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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2167
of the Swiss
Accident Investigation Board SAIB

concerning the serious incident - Airprox

involving the Saab 2000 aircraft, registration HB-IZJ

operated by Darwin Airline SA

under radio call sign SWR 75PE

and the Pilatus PC-7 aircraft, registration A-939

operated by the Swiss Air Force

under radio call sign A939

on 10 September 2010

4 NM north-east of Lugano airport

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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/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

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

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Synopsis

Aircraft 1	
Owner	LOCAT S.P.A., Lugano, Switzerland
Operator	Darwin Airline SA, Bioggio, Switzerland
Manufacturer	Saab-Scania Flugzeugwerke, Stockholm, Sweden
Aircraft type	Saab 2000
Country of registration	Switzerland
Registration	HB-IZJ
Commercial flight number	LX 2902
ATC call sign	SWR 75PE
Radio call sign	*Swiss seven five papa echo*
Flight rules	IFR
Type of operation	Scheduled flight on behalf of Swiss European Airlines
Departure point	Zurich (LSZH)
Destination point	Lugano (LSZA)
Aircraft 2	
Owner	Swiss Confederation, Bern, Switzerland
Operator	Swiss Air Force
Manufacturer	Pilatus Flugzeugwerke, Stans, Switzerland
Aircraft type	Pilatus PC-7
Country of registration	Switzerland
Registration	A-939
Radio call sign	*Alfa niner three niner*
Flight rules	VFR
Type of operation	Training
Departure point	Locarno (LSZL)
Destination point	Locarno (LSZL)
Location	4 NM north-east of Lugano airport, Swiss sovereign territory
Date and time	10 September 2010, 08:02 UTC
ATS unit	Lugano aerodrome control
Airspace	Class D
Closest point of approach of the aircraft	Lateral distance 0.5 NM, altitude difference 200 ft
Airprox category of the serious incident	ICAO category A - high risk of collision

Investigation

The serious incident occurred on 10 September 2010 at 08:02 UTC. The notification was received by the Aircraft Accident Investigation Bureau (AAIB) on 13 September 2010. After the preliminary clarifications customary for this type of event, the investigation was opened on 24 September 2010 at 14:00 UTC.

The final report is published by the Swiss Accident Investigation Board (SAIB).

Summary

On the morning of 10 September 2010, a Saab 2000 aircraft with the call sign SWR 75PE was on a scheduled flight from Zurich to Lugano. The crew made contact with Lugano aerodrome traffic control centre and requested a visual approach on runway 19. Shortly before this, a Swiss Air Force PC-7 training aircraft with the call sign A939 had taken off in Locarno. Approximately one nautical mile south of Monte Ceneri, its crew made contact with Lugano aerodrome control centre and reported in order to cross the Lugano control zone at an altitude of 3500 ft. This crossing was approved by the aerodrome traffic control centre, with information about two aircraft which were landing.

When a short time later SWR 75PE turned onto the left hand base leg for runway 19, the crew received a climb resolution advisory (RA) from the traffic alert and collision avoidance system (TCAS). The crew then immediately initiated a climb and followed the missed approach procedure.

A Beech 300 with the call sign HB-GJU, which was behind SWR 75PE and also on approach to runway 19 in Lugano, shortly afterwards received an RA from their TCAS, which caused them to maintain their current flight altitude.

The two aircraft, the Saab 2000 and the Beech 300, then landed uneventfully in Lugano, whilst the PC-7 continued its training flight.

Causes

The serious incident is attributable to a convergence of an Air Force training aircraft with a civil commercial aircraft, because the flight instructor allowed the trainee to control the aircraft in a manner that endangered the commercial aircraft. The instructor and the trainee pilot were not aware of any threat.

Contributing to the serious incident is the fact that the air traffic control officer in the Lugano aerodrome control center did issue the crossing clearance without having an adequate overview over the situation regarding possible danger.

The systemic cause of this serious incident is that the crew of the training aircraft had an inadequate awareness of the overall situation because they had insufficient knowledge of the consequences of the utilisation concept of class D airspace with regard to the method of the operation of TCAS, the onboard aviation safety net.

The following have been identified as systemic factors contributing to the serious incident:

- The Air Force flight mission included elements that featured insufficient tolerance of errors in the Lugano control zone.
- Some inaccurate aids were used for the preparation and the execution of the flight mission.
- The exchange of information between the Air Force and Lugano aerodrome control centre concerning a series of special flights was not effective.
- The extent of the Lugano control zone, the location of the reporting points, the speed limits and the operating procedures also in an airspace of class D were not effective.

Safety recommendations

In the context of the investigation, two safety recommendations were 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 History of the flight

1.1.1 General

The recordings of the radiotelephony, radar data and the stored data from the traffic alert and collision avoidance system (TCAS), plus the statements of crew members and air traffic controllers, were used for the following descriptions of the prehistory and history of the serious incident.

On flight SWR 75PE the commander was pilot flying (PF) and the copilot was pilot not flying (PNF).

In the Swiss Air Force PC-7 training aircraft, a trainee was in the front seat as pilot flying and a flight instructor who was examining the trainee's work was in the rear seat.

In air traffic control, the Lugano Tower aerodrome control centre, with the aerodrome control (ADC) workstation, was involved in the serious incident.

The flight of SWR 75PE was being conducted under instrument flight rules (IFR) with a visual approach, and the flight of the A939 was being conducted according to visual flight rules (VFR).

1.1.2 Prehistory

1.1.2.1 Air traffic control

At the time of the serious incident the aerodrome control (ADC) workstation in the Lugano control tower was occupied. A second air traffic controller, who occupied the ground (GND) workstation, was briefly absent.

1.1.2.2 Air Force

In the autumn of 2010, the Air Force pilots' school, which was stationed in Locarno for training on the PC-7 Turbotrainer, conducted the annual selection phase for prospective military pilots. On 10 September 2010, identical flights in the PC-7 aircraft were made by 24 trainee pilots. In each case the crew each consisted of a trainee pilot in the selection phase and a flight instructor. The flight mission envisaged a flight from Locarno via Monte Ceneri, Tesserete, Melide, Mendrisio and other waypoints back to Locarno (cf. Annex 3).

The basic sequence of this selection flight was discussed with the flying students a few days in advance and they then had to prepare for this flight independently. Since this mission constituted a test flight towards the end of the selection phase, only a briefing on the prevailing weather conditions and general conditions such as flight restriction areas took place before the flight. The trainee was expected to carry out the flight as independently as possible, whilst the instructor had the task of evaluating his work. He was to intervene only if hazardous situations were to be prevented.

Before the flight, the flight instructor had prepared for the flight using the visual approach chart for Lugano (cf. Annex 2) and a national map to a scale of 1:100 000. By means of this preparation, he wanted to make sure that he had detailed knowledge of the form of the Lugano CTR boundary.

1.1.3 History of the serious incident

On the morning of 10 September 2010, a Saab 2000 aircraft with the ATC call sign SWR 75PE was on a scheduled flight from Zurich to Lugano. At 07:53:23

UTC, the crew made contact with Lugano aerodrome control centre (Lugano TWR) and requested a visual approach on runway 19. At this point, the aircraft was passing flight level FL 170 in descent, approximately three nautical miles west of Brissago (cf. Annex 1). The Lugano TWR air traffic control officer (ATCO) gave clearance for the visual approach and instructed the crew to report when on the downwind leg.

A short time later, the crew of a Beech 300, registration HB-GJU, flying from Farnborough (GB), which was also approaching Lugano reported on the Lugano TWR frequency. The ATCO then cleared the crew for a visual approach on runway 19, as the second aircraft behind SWR 75PE.

At 07:50 UTC a Pilatus PC-7 military training aircraft with the call sign A939 had taken off in Locarno. The trainee pilot reported at 08:01:40 UTC on the Lugano TWR frequency as follows: *"Lugano tower, swiss air force niner three niner, is ah Monte Ceneri three thousand five hundred feet, crossing your CTR ah via routing Tesserete Melide Mendrisio"*. At this point, the aircraft was at 3500 ft QNH, approximately one nautical mile south of Monte Ceneri, west south-west of the village of Bironico, and was flying south at a speed of approximately 175 kt (cf. Annex 1). In the flight instructor's opinion, this initial radio contact was made in good time and in the right place. The ATCO then issued the following traffic information to the PC-7: *"roger, ah traffic Saab two thousand now end of downwind ah turning base for runway one niner and following traffic is ah now on downwind four thousand feet as well landing in Lugano"*. At 08:02:22 UTC the crew of A939 reported: *"niner three niner, traffic in sight."* At this time the PC-7 was on a southerly heading approximately 300 metres before entering Lugano CTR. Both the trainee and the instructor had visual contact with the Saab 2000 during this phase. At 08:02:26 UTC, the aerodrome controller gave clearance to cross Lugano CTR at an altitude of 3500 ft QNH, with the request to report again over reporting point E. At this point the PC-7 was already just inside the Lugano control zone, whilst SWR 75PE was passing 3900 ft QNH in descent at the start of the left hand base leg.

The aerodrome controller then also wanted to provide traffic information to SWR 75PE concerning the PC-7 which was incoming, but this was not possible because immediately after the last radio message from the A939, at 08:02:40 UTC, the crew of HB-GJU reported and stated that they were on the left hand downwind on runway 19 and had visual contact with SWR 75PE (cf. Annex 1).

In this phase, the PC-7 was displayed on the Saab 2000's traffic alert and collision avoidance system (TCAS) and triggered a traffic advisory (TA) *"traffic, traffic"*. A few seconds later the TCAS issued the resolution advisory (RA) *"climb, climb"*, thereby instructing the crew to climb. The crew immediately initiated a climb, followed the missed approach procedure up to 6000 ft QNH and directed the aircraft to waypoint PINIK. At 08:02:56 UTC the crew of SWR 75PE reported: *"Lugano Swiss seven five Papa Echo, climbing ah TCAS RA, Swiss seven five Papa Echo"*. The copilot of the Saab 2000 was able to establish visual contact with the PC-7 only after the triggering of the resolution advisory. The commander of SWR 75PE had not heard the crossing clearance for the A939, nor was he able to establish visual contact with this aircraft.

The two aircraft crossed at 08:02:49 UTC with a lateral distance of 0.5 NM and an altitude difference of 200 ft. From the point of view of the crew of the PC-7, the lateral or vertical distance to the Saab 2000 did not seem at any time to be too low or dangerous. They continued the flight as originally scheduled without taking any evasive action.

The crew of HB-GJU had heard the clearance issued to the A939 to cross the CTR at an altitude of 3500 ft QNH and for this reason opted not to descend further on the downwind leg and instead to maintain an altitude of 4000 ft QNH.

At 08:04:31 UTC, the crew of the Beech 300 HB-GJU reported that they had received a resolution advisory (RA) from their TCAS concerning the A939. The RA instructed the crew to monitor their vertical speed *("monitor vertical speed")*; in the present case this meant that they maintained their altitude of 4000 ft QNH. The instructor in the PC-7 then reported: *"niner three niner, we had the traffic opposite in sight, and ah, no problem".* Shortly before this, the flight instructor had instructed the trainee to descend 500 ft to 3000 ft QNH, in order to establish greater vertical separation from HB-GJU.

The A939 continued its training flight in the direction of Capolago, whilst HB-GJU landed uneventfully in Lugano. Another PC-7 military training aircraft with the call sign A930, which had requested crossing clearance from Lugano CTR at 08:09:00 UTC, was instructed by the air traffic control officer to fly a holding pattern over reporting point MEZZO at 3500 ft QNH. In the meantime, after a holding pattern over PINIK, SWR 75PE received clearance once again for a visual approach on runway 19 and subsequently landed uneventfully.

1.1.4 Location of the serious incident

Geographical position	4 NM north-east of Lugano airport
Date and time	10 September 2010, 08:02 UTC
Lighting conditions	Day
Elevation above sea level	3500 ft AMSL

1.2 Personnel information

1.2.1 Flight crew SWR 75PE

1.2.1.1 Commander

Person	British citizen, born 1971
Licence	Airline transport pilot licence aeroplane – ATPL(A) according to joint aviation requirements (JAR), first issued by the UK Civil Aviation Authority on 7 June 2007, valid till 6 June 2012
Ratings	Type rating Saab 2000 as pilot in command, valid till 30 September 2010 International radiotelephony for flights according to visual and instrument flight rules RTI (VFR/IFR)
Instrument flying rating	Instrument flight aircraft IR(A) last extended on 20 September 2009, valid till 30 September 2010
Last proficiency check	Line check on 31 August 2010, Simulator check with TCAS refresher on 7 March 2010
Medical fitness certificate	Class 1, no restrictions, issued on 4 May 2010, valid till 4 May 2011

	Last medical examination	4 May 2010
1.2.1.1.1	Flying experience	
	Total	4080 hours
	on the type involved in the incident	2000 hours as commander 390 hours as copilot
	during the last 90 days	20 hours
1.2.1.1.2	Duty times	
	Duty times before day of incident	8 and 9 September 2010 off duty
	Start of flight duty on day of incident	04:10 UTC
	Flight duty time at time of serious incident	03:52 hours
1.2.1.2	Copilot	
	Person	Italian citizen, born 1983
	Licence	Commercial pilot licence aeroplane – CPL(A) according to joint aviation requirements (JAR), first issued by the UK Civil Aviation Authority on 13 June 2008, valid till 12 June 2013
	Ratings	Type rating Saab 2000 as copilot, valid till 21 January 2011 International radiotelephony for flights according to visual and instrument flight rules RTI (VFR/IFR)
	Instrument flying rating	Instrument flight aircraft IR(A) last extended on 21 January 2010, valid till 20 January 2011
	Last proficiency check	Line check on 19 March 2010, Simulator check with TCAS refresher on 20 January 2010
	Medical fitness certificate	Class 1, no restrictions, issued on 11 November 2009, valid till 10 November 2010
	Last medical examination	11 November 2009
1.2.1.2.1	Flying experience	
	Total	590 hours
	on the type involved in the incident	280 hours
	during the last 90 days	137 hours
1.2.1.2.2	Duty times	
	Duty times before day of incident	8 September 2010, 04:10 – 12:21 UTC 9 September 2010, 04:20 – 08:00 UTC
	Start of flight duty on day of incident	04:10 UTC

	Flight duty time at time of serious incident	03:52 hours
1.2.2	Crew A939	
1.2.2.1	Flight instructor	
	Person	Swiss citizen, born 1976
	Licence	Brevet for military pilots, issued on 1 September 2000 Airline transport pilot licence helicopter – ATPL(H) according to joint aviation requirements (JAR), first issued by the Federal Office of Civil Aviation (FOCA) on 9 April 2008, valid till 20 April 2015 Commercial pilot licence aeroplane – CPL(A) according to joint aviation requirements (JAR), first issued by the FOCA on 15 April 1997, valid till 20 April 2015
	Ratings	Military type rating PC7(M), valid till 31 December 2011 Military type rating FI(M), no restrictions. Type rating PC-7 as pilot in command, valid till 27 February 2012 Flight instructor rating FI(A), valid till 23 March 2011 International radiotelephony for flights according to visual and instrument flight rules RTI (VFR/IFR)
	Instrument flying rating	Military instrument flying IFR(M), valid till 31 December 2010. Instrument flying category 1, valid till 23 March 2011
	Medical fitness certificate	Class 1, no restrictions, Authorisation for military flight duty without restrictions, issued on 11 February 2010, valid till 21 February 2011
1.2.2.1.1	Flying experience	
	Total	3932 hours
	on the type involved in the incident	481 hours
	during the last 90 days	102 hours

1.2.2.1.2 Duty times

Flight duty times and rest times are regulated by the Air Force operations manual (OM) A and are complied with by crew members under their own responsibility.

1.2.2.2	Trainee pilot	
	Person	Swiss citizen, born 1988

	Licence	None
	Ratings	None
	Medical fitness certificate	None

1.2.2.2.1 Flying experience

Total	28 hours
on the type involved in the incident	17 hours
during the last 90 days	17 hours

1.2.2.2.2 Duty times

Flight duty times and rest times are regulated by the Air Force operations manual (OM) A and are complied with by crew members under their own responsibility.

1.2.3 Air traffic control personnel

1.2.3.1 Air traffic control officer

Function	Aerodrome control (ADC)
Person	Swiss citizen, born 1970
Duty before day of incident	8 September 2010: 11:00 – 18:00 UTC 9 September 2010: 04:30 – 11:30 UTC
Start of duty on the day of incident	06:30 UTC
Licence	Air traffic controller licence, based on European Community Directive 2006/23, issued by the Federal Office of Civil Aviation (FOCA) on 24 May 2008, valid till 15 May 2011
Medical fitness certificate	Class 3, no restrictions, valid till 15 May 2011

1.3 Aircraft information

1.3.1 Aircraft 1

Registration	HB-IZJ
Aircraft type	Saab 2000
Characteristics	Twin-engine regional aircraft with turbo-prop propulsion
Manufacturer	Saab-Scania Flugzeugwerke, Stockholm, Sweden
Year of manufacture	1995
Owner	LOCAT S.P.A., Lugano, Switzerland
Operator	Darwin Airline SA, Bioggio, Switzerland
Equipment	TCAS II

1.3.2 Aircraft 2

Registration	A-939

Aircraft type	Pilatus PC-7
Characteristics	Single-engine two-seater training aircraft with turboprop propulsion
Manufacturer	Pilatus Flugzeugwerke, Stans, Switzerland
Year of manufacture	1979
Owner	Swiss Confederation, Bern, Switzerland
Operator	Swiss Air Force
Equipment	Military transponder Mode A/C with identification friend or foe (IFF)

1.4 Meteorological information

1.4.1 General

The information in sections 1.4.2 to 1.4.6 was provided by MeteoSwiss and translated from German.

1.4.2 General meteorological situation

A flat area of high pressure extended from France to the Alps. It substantially determined the weather in the western parts of the country and on the southern side of the Alps.

1.4.3 Weather at the time of the serious incident

The following information on the weather at the time of the serious incident is based on a spatial and chronological interpolation of the observations of different weather stations.

Weather/cloud	No cloud
Visibility	Over 20 km
Wind	North wind at 5 kt
Temperature/dewpoint	14 °C / 04 °C
Atmospheric pressure	QNH Lugano 1019 hPa
Hazards	None detectable

1.4.4 Astronomical information

Position of the sun	Azimuth: *118°*	Elevation: *31°*
Lighting conditions	Daylight	

1.4.5 Aerodrome meteorological reports

In the period from 07:50 UTC up to the time of the serious incident the following meteorological aerodrome routine weather report (METAR) was valid:

LSZA 100750Z 14003KT 100V200 CAVOK 17/13 Q1019 NOSIG

In clear text, this means:

On 10 September 2010, shortly before the 07:50 UTC issue time of the aerodrome weather report, the following weather conditions were observed at Lugano airport:

Wind	From 140° at 3 kt, wind direction changeable from 100° to 200°
Meteorological visibility	10 km or more
Weather	No significant weather phenomena
Cloud	No cloud below 13 000 ft AMSL, no cumulonimbus or towering cumulus at any altitude
Temperature	17 °C
Dewpoint	13 °C
Atmospheric pressure	1019 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere

1.4.6 Forecasts

At the time of the serious incident, the following terminal aerodrome forecast (TAF) applied:

100525Z 1006/1015 VRB03KT CAVOK

In clear text, this means:

On 10 September 2010, the following weather conditions were forecast for Lugano airport between 06:00 UTC and 15:00 UTC:

Wind	From changeable directions at 3 kt
Meteorological visibility	10 km or more
Weather	No significant weather phenomena
Cloud	No cloud below 13 000 ft AMSL, no cumulonimbus or towering cumulus at any altitude

1.5 Aerodrome information

1.5.1 General

The Lugano Airport control zone is Class D airspace. In this airspace, traffic information between IFR and VFR traffic is assured as an air traffic control service. Alternate route recommendations are issued at the request of crews. In addition, no separation minima exist between IFR and VFR traffic and between VFR and VFR traffic. Crews themselves are responsible, according to the principle of "see and be seen", for maintaining sufficient separation from other aircraft.

1.5.2 Aerodrome control

The air traffic control officers in Lugano in principle work with visual contact with the outside. It should be noted in this context that the MEZZO approach point, via which the 24 PC-7 aircraft flew into the control zone on the day of the serious incident, is not visible from the control tower. It should be noted that at most airports not all approach and departure points are directly visible from the control tower.

Lugano aerodrome control centre is additionally equipped with a radar display, which is used as a distance from touchdown indicator (DFTI). The use of DFTI by air traffic control officers in Lugano control tower is regulated in the air traffic management manual (ATMM) II Lugano and permits the use of the radar display only for the following cases:

- determining the distance of an approaching aircraft from the start of the runway
- reviewing the estimated overflight times of incoming aircraft (estimates)
- support for pilots in an emergency situation

In the present case the radar display was not used to issue traffic information or to ensure separation between aircraft.

1.5.3 Visual approach procedures

The approach procedures for Lugano are laid down in the aeronautical information publication (AIP). In accordance with the corresponding visual approach chart (VAC), the first radio contact with the aerodrome control centre must be made 5 minutes before entering the control zone (CTR) or over the reporting points LUINO, MEZZO, PORLEZZA or CAPOLAGO (cf. Annex 2).

In addition, three mandatory reporting points are defined (W, S, and E) and it is stated that within the triangle defined by these three points the maximum speed is 180 KIAS.

1.5.4 Control zone

The lateral limit of the Lugano control zone (CTR) was extended northwards at the beginning of 2004. The intention was to ensure that aircraft making a circling approach with prescribed flight tracks on runway 19 can do so within the CTR.

The modified CTR was published in the 1:500 000 ICAO Aeronautical Chart for Switzerland in April 2004 (cf. Annex 3) and somewhat later in the 1:500 000 Mil airspace chart for Switzerland.

1.5.5 Information exchange with Locarno aerodrome

According to his statement, the chief flight operation (CFO) of the Air Force pilots' school in Locarno had sent the planned programme of 24 selection flights by fax to Lugano aerodrome control centre the day before the serious incident. The air traffic control officer in Lugano TWR stated that on commencing duty on 10 September 2010 he had not found any fax form concerning these flights.

According to Lugano TWR statements, military exercise flights were only reported in writing or by telephone if the aircraft were carrying out approaches in Lugano.

1.6 Traffic alert and collision avoidance system

Aircraft HB-IZJ was equipped with a Collins TCAS II system (Version 7.0) traffic alert and collision avoidance system (TCAS[1]).

The system is independent of ground-based systems. It transmits signals and on the basis of radar response signals from the transponders of other aircraft, determines their position and motion vector. From these it calculates the closest point of approach (CPA). In the event of the convergence of another aircraft, which is capable of communicating with the system in the manner described, traffic information is first generated acoustically and optically (traffic advisory - TA); if the convergence continues and is dangerous, an acoustic and optical resolution advisory (RA) is generated. There are two kinds of resolution advisories: correc-

[1] The name of the basic concept of this collision prevention system is airborne collision avoidance system (ACAS). The International Civil Aviation Organization (ICAO) uses this term when drawing up the standards with which the system must comply. The traffic alert and collision avoidance system (TCAS) is a concrete implementation of this concept.

tive RAs, which require a change in vertical speed, and preventive RAs, which require monitoring of vertical speed.

Thresholds for triggering traffic advisories or resolution advisories are dependent on the respective height above ground of the two aircraft. If one of the two aircraft changes direction within a short time, this may also lead to the direct generation of a resolution advisory.

An acoustic traffic advisory (TA) *"traffic, traffic"* is to be expected, as soon as the aircraft are 25 seconds or less from the CPA. In the present case, this traffic advisory was generated on the convergence of the PC-7 with the base leg of the SWR 75PE.

The acoustic and optical resolution advisory (RA) was activated in the present case when the aircraft were 15 seconds or less from the CPA.

The crew of aircraft SWR 75PE received the corrective RA *("climb, climb")* and the crew of the following aircraft HB-GJU received the preventive RA to monitor their vertical speed *("monitor vertical speed")*.

The international standards for dealing with resolution advisories specify that a resolution advisory must be followed even if visual contact has previously been established with the aircraft presumably triggering the alert. The reason for this rule is that there is no certainty whether the aircraft in sight is actually the aircraft responsible for triggering the resolution advisory or whether there may be another aircraft in the vicinity which cannot be seen and which generated the resolution advisory. This rule also applied within the operator Darwin Airlines.

The Air Force PC-7 was not equipped with a TCAS. The only relevant equipment was an identification friend or foe (IFF) system. This device corresponds to a Mode A/C transponder. This enables the location of the military aircraft to be determined, and a TA or an RA can be generated in the event of a corresponding convergence with an aircraft equipped with TCAS.

In the selection phase which the Air Force trainee pilots were undergoing, these pilots were informed neither about the TCAS collision avoidance system nor about its method of operation.

According to the instructor's statement, he was essentially aware of the TCAS but he was not aware of the individual parameters, the functions of the system and the corresponding procedures in the event of TCAS alerts and advisories.

According to the European Organisation for the Safety of Air Navigation (Eurocontrol), approximately 8 percent of TCAS resolution advisories are generated in cases of dangerous convergences between IFR and VFR traffic. In the vast majority of cases, these alerts indicate a substantial risk of collision and thus represent a decisive improvement in aviation safety.

In the Air Force's view, the crossing with a civil commercial aircraft was perceived as being somewhat close, though was not considered a threat to aviation safety. Similar close crossings involving civil light aircraft are apparently not unusual in the vicinity of aerodromes, especially when gliding operations are taking place in parallel.

1.7 Information on the flight mission

1.7.1 General

As mentioned in section 1.1.2.2, the trainee pilots had to prepare for the selection flights independently. In addition to a theoretical briefing by the school, in which reference was made to CTR Lugano, according to the chief flight operation, the

trainee pilots received a description of the mission programme. In this briefing, the headings, waypoints and altitudes to be flown were specified. Individual reporting points were also mentioned. The beginning of the mission, which involved two heading changes in the Tesserete area by means of turns at bank angles of 60° and compliance with specific times, is relevant to the serious incident.

The mission programme made no mention of the fact that on this flight Lugano CTR would be crossed and that a corresponding clearance should be requested from Lugano TWR.

In addition, the school provided the trainee pilots with a map of the topography, to a scale of 1:100 000, of the corresponding area. A visual approach chart (VAC) of Lugano was not issued to the trainee pilots. According to the trainee pilot's statement, he had copied the Lugano CTR onto his personal chart in pencil.

During the briefing on the mission programme, the Air Force projected a 1:100 000 scale chart on which the route of the selection flight and the Lugano CTR were entered by hand. This sketch dated from the time when this selection flight had been designed. The Lugano CTR drawn on this section of the chart was identical to the shape, which was applicable up to March 2004. At that time, the CTR was extended northwards (cf. section 1.5.4 and Annex 3). During this briefing, according to the chief flight instructor, the trainees were informed that the CTR was now larger.

The trainee pilot's flight preparation included notes on the mission programme and a schedule for the mission, which he took with him on the flight. These correspond to the information in the mission programme. There was no information about the Lugano airport control zone or reporting points in these notes.

Before the flight, the flight instructor had prepared for the flight using the visual approach chart for Lugano and a national map to a scale of 1:100 000. By means of this preparation, he wanted to make sure that he had detailed knowledge of the form of the Lugano CTR boundary.

1.7.2 Crossing the Lugano control zone

According to the statement of the persons responsible of the pilots' school, the crossing of the Lugano control zone was mentioned during a preliminary briefing for the selection flight, stipulating that corresponding clearance would have to be requested.

The radar plots of all 24 selection flights which made the same flight on that day show that in 11 of 24 cases this clearance was requested less than three nautical miles from the boundary of the control zone, which corresponds to less than one minute before reaching the control zone boundary, at the speed of 180 kt being flown on the selection flight.

Records of the radio conversations show that 19 pilots requested a crossing clearance. The other five pilots, including the trainee in the A939, merely informed the ATCO in the control tower of their forthcoming crossing of the CTR, without actually requesting clearance.

1.8 Anonymous survey on VFR flying in Class D airspace

The investigation included an anonymous survey of 241 civil pilots of all licence categories and levels of experience in the period from February to June 2012. The survey was intended to give an indication of how the procedures documented in the relevant regulations regarding flying in Class D airspace and use of the traffic alert and collision avoidance system (TCAS) are understood and interpreted in practical implementation.

The survey was conducted using a questionnaire at advanced training events for pilots and flight instructors. These seminars also dealt with aviation safety topics and were organised by the Swiss Aircraft Owners and Pilots Association (AOPA) and the SwissPSA association of flying schools. The Swiss Accident Investigation Board is grateful for the opportunity to conduct such an anonymous survey as part of these events.

Using 27 statements that had to be rated as "applicable" or "not applicable", knowledge of the following aspects of flying in Class D airspace was examined:

- principles of collision prevention (the concept of separation)
- air traffic control services and facilities
- tasks of flight crews
- characteristics and consequences of TCAS

The results relating to the questions listed below were especially noteworthy; the responses were broken down according to different licensing or rating levels. The correct fact is shown in italics in each case.

The group of 241 pilots surveyed included 114 pilots with a private pilot licence, 82 pilots with a commercial pilot licence and 42 pilots with an airline transport pilot licence, including 106 pilots with a flight instructor licence.

In Class D airspace, air traffic control ensures adequate separation (a sufficient lateral and vertical distance) between IFR and VFR traffic, e.g. by providing heading and altitude instructions.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
68.5	75.4	55.1	70.0	60.4
This statement is incorrect. In class D airspace, air traffic control is not responsible for maintaining sufficient separation between IFR and VFR traffic.				

In class D airspace, there is no minimum separation between IFR and VFR traffic.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
41.1	36.0	53.8	35.0	44.3
This statement is correct.				

In class D airspace, the instruction *"keep own separation"* to IFR and VFR traffic is the norm and means that flight crews themselves should maintain a sufficient distance from each other.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
52.3	42.1	57.7	70.0	60.4
This statement is correct.				

In a Class D control zone, the air traffic controller can detect, e.g. by means of

radar, whether the distance between two aircraft is sufficient and if necessary can give heading and altitude instructions in order to ensure this distance.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
78.0	79.8	80.8	72.5	74.5
This statement is incorrect. At many aerodromes, air traffic control is not able to monitor separations between aircraft and give heading or altitude instructions.				

The traffic alert and collision avoidance system (TCAS) is not intended for use in Class D airspace or for a combination of IFR and VFR traffic.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
51.0	52.6	48.7	45.0	49.1
This statement is incorrect. The TCAS was deliberately developed for use in combined airspace, among other things.				

The use of TCAS near to aerodromes in particular frequently leads to false alarms, above all in circuits and circling areas.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
66.4	68.4	70.5	55.0	66.0
This statement is incorrect. According to the Eurocontrol statistics, false alarms are very rare in these situations.				

The respondents were also prompted to indicate to what extent in the course of their career they were trained as a pilot on the method of operation and use of the traffic alert and collision avoidance system (TCAS).

I received no training of any kind on TCAS during my flying career.				
Agreement as a percentage of the respective group				
All	Private pilots	Commercial pilots	Airline transport pilots	Flight instructors
57.3	74.4	55.1	5.0	35.8

2 Analysis

2.1 Technical aspects

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

2.2 Human and operational aspects

2.2.1 Air traffic control

During the air traffic control officer's shift from 06:30 - 13:30 UTC, 18 flights by Air Force PC-7 aircraft took place. According to the radio recordings, all crews received crossing clearance for Lugano CTR from the ATCO.

The Lugano control zone is allocated to Class D airspace. In class D airspace, instrument and visual flight rules traffic is not separated; only traffic information is issued. Such traffic information was issued to the crew of the A939 when it requested the crossing. Analogue traffic information could not be delivered to the crew of SWR 75PE because the frequency was occupied. Nevertheless, the crossing clearance issued by the ATCO to the A939 corresponded to the rules for operation in this class of airspace.

It should be noted, however, that the issuing of the crossing clearance for the A939 involved the following risks as a result of the combination of the following points:

- the clearance was issued at a time when two aircraft being operated under instrument flight rules were on the airport circuit and at an altitude which corresponded roughly to that of the A-939.
- the PC-7 and the two civil aircraft exhibited potentially conflicting flight paths.
- the arrival of an aircraft via MEZZO is not visible from the control tower for topographical reasons. An aircraft becomes visible to the ATCO just before crossing the approach axis of runway 19.

The programme of the 24 selection flights made from Locarno on this day had, according to the persons responsible of the Air Force pilot school, been sent by fax to Lugano aerodrome control on the day before the serious incident. According to his statement, the Lugano air traffic control officer concerned had never received prior information about these flights. In the course of the investigation, the impression arose, not only owing to these contradictory statements but also owing to comments made by persons on both sides, that cooperation between the Air Force and the Lugano aerodrome control centre is generally characterised by certain differences. It is not for this air safety investigation to assume an arbitration role. But the fact remains that a more effective exchange of information about this significant number of identical flights would have been valuable but this was not the case. This had the effect that the air traffic controller had only a limited awareness of the overall situation and this contributed to the genesis of the dangerous convergence.

2.2.2 Crews

2.2.2.1 Crew of A939

The crew of the PC-7, the trainee pilot and the flight instructor were informed about the traffic in the CTR. As they were flying according to visual flight rules, it was up to them to identify the traffic and avoid it if necessary.

In the serious incident currently under investigation, in SWR 75PE a resolution advisory was generated 15 seconds or less before the calculated closest point of approach (CPA) of the two aircraft. According to the radar recordings, the PC-7 was flying at a speed of 175 knots and the Saab 2000 at 130 knots. The resolution advisory (RA) in the Saab 2000 was triggered when the PC-7 was at a distance of approximately 0.7 NM. The distance to the Saab 2000 was not perceived as low or even dangerous, either by the trainee pilot or by the flight instructor. According to the objective criteria of the traffic alert and collision avoidance system (TCAS), however, it did constitute a threat, so a resolution advisory ensued which the crew of SWR 75PE had to obey.

As the interviews showed, the crew of the A939 were not aware that in the event of a convergence with aircraft which are equipped with a collision warning system, optical and acoustic resolution advisories are generated which the crew must follow.

This lack of awareness can be traced back to the fact that the trainee pilots had received no TCAS training and the instructor had only marginal knowledge in this respect. In addition, there is the fact that military pilots are generally instructed and trained to carry out flight movements in close proximity to other aircraft.

In the flight instructor's opinion, the trainee pilot had reported to Lugano TWR for the crossing sufficiently early, some 2.2 NM before the CTR boundary, and therefore before reporting point MEZZO. By doing so, he fulfilled the conditions as published on the Lugano visual approach chart.

It should, however, be noted that at the airspeed of 175 kt the ATCO only had approximately 40 seconds to clear or refuse a crossing. Depending on the traffic conditions and frequency occupancy, this time is not sufficient for the ATCO to undertake a situation analysis and give an appropriate clearance. The fact that the PC-7 was already inside the CTR when the crossing clearance was issued shows that the crew was not aware of this problem. If the clearance had not been given by the ATCO, the crew would no longer have been able to react in a timely manner and would clearly have penetrated the CTR. The whole process proves that even given an initial radio call as provided for on the visual approach chart (VAC) there is hardly any margin left for a safety-conscious and prudent entry into the CTR, if the maximum speed of 180 KIAS indicated on the VAC is adopted.

2.2.2.2 Crew of SWR 75PE

The crew of SWR 75PE were making a visual approach on runway 19; because of the terrain, this tends to be a challenging manoeuvre. They received a traffic advisory by the TCAS concerning an opposing aircraft but were unable to establish visual contact with the A939 in this phase. However, such contact would have changed nothing, given the same flight path, because in the event of a dangerous convergence which generates a TCAS resolution advisory this instruction must be obeyed regardless of any other visible aircraft. When the crew of SWR 75PE received the *"climb, climb"* resolution advisory, they immediately initiated a climb and followed the missed approach procedure. They therefore acted in accordance with the system and contributed to resolving the dangerous situation.

2.2.2.3 Crossing of the A939 and HB-GJU

The crew of the Beech 300 HB-GJU maintained their altitude of 4000 ft QNH because on the one hand they had listened to the crossing clearance at 3500 ft QNH issued to the A939 on the radio and on the other hand they had received traffic information from the ATCO in Lugano. On the basis of their experience,

they were able to anticipate a possible dangerous development and therefore did not continue their descent. In the meantime, the flight instructor in the A939 had instructed the trainee pilot to descend from 3500 ft QNH to 3000 ft, but without this being reported to air traffic control. In combination, the two measures had the effect that the convergence between the A939 and HB-GJU did not involve a significant risk of collision. The convergence of the PC-7 caused the TCAS on HB-GJU to require monitoring of the current vertical speed only, i.e. a continuation of the horizontal flight. The actions of both the crew of HB-GJU and the flight instructor in the A939 were therefore forward-looking and safety-conscious.

2.2.3 Procedures in Lugano

Unlike the other reporting points, MEZZO is only approximately 1.5 NM from the boundary of the CTR. At an airspeed of 180 knots, this distance corresponds to a flying time of approximately 30 seconds. The ATCO therefore has little time to analyse the situation and to decide in good time whether a crossing clearance may be granted or whether it is necessary to implement a holding procedure outside the CTR.

The other three reporting points LUINO, CAPOLAGO, and PORLEZZA are located approximately three times further from the CTR boundary, giving the ATCO considerably more time to coordinate the traffic.

It is therefore clear that the speed at which an aircraft approaches the CTR boundary and flies within it is of crucial importance. The reference on the visual approach chart that only within the three reporting points W, S and E, which includes only approximately one third of the CTR area, a maximum speed of 180 KIAS is prescribed, therefore appears to be not very logical from an aviation safety perspective and is very high given the width of the CTR of approximately 4 NM.

The serious incident has shown that the extent of the control zone, the location of the reporting points, the speed limits and the operating procedures are insufficiently coordinated.

2.2.4 Air Force

The trainee pilots were not supplied with a civil visual approach chart (VAC) for Lugano Airport. During the briefing for the selection flight, the trainee pilots were shown a copy of the 1:100 000 scale chart on which the flight path of the selection flight and the Lugano control zone were entered by hand. On this chart, the marked flight path after MEZZO went north of the Lugano CTR and only crossed the Lugano CTR at a later point in time. The reason for this is that the CTR drawn on the map corresponded to that which was valid until March 2004. Clearly, no adaptation of the chart had been undertaken.

As the serious incident indicates, the crew of the A939 were insufficiently aware of the extent of the CTR, otherwise it is difficult to explain why the flight instructor tolerated the actual intrusion of the trainee into the CTR before the latter had even received a crossing clearance. The reason for this incorrect conception is probably less due to inadequate preparation and more on the use of inappropriate aids.

According to the air force, in the context of the selection flight greater priority was given to the military mission and airspace monitoring than to the significance of the civil control zone.

This is highlighted, for example, by the fact that the mission programme for this flight made no reference to the crossing of a civil CTR. When, according to the

CFO's statement, reference was made in the briefing to the trainees having to report to the appropriate air traffic control unit for crossing the CTR, though this probably did describe the procedural regulations, it clearly did not make the trainees sufficiently aware of how such a procedure was to be implemented.

A detailed analysis of the 24 PC-7 flights on that day yields the same conclusion. All pilots made contact with Lugano control tower. It is surprising that in 11 cases the first radio contact was made so late that the aircraft at its current speed would already have been inside the control zone if a crossing had been refused by the ATCO.

All of this indicates that the crews were lacking in essential knowledge and requirements concerning flying into a control zone and the associated possible consequences.

The selection flight had been developed at a time when the northern boundary of the Lugano CTR was located further to the south (cf. Annex 3). On the one hand, the pilots consequently had more time to obtain a crossing clearance and on the other hand the flight path intersected the CTR only on its north-eastern edge. In addition, prior to entering the control zone there was more space, with regard to the terrain, to remain outside the CTR if necessary.

The change of heading specified in the mission programme from a southerly direction with a left turn onto a heading of 100 degrees took place, unlike in relation to the earlier CTR, no longer outside but inside the northern part of the control zone (cf. Annex 3). This is confirmed by the radar records of the flights which were made. It is remarkable that the planned change in heading in the selection flight takes place shortly before crossing the runway 19 approach centre line. In this left turn, which must be flown at a bank angle of 60°, it is difficult for the pilot to maintain visual contact with traffic approaching on runway 19.

In addition, the mission program specified that the trainee pilot, on entering the CTR at a speed of 175 kt, had to perform several tasks, such as timing time segments and changing to a specific heading at a prescribed bank angle. A trainee pilot with little flying experience and under examination pressure who, in addition to these tasks, suddenly has to avoid two civil IFR aircraft can be stretched to the limit of his ability, as the serious incident shows.

The entire training layout allows little room for error and can quickly and unexpectedly lead to situations which demand increased attention from the flight instructor. It is also obvious that the trainees, because of their situation, were onesidedly focused on their mission and therefore gave too little consideration to the safety-critical aspects concerning airspace users. This situation *per se* does not have to give rise to a dangerous situation. However, it does mean that the instructor can ensure adequate safety in all instances when the trainee pilot is no longer able to do so because of his experience. In the present serious incident the flight instructor did not manage to do this at the time of the convergence with the commercial aircraft, and this led to a threat according to the objective criteria of TCAS. During the subsequent convergence with the Beech 300, however, he was able to avoid a dangerous crossing.

Finally it should be noted that at the time of the serious incident the Air Force had no systematic safety management system. The safety of the existing training layout and the training of the deployed crews were assessed by the competent commanders. In this context the training layout was considered as an acceptable risk. The systemic shortcomings listed above were identified only within the framework of this investigation.

2.2.5 Handling of IFR and VFR traffic in Class D airspace

The investigation of the serious incident and the associated anonymous survey of pilots of all licensing levels, ages and levels of experience has shown that information deficits exist in particular in relation to the possibilities and duties of air traffic control in Class D airspace and with regard to the consequences of the traffic alert and collision avoidance system (TCAS).

It is especially striking that a majority of the pilots questioned were apparently ensconced in a form of false security; depending on the rating level up to 75% of pilots are of the incorrect opinion that air traffic control ensures adequate separation between mixed instrument flight rules and visual flight rules traffic. Even 70% of the airline transport pilots, who mostly have many thousand hours of flying experience, shared this incorrect view. Also, the fact that no separation minima exist between IFR and VFR traffic is known to less than half of the pilots questioned.

Another principle associated with flying in Class D airspace is that the crews of IFR and VFR traffic are themselves responsible for maintaining sufficient separation from all other aircraft. The survey results show that only approximately half of the private and commercial pilots questioned are acquainted with this principle. Flight instructors and airline transport pilots are obviously better informed about this.

It is noteworthy that the ideas and expectations which the different flight crews have about the possibilities of air traffic control differ significantly from the real circumstances. Thus the vast majority of the pilots questioned, regardless of qualifications and experience, are of the view that in control zones, air traffic control is able to give heading and altitude instructions using radar in order to establish sufficient separation between IFR and VFR traffic. The aerodrome control centres of the regional airports are equipped with radar systems which do not allow precisely this service. Thus it was neither permitted nor possible in the present case for the aerodrome control officer, using the distance from touchdown indicator (DFTI) available in Lugano, to provide traffic alerts or even to ensure sufficient separation between the aircraft concerned. In terms of aviation safety, it would be desirable for at least the regional airports to have available appropriate aids to display the traffic situation.

The concepts of the pilots questioned regarding the importance and utilisation of TCAS in Class D airspace also do not correspond to the actual design of this important safety net. For example, the majority of the pilots questioned are of the view that TCAS is not suitable for use in class D airspace or for a combination of IFR and VFR traffic. The belief that the use of TCAS frequently leads to false alarms in this environment is probably directly linked to this unfounded assumption. In actual fact, TCAS was developed after various collisions involving aircraft flying according to visual flight rules on the one hand and instrument flight rules on the other. Also, the global statistics show that TCAS alerts, in the vast majority of cases, are justified, in that they warn of a significant risk of collision.

It could be argued that the system is overcautiously designed or that the fact that one can see other aircraft would automatically prevent a collision or a threat. The global accident statistics show, however, that this is not the case: the reliable estimation of distances and the determination of relative directions of movement in airspace is more challenging than is commonly believed and false assessments can occur even with experienced crews. In contrast to human perception, TCAS is objective and requires a resolution advisory if a convergence of less than a few hundred feet vertical distance will occur within the next 10 to 15 seconds.

As the present case shows, neither the experienced flight instructor nor the inexperienced trainee pilot in the air force training aircraft considered the distance to the two civil aircraft to be insufficient at any time. In fact, the PC-7 intruded into the protective envelope of a commercial aircraft which has been developed by a scientific analysis of numerous collisions and dangerous convergences and which has been implemented in the TCAS safety net. The fact that despite the threat the crew always had a good feeling therefore shows that their judgment, which was characterised by everyday Air Force experience, was contrary to recognised principles of civil safety.

Finally, with regard to the survey of civil pilots and pilots of all ratings, ages and experience levels it should be noted that there is a widespread information deficit about flying in class D airspace and the use of TCAS which could, however, be resolved by increasing awareness and providing information.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft were licensed for VFR/IFR transport.
- The investigation produced no indications of any pre-existing technical faults which might have caused or influenced the serious incident.
- The Saab 2000 and Beech 300 aircraft were equipped with TCAS; the Pilatus PC-7 was not.

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 necessary licences for the exercise of his activity.
- There are no indications of the air traffic control officer suffering health problems at the time of the serious incident.

3.1.4 History of the serious incident

- The crew of aircraft SWR 75PE made contact at 07:53:23 UTC with the Lugano aerodrome control centre and requested a visual approach on runway 19, which was promptly granted.
- A little later the crew of the Beech 300 HB-GJU also requested a visual approach on runway 19, which was granted.
- At 08:01:40 UTC the crew of the PC-7 with the call sign A939 reported north of reporting point MEZZO and informed about the crossing of the CTR at 3500 ft QNH via Tesserete, Melide and Mendrisio.
- The ATCO issued the crew of the PC-7 traffic information about the two approaching aircraft.
- After the crew of the PC-7 had reported visual contact, the ATCO cleared them to cross the CTR at 3500 ft QNH at 08:02:26 UTC.
- At this point, the A939 was already just inside the Lugano CTR flying at a speed of approximately 175 knots.
- At the same time, SWR 75PE was passing 3900 ft QNH in descent and at the beginning of the left hand base leg for runway 19.
- No traffic information about the PC-7 could be issued to the crew of SWR 75PE because the frequency was occupied.
- At 08:02:56 UTC the crew of SWR 75PE reported that they had initiated a climb on the basis of a TCAS resolution advisory (RA).
- The two aircraft, SWR 75PE and A939, crossed with a lateral distance of 0.5 NM and an altitude difference of 200 ft.

- At 08:04:31 UTC the crew of the Beech 300 HB-GJU reported that they had received an RA triggered by the A939 which instructed them to monitor their vertical speed.
- Shortly before this, the flight instructor in the A939 had instructed the trainee pilot to descend to 3000 ft QNH in order to establish clear separation from HB-GJU.

3.1.5 General conditions

- The MEZZO reporting point is located close to the CTR boundary and is not visible to the air traffic control officer.
- The documentation used by the Air Force to prepare for the selection flights by the trainee pilots were partially incorrect.
- The flight instructor and the trainee pilot suffered from a significant information deficit with regard to encounters with aircraft equipped with TCAS.
- The weather conditions had no influence on the serious incident.
- The survey of civil pilots indicated that a substantial information deficit exists concerning flying in Class D airspace and the use of TCAS.

3.2 Causes

The serious incident is attributable to the convergence of an Air Force training aircraft with a civil commercial aircraft, because the flight instructor allowed the trainee to control the aircraft in a manner that endangered the commercial aircraft. The instructor and the trainee pilot were not aware of any threat.

Contributing to the serious incident is the fact that the air traffic control officer in the Lugano aerodrome control center did issue the crossing clearance without having an adequate overview over the situation regarding possible danger.

The systemic cause of this serious incident is that the crew of the training aircraft had an inadequate awareness of the overall situation because they had insufficient knowledge of the consequences of the utilisation concept of class D airspace with regard to the method of the operation of TCAS, the onboard aviation safety net.

The following have been identified as systemic contributing factors of the serious incident:

- The Air Force flight mission included elements which were not sufficiently error-tolerant concerning flying in the Lugano control zone.
- Some inaccurate aids were used for the preparation and the execution of the flight mission.
- The exchange of information between the Air Force and the Lugano aerodrome control centre concerning a series of special flights was not effective.
- The extent of the Lugano control zone, the location of the reporting points, the speed limits and the operating procedures also in an airspace of class D were not effective.

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 the morning of 10 September 2010 a Saab 2000 aircraft with the call sign SWR 75PE was on a scheduled flight from Zurich to Lugano. The crew made contact with Lugano aerodrome traffic control centre and requested a visual approach on runway 19. Shortly before this, a Swiss Air Force PC-7 training aircraft with the call sign A939 had taken off from Locarno. Approximately one nautical mile south of Monte Ceneri, its crew made contact with Lugano aerodrome control centre and reported in order to cross the Lugano control zone at an altitude of 3500 ft. This crossing was approved by the aerodrome traffic control centre, with information about two aircraft which were landing.

When a short time later SWR 75PE turned onto the left hand base leg for runway 19, the crew received a climb resolution advisory (RA) from the traffic alert and collision avoidance system (TCAS). The crew then immediately initiated a climb and followed the missed approach procedure.

A Beech 300 with the call sign HB-GJU, which was behind SWR 75PE and also on approach to runway 19 in Lugano, shortly afterwards received an RA from their TCAS, which required them to maintain their current flight altitude.

The two aircraft, the Saab 2000 and the Beech 300, then landed uneventfully in Lugano, whilst the PC-7 continued its training flight.

The analysis of the serious incident and an anonymous survey in the course of the investigation permit the conclusion that a significant proportion of flight crews have only insufficient knowledge of the consequences of the utilisation concept for Class D airspace and the operation of TCAS, the onboard aviation safety net.

4.1.2 Safety recommendation nos. 463 and 464

"Das Bundesamt für Zivilluftfahrt sollte sicherstellen, dass Ausbildungslehrgänge zum Erwerb aller Lizenzstufen ausreichende Kenntnisse vermitteln, damit die Li-

zenzträger die praktischen Konsequenzen des traffic alert and collision avoidance systems (TCAS) sowie des Nutzungskonzepts von Lufträumen der Klasse D verstehen und umsetzen können."

[The Federal Office of Civil Aviation should ensure that training courses to acquire all levels of licences provide sufficient knowledge to enable the licence holders to understand and implement the practical consequences of traffic alert and collision avoidance systems (TCAS) as well as the utilisation concept of Class D airspace.]

"Das Bundesamt für Zivilluftfahrt sollte in Zusammenarbeit mit der Luftwaffe und massgeblichen Luftfahrtverbänden einfache und effektive Mittel entwickeln, um die Kenntnisse von Flugbesatzungen bezüglich dem Umgang mit TCAS und dem Fliegen in Mischlufträumen aufzufrischen und zu vertiefen."

[The Federal Office of Civil Aviation should, in cooperation with the Air Force and relevant aviation associations, develop simple and effective means of updating and enhancing the knowledge of flight crews regarding the use of TCAS and flying in mixed air space.]

4.2 Measures taken since the serious incident

4.2.1 By Lugano airport

None

4.2.2 By the Air Force

Before the subsequent selection stage, the Air Force contacted the former AAIB and took the following measures on the basis of the information available at this time:

- All trainee pilots in the selection phase had been provided with civil visual approach charts for Lugano.
- The flight instructor and trainee pilots had been informed about the serious incident of 10 September 2010 and had been made aware of time compression when crossing the Lugano CTR.
- The crews had been urged to log off from Locarno as early as possible and to make contact immediately with Lugano aerodrome control centre.
- It was ensured that Lugano aerodrome control centre will be informed of such special flights by the Air Force.

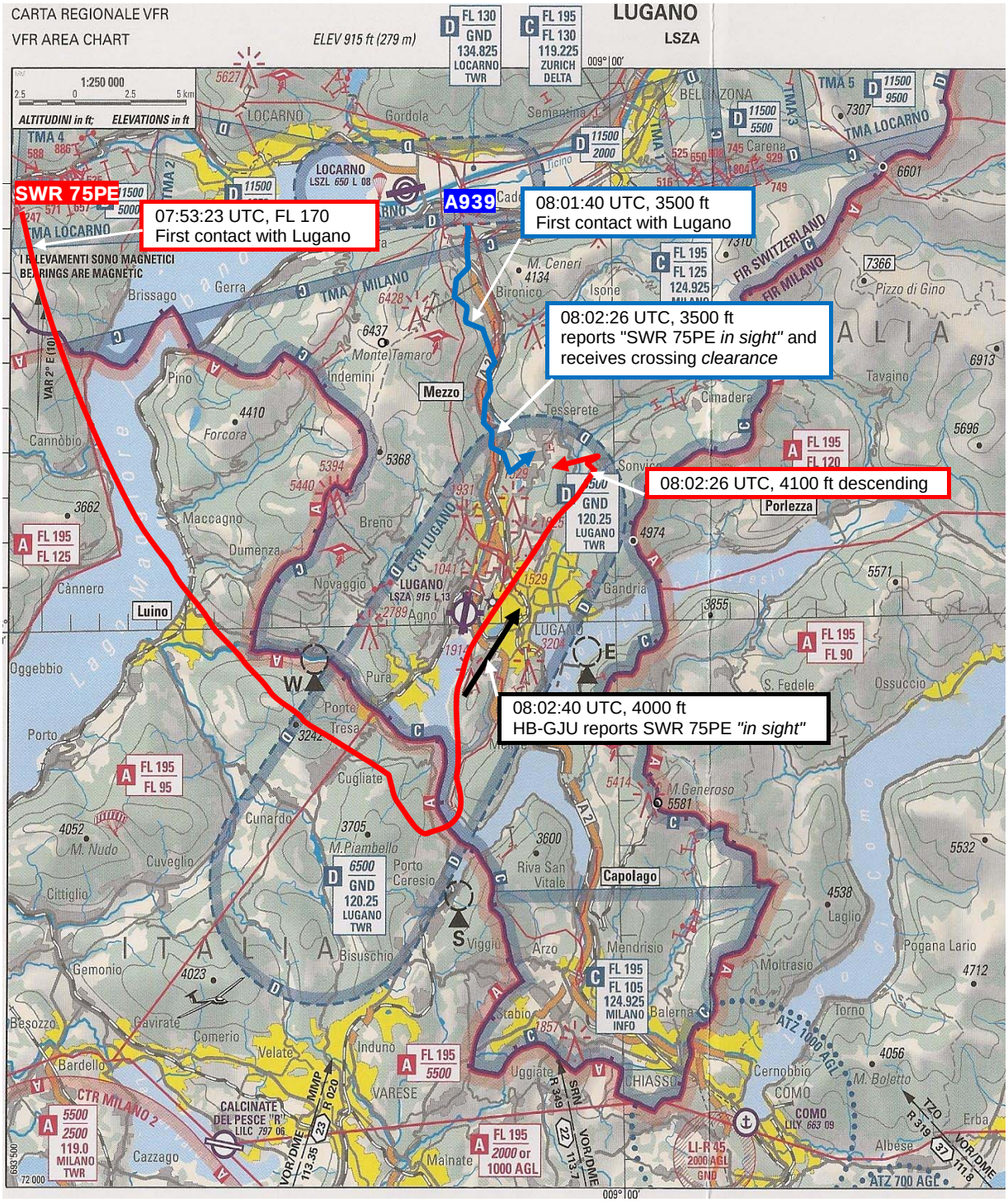
Payerne, 8 January 2013 Swiss Accident Investigation Board

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).

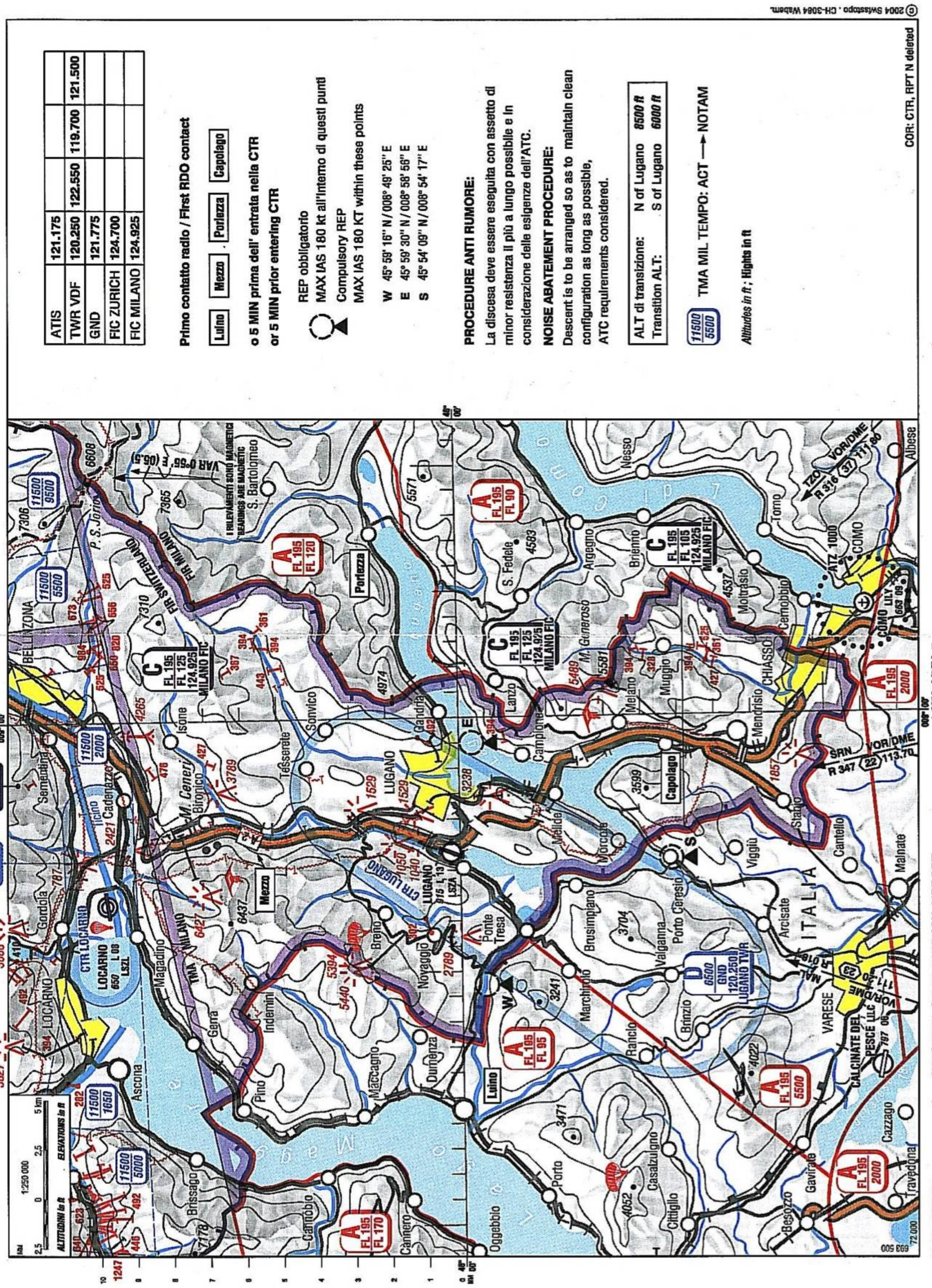
Berne, 5 February 2013

Annexes

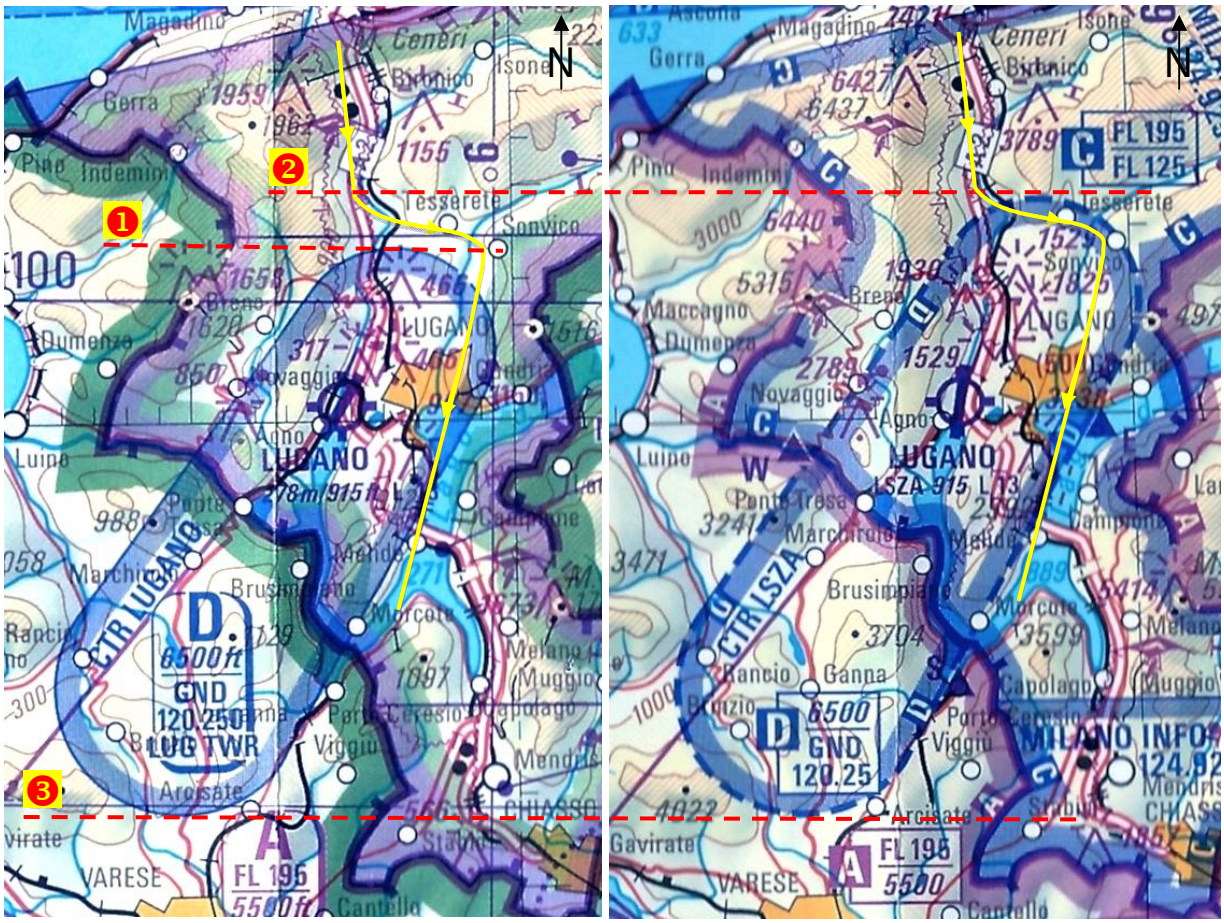
Annex 1: Flight paths of the aircraft involved according to the radar data



Annex 2: Visual approach chart Lugano



Annex 3: Change to the Lugano control zone



Mil airspace chart of Switzerland, 1:500 000
of 30 October 2003

Aviation chart ICAO Switzerland, 1:500 000
of 11 March 2010
(identical to the edition of April 2004)

Envisaged flight path

1 Northern limit of CTR Lugano (before April 2004)

2 Northern limit of CTR Lugano (after April 2004)

3 Southern limit of CTR Lugano