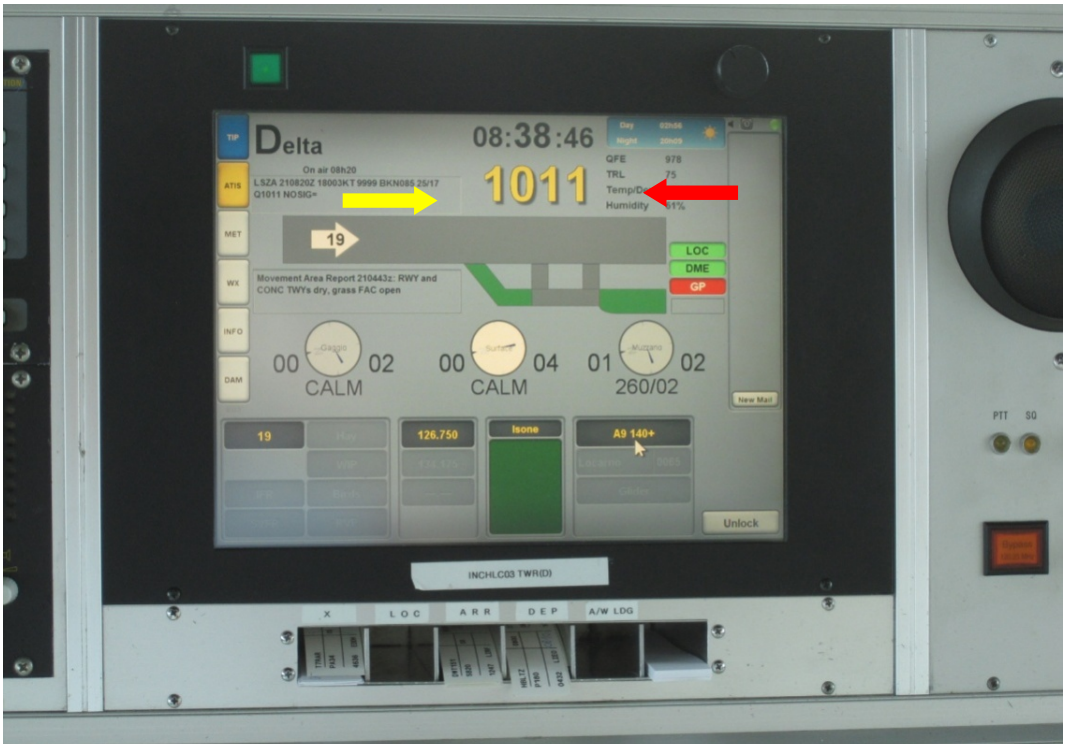


Figure 1: Depiction of the QNH (yellow arrow) and transition level (TL) (red arrow) on the information system at the ADC workstation. This photograph was not taken on the day of the serious incident and is purely for purposes of illustration.

1.8.3 Separation of aircraft

Air traffic control separates aircraft operating under instrument flight rules (IFR) by at least 1000 ft vertically. Since the air pressure in the atmosphere varies with time and place, separation can be guaranteed only if all aircraft set their pressure altimeters so that they display the altitude with reference to the same reference pressure. The international reference pressure in cruise is the standard pressure of 1013 hPa. When the air pressure changes, the effective altitude of aircraft changes synchronously. As a result of this the relative vertical distance, and therefore the separation of the aircraft, are maintained.

On take-off and landing at an aerodrome, however, the effective altitude plays a crucial role: it is, for example, necessary to ensure separation from obstacles. For this reason, the current air pressure (QNH) for the respective aerodrome, reduced to sea level, calculated using the values of the ICAO standard atmosphere, is set on the pressure altimeter as the reference pressure during take-off and landing. This setting alteration takes place at the transition level (TL) during a descent.

If the QNH exceeds 1013 hPa, the minimum separation between an aircraft flying at FL 70, for example, and another aircraft flying at 6000 ft QNH is always guaranteed, because the reference pressure of the aircraft flying according to the QNH is lower than the standard pressure. The vertical distance between the two aircraft therefore increases by approximately 27 ft per hectopascal of pressure difference.

On the other hand, if the QNH is less than 1013 hPa, the separation of an aircraft flying at FL 70 from one flying at 6000 ft QNH decreases by 27 ft per hectopascal of pressure difference and therefore violates the minimum separation of 1000 ft.

In the serious incident that is the subject of the investigation, the QNH in Lugano was 995 hPa. The difference from the standard pressure of 1013 hPa was thus 18 hPa, corresponding to an altitude difference of just under 500 ft. Since MXY 451 was flying at FL 70 with a set standard pressure of 1013 hPa and DWT 9401 was flying at 6000 ft QNH, the vertical separation was effectively still approximately 500 ft.

1.8.4 Additional information

The transition levels of Lugano and Zurich are relatively low and were therefore flown through in a phase with relatively high workload for crews and air traffic control. Within Europe and as well in other parts oft he earth this is not unusual. The transition levels vary from country to country or are – for example in Switzerland – even airport specifically. Within Europe their value is typically between 3000 ft and approximately 8000 ft AMSL[3].

Since quiet some time several organizations and research institutions are therefore conducting studies[4] that shall clarify negative impact of different transition levels in regard to flight safety and show possibilities of improvement. Based on this findings, the international civil aviation organization (ICAO) recommends that within an ICAO-region a consistent transition level shall be implemented.

[3] In the United States of America and in Canada a consistent transition altitude of 18 000 ft AMSL applies

[4] For example from Eurocontrol: *"Towards a common transition altitude – a flight deck perspective"*, *"A common European transition altitude – an ATC perspective"*.

2 Analysis

2.1 Technical aspects

2.1.1 General

There is no evidence either on the aircraft involved or ground-side of any pre-existing technical defects which might have affected the serious incident.

2.1.2 Radar display

Use of the DFTI installed in the Lugano control tower is restricted in accordance with the provisions of the skyguide air navigation services company, which are laid down in the ATMM II Lugano. Since the MV-NT is not configured for multiple QNH zones, all radar altitude readings below TL/TA are based on the Zurich QNH and TL. If there is a difference between the air pressure in Zurich and Lugano, these altitude readings will be displayed wrong.

Even though the DFTI is not intended for the purpose of separation, it is amongst others intended as an aid in emergency situations. Especially in cases of emergency, time-critical stress situations may arise which might be further exacerbated by incorrect altitude information. For this reason, this configuration defect in the system constitutes a considerable risk from an aviation safety perspective.

2.2 Human and operational aspects

2.2.1 Air traffic control

The air traffic control officer had come on duty just three hours before the serious incident. *Milano control* approach control had transferred the two aircraft, DWT 9401 and MXY 451, to the Lugano tower with sufficient IFR separation. After DWT 9401 had at its own request joined the PINIK holding pattern and reported an altitude of 6300 feet, the ATCO gave MXY 451 clearance to descend to FL 70. In this context, it should be noted that the QNH in Lugano was 995 hPa and was therefore 18 hPa lower than the standard pressure. This pressure difference corresponded to an altitude difference of approximately 500 ft and led to a separation of only approximately 500 ft between FL 70 and 6000 ft QNH.

For nine days before the serious incident a high-pressure situation had prevailed in Ticino; this resulted in a QNH of more than 1013 hPa. Consequently, a transition level of FL 70 was applied for a fairly long time. On the day of the serious incident, the air pressure fell to 995 hPa within a few hours. This low pressure required a transition level of FL 75, which would have allowed clearance to descend to only FL 80 in order to guarantee safe separation from DWT 9401. The air traffic control officer was not aware of this fact at the time he gave MXY 451 clearance to FL 70. It is clear that as a result of the extended period during which FL 70 was applied as the transition level he had become accustomed to this value and therefore made this error, based on routine.

After the crew of DWT 9401 had reported a resolution advisory (RA) from their TCAS, the ATCO noted that the DFTI radar display was indicating an altitude of 6200 ft for aircraft MXY 451. He then emphatically instructed the crew of MXY 451 to maintain flight level 70; this was confirmed by the crew. At this time the ATCO did not realise that the altitude of 6200 feet displayed for MXY 451 corresponded to the atmospheric pressure in Zurich, not that in Lugano, and that MXY 451 was therefore flying at approximately 6500 ft QNH, corresponding to flight level 70 at the prevailing atmospheric pressure. Although the radar display was not intended for comparisons of altitudes or to establish separation, the air traffic

control officer allowed himself to be confused by the incorrect altitude information.

At the time of the serious incident the ADC control officer was alone in the control tower. The GRO control officer had briefly left his workstation because he was unwell. Consequently there was no second person in the control tower who might have been able to notice and correct the ADC control officer's incorrect clearance.

2.2.2 Crews

The crew of DWT 9401 were in level flight at 6000 ft QNH when they received the preventive advisory *"monitor vertical speed"*. They subsequently maintained their altitude and behaved as intended by the TCAS safety net.

Owing to the acoustic *"traffic"* warning issued by their TAS, the crew of MXY 451 decided to carry out a vertical avoidance manoeuvre. The fact that both aircraft were in cloud and had no visual contact with each other made it considerably more difficult for the crew to carry out a situation analysis. Another complicating factor is the fact that unlike a TCAS II, the TAS cannot generate resolution advisories. This explains why the entirely appropriate avoiding action was not initiated until shortly after the aircraft had crossed.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft were licensed for VFR/IFR traffic.
- The investigation did not reveal any indications of any pre-existing technical faults which might have influenced the serious incident.

3.1.2 Crews

- The pilots were in possession of the necessary licences for the flight.
- There are no indications of the pilots suffering health problems during the flight involved in the serious incident.

3.1.3 Air traffic control personnel

- The air traffic control officer was in possession of the licences necessary to exercise his activities.
- There are no indications of the air traffic control officer suffering health problems at the time of the serious incident.
- At the time of the serious incident the ADC air traffic control officer was alone in the tower.

3.1.4 History of the serious incident

- The crew of aircraft DWT 9401 made contact with Lugano aerodrome control at 14:36:08 UTC and requested to join the holding pattern over PINIK.
- At 14:36:39 UTC they received clearance to descend to 6000 feet, with reference to a QNH of 995.
- The crew of aircraft MXY 451 made contact with the Lugano aerodrome control at 14:37:32 UTC and received clearance for an "*ODINA6L arrival"* approach.
- At 14:38:11 UTC the crew of DWT 9401 reported that they were passing 6300 feet in descent.
- Shortly afterwards, at 14:38:25 UTC, the ADC control officer gave the crew of MXY 451 clearance to descend to FL 70.
- At this time the atmospheric pressure (QNH) in Lugano was 995 hPa and the transition level was accordingly FL 75.
- At 14:41:32 UTC the TCAS in aircraft DWT 9401 generated the preventive resolution advisory (RA): *"monitor vertical speed"*, which led to the crew maintaining their altitude of 6000 ft.
- The two aircraft crossed at a lateral distance of 0.1 NM and an altitude difference of 500 ft.
- At 14:45:22 UTC the crew of MXY 451 reported that they had carried out a vertical climb avoidance manoeuvre on the basis of traffic information from their traffic advisory system (TAS).
- Both aircraft then landed uneventfully on runway 19 in Lugano.

3.1.5 General conditions

- The altitude information displayed on the DFTI was based on the air pressure and transition level (TL*)* in Zurich-Kloten, and did not correspond to that in Lugano.

3.2 Causes

The serious incident is attributable to the fact that the air traffic control officer gave clearance to descend to an aircraft in the area of the transition level (TL); given the prevailing atmospheric pressure this led to a dangerous convergence with another aircraft, which involved a significant risk of collision.

The following factors made it more difficult to identify the incorrect clearance and defuse the situation:

- The air traffic control officer was working alone.
- The altitude readings on the radar display below TL/TA are based on Zurich airport and were wrong for the airport Lugano that hampered the overview.

4 Safety recommendations and measures taken since the serious incident

According to the provisions of Annex 13 of the ICAO, all safety recommendations listed in this report are intended for the supervisory authority of the competent state, which has to decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, establishment or individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

In the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents (OIAASI), the Swiss legislation provides for the following regulation regarding implementation:

"Art. 32 Safety recommendations

[1] DETEC, on the basis of the safety recommendations in the SAIB reports and in the foreign reports, addresses implementation orders or recommendations to the FOCA.

[2] The FOCA informs DETEC periodically about the implementation of the orders or recommendations pronounced.

[3] DETEC informs the SAIB at least twice a year on the state of implementation by the FOCA."

4.1 Safety recommendations

4.1.1 Safety deficit

On 16 December 2011 the Saab 2000 commercial aircraft, flight number DWT 9401, was on a ferry flight from Geneva to Lugano. The crew joined the PINIK holding pattern and received clearance from the Lugano aerodrome air traffic control officer to descend to 6000 feet, based on QNH 995. Shortly afterwards, the C510 Mustang executive aircraft, flight number MXY 451, which was on a commercial flight from Biggin Hill to Lugano, reported to Lugano aerodrome control and received clearance to descend to flight level 70. At 14:44:16 UTC, the traffic alert and collision avoidance system (TCAS) in the cockpit of DWT 9401 generated the preventive advisory "*monitor vertical speed*", while the traffic advisory system (TAS) in the cockpit of MXY 451 indicated an opposing aircraft visually and acoustically to the crew. The two aircraft crossed in opposite directions at a lateral distance of 0.1 NM and an altitude difference of 500 ft. Instrument meteorological conditions prevailed.

The altitude information for both aircraft on the radar display (DFTI) in Lugano indicated to the air traffic control officer altitudes which were based on the air pressure and the transition level (TL) for Zurich. The air pressure difference between Zurich and Lugano was eleven hectopascals, corresponding to an altitude difference of approximately 300 ft. This meant that the altitude information did not correspond to the altitudes actually being flown and made it more difficult for the air traffic controller to gain an overall view.

Even though the DFTI is not intended for the purpose of separation, it is intended as an aid in emergency situations. Especially in cases of emergency, time-critical stress situations may arise which might be further exacerbated by incorrect altitude information. For this reason, this configuration defect in the system constitutes a considerable risk from an aviation safety perspective.

4.1.2 Safety Recommendation no. 472

"Das Bundesamt für Zivilluftfahrt sollte zusammen mit dem Flugsicherungsunternehmen skyguide sicherstellen, dass zumindest auf allen Radarsystemen, die unter anderem für den Einsatz in Notsituationen vorgesehen sind, korrekte Daten angezeigt werden."

[The Federal Office of Civil Aviation, together with skyguide, the air navigation services company, should ensure that correct data are displayed at least on all radar systems which amongst others are intended for use in emergency situations.]

4.2 Measures taken since the serious incident

In a letter dated 30 April 2013 skyguide informed the SAIB-AV that they had taken the following measures since the serious incident:

"1) Auffrischungskurs

Während eines internen Auffrischungskurses (refresher training) mit der gesamten Platzverkehrsleitung Lugano im Herbst 2012 wurden die FVL wieder auf die Tatsache hingewiesen, dass das TASD mit dem QNH von Zürich arbeitet und dass deshalb die dargestellte Flughöhe nicht zwingend korrekt dargestellt wird (was für den Gebrauch des DFTI akzeptabel ist.)

2) Simulationsübungen

Es wurde eine neue Simulationsübung für Lugano kreiert, welche eine Situation mit einem sehr tiefen QNH beinhaltet (analog des hier untersuchten Vorfalles). Diese neue Übung wird für alle FVL in Lugano m Rahmen des nächsten Notfall-Simulatortrainings angewendet.

3) Einmann Betrieb

Bereits im 2011 (vor dem Vorfall) hat die Führung von skyguide national beschlossen, die Zeiten zu reduzieren, in welchen mit nur einem FVL gearbeitet wird. skyguide national ist zur Zeit am Ausbilden von zusätzlichem Personal, um die dafür benötigte Anzahl FVL zu erreichen."

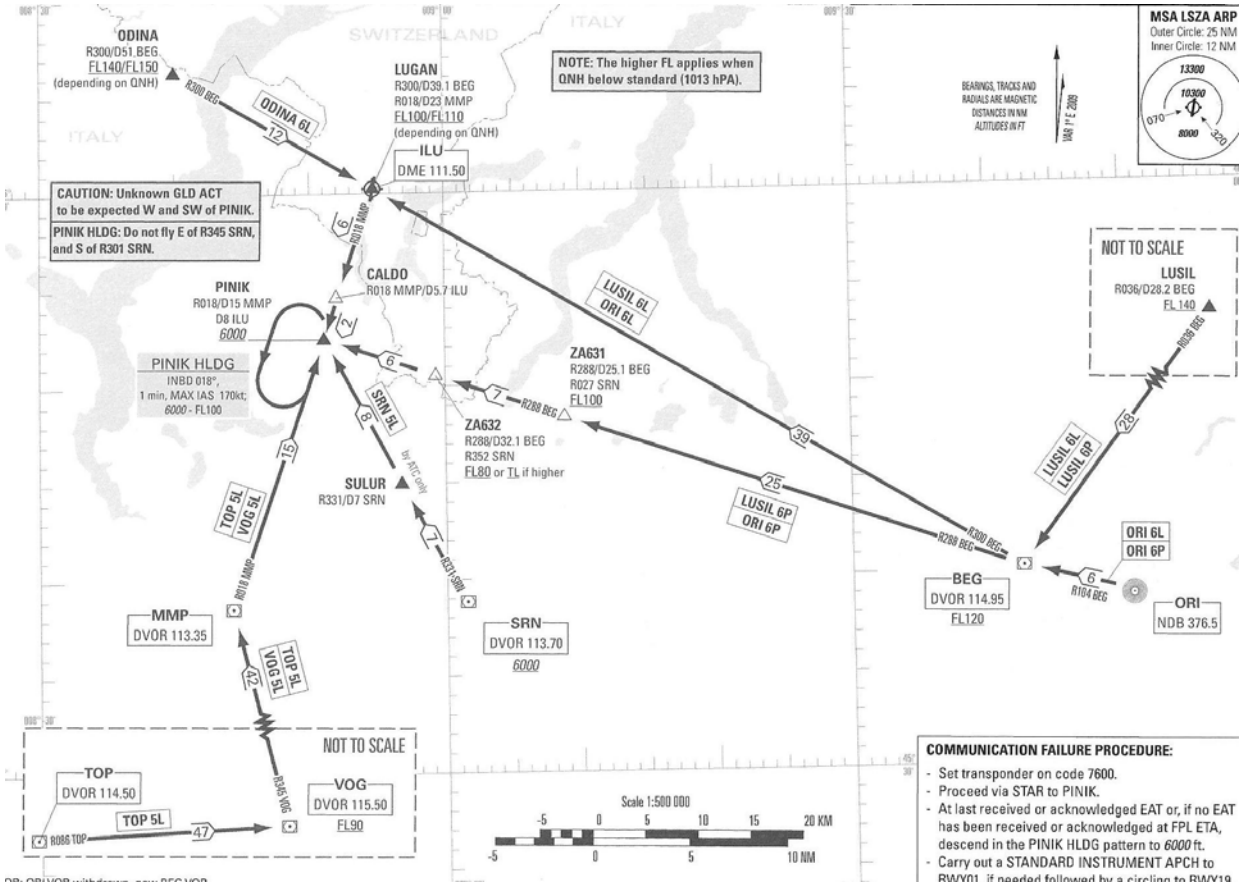
Payerne, 17 July 2013 Swiss Accident Investigation Board

This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

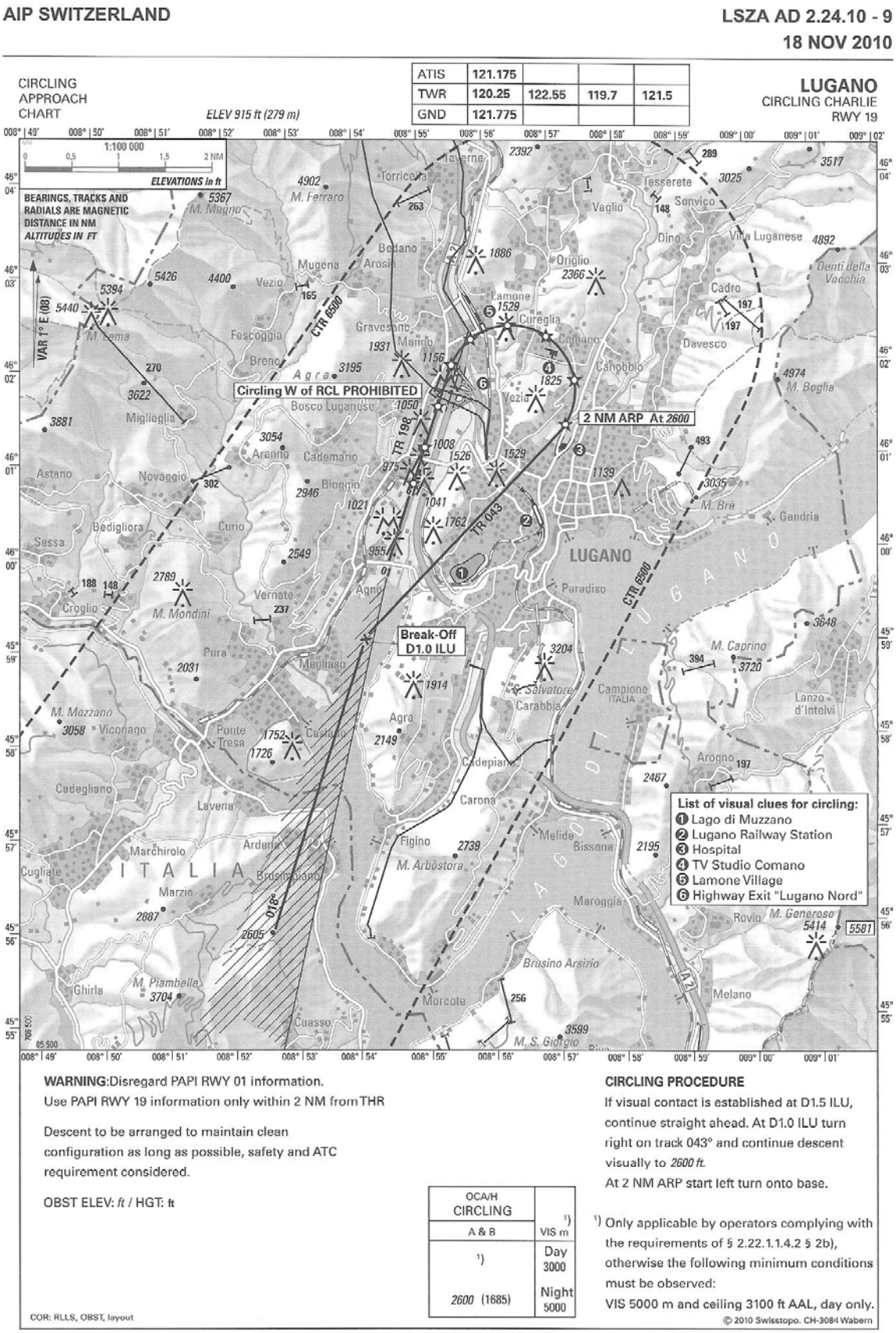
Berne, 27 August 2013

Annexes

Annex 1: Standard Arrival Routes (STAR) in Lugano



Annex 2: Circling CHARLIE RWY 19 Lugano



Annex 3: ADC workstation in the Lugano control tower

Annex 4: DFTI radar display