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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2140 by the Swiss Accident Investigation Board SAIB

concerning the accident involving the Raytheon 390 aircraft, registration D-IAYL

on 19 December 2010

Bever/GR

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Ursachen

Der Unfall ist darauf zurückzuführen, dass aufgrund eines Strömungsabrisses die Kontrolle über das Flugzeug verloren ging und dieses in der Folge mit dem Boden kollidierte.

Die folgenden Faktoren wurden als kausal für den Unfall ermittelt:

- Die Besatzung führte den Anflug unter Wetterbedingungen weiter, welche eine sichere Führung des Flugzeuges nicht mehr gestatteten.
- Die Besatzung führte statt eines konsequenten Fehlanflugverfahrens ein risikoreiches Manöver in Bodennähe durch.

Der Umstand, dass der Fluginformationsdienst relevante Wetterinformationen eines anderen Flugzeuges nicht konsequent an die Besatzung weitergab, hat zum Unfall beigetragen.

Als systemischer Faktor, der zum Unfall beigetragen hat, wurde folgender Punkt identifiziert:

- Die auf dem Flughafen Samedan ermittelten Sichtweiten und Wolkenuntergrenzen waren für einen Anflug von Zernez her nicht repräsentativ, weil sie nicht den tatsächlichen Verhältnissen im Anflugsektor entsprachen.

General information on this report

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

In accordance with Art 3.1 of the 10th edition, applicable from 18th 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 universal time coordinated (UTC) format. At the time of the accident, Central European Time (CET) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is:
LT = CET = UTC + 1 hour.

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Synopsis

Owner	SG Equipment Finance Schweiz AG Gladbacherstr. 105, 8044 Zurich, Switzerland
Operator	Windrose Air Jetcharter GmbH Berlin-Schönefeld Airport, GAT, 12521 Berlin, Germany
Manufacturer	Hawker Beechcraft Corporation (formerly Raytheon Aircraft Company)
Aircraft type	Raytheon 390 (Beech 390 Premier 1A)
Country of registration	Germany
Registration	D-IAYL
Location	Bever, municipality Bever/GR
Date and time	19 December 2010, 14:02 UTC

Investigation

The accident occurred on 19 December 2010 at 14:02 UTC. The notification was received at 14:19 UTC. The investigation was opened on the same day at 17:30 UTC by the Aircraft Accident Investigation Bureau (AAIB) in cooperation with the Grisons cantonal police. The AAIB informed the following national authorities about the accident: Germany, Croatia and the United States of America. All three states nominated an authorised representative, who assisted with the investigation.

The present investigation report is published by the AAIB.

Summary

On 19 December 2010, the Raytheon 390 aircraft, registration D-IAYL, took off at 13:01 UTC from Zagreb (LDZA) on a commercial flight to Samedan (LSZS) under callsign QGA 631V, under instrument flight rules (IFR), under an ATC flight plan Y. Two crew members were on board. After an uneventful flight, the IFR flight plan was cancelled at 13:53:09 UTC and the flight continued under visual flight rules (VFR).

When the crew of D-IAYL were requested at 13:54:01 UTC by the Zurich sector south air traffic controller (ATCO) to switch to the Samedan Information frequency, they wanted to remain on the frequency for a further two minutes. The aircraft was on a south-westerly heading, approx. 5 km south of Zernez, when the crew informed the ATCO at 13:57:12 UTC that they would now change frequency.

After first contact with Samedan Information, when the crew reported that they were ten miles before the threshold of runway 21, the aircraft was in fact approximately eight miles north-east of the threshold of runway 21.

When at 13:58:40 UTC the crew of a Piaggio 180 asked the flight information service officer (FISO) of Samedan Information about the weather as follows: *"(…) and the condition for in-*

bound still ok?", the crew of D-IAYL responded at 13:58:46 UTC, before the FISO was able to answer: *"Yes, for the moment good condition (…)"*.

D-IAYL was slightly north-east of Zuoz when the crew asked the FISO about the weather over the aerodrome. D-IAYL was over Madulein when at 13:59:46 UTC the FISO informed the crew that they could land at their own discretion. Immediately afterwards, the crew increased their rate of descent to over 2200 ft/min and maintained this until a final recorded radio altitude (RA) of just under 250 ft, which they reached over the threshold of runway 21.

The crew then initiated a climb to an RA of approximately 600 ft, turned a little to the left and then flew parallel to the runway centre line. The landing gear was extended and the flaps were set to 20 degrees with a high probability. At the end of runway 21 the crew initiated a right turn onto the downwind leg, during which they reached a bank angle of 55 degrees; in the process their speed increased from 110 to 130 knots.

Abeam the threshold of runway 21, the crew turned onto the final approach on runway 21. The bank angle in this turn reached up to 62 degrees, without the speed being noticeably increased. The aircraft then turned upside down and crashed almost vertically.

Both pilots suffered fatal injuries on impact. A power line was severed, causing a power failure in the Upper Engadine valley. An explosion-type fire broke out. The aircraft was destroyed.

Causes

The accident is attributable to the fact that the aircraft collided with the ground, because control of the aircraft was lost due to a stall.

The following causal factors have been identified for the accident:

- The crew continued the approach under weather conditions that no longer permitted safe control of the aircraft.
- The crew performed a risky manoeuvre close to ground instead of a consistent missed-approach procedure.

The fact that the flight information service did not consistently communicate to the crew relevant weather information from another aircraft was a contributing factor to the genesis of the accident.

As a systemic factor that contributed to the genesis of the accident, the following point was identified:

- The visibility and cloud bases determined on Samedan airport were not representative for an approach from Zernez, because they did not correspond to the actual conditions in the approach sector.

Safety recommendations

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

In accordance with Annex 13 of the ICAO, all safety recommendations listed in this report are addressed to the supervisory authority of the competent State, which must decide on the extent to which these recommendations are to be implemented. However, every agency, undertaking and individual is invited to attempt to improve aviation safety in the sense of the issued safety recommendations.

In the Ordinance on the Investigation of Air Accidents and Serious Incidents, Swiss legislation provides for the following regulation:

"Art. 32 Safety recommendations

[1] DETEC shall address implementation assignments or recommendations to FOCA, based on the safety recommendations in the reports from SAIB or on the foreign reports.

[2] FOCA shall inform DETEC regularly about the implementation of the assignments or recommendations.

[3] DETEC shall inform the SAIB at least twice a year about the progress made by FOCA with implementation."

1 Factual information

1.1 History of the flight

1.1.1 General

The radiotelephony recordings, the radar data, the observations of eye-witnesses, the recordings of the enhanced ground proximity warning system (EGPWS) and the computations based on video recordings were used for the following description of the history of the flight. On the basis of the existing documents and statements, it can be concluded that at least during the last part of the accident flight the commander was acting as the pilot not flying (PNF) and the copilot as the pilot flying (PF).

The flight was conducted as far as the Samedan region in accordance with instrument flight rules (IFR) according to an ATC flight plan Y[1]. The approach in Samedan with the subsequent level flight over the airport and the renewed approach on runway 21 took place under visual flight rules (VFR).

The analysis of the flight path and attitudes permits the conclusion that, at least after completion of the flight under instrument flight rules, the autopilot was not used.

1.1.2 Pre-flight history

1.1.2.1 Crew

Aircraft D-IAYL was flown on a ferry flight on 10 December 2010 from Berlin-Schönefeld (EDDB) to Milano-Linate (LIML). After maintenance work on the electrical system had been carried out, the aircraft was flown on 16 December 2010 by the commander involved in the accident and a copilot from the operator to Roma-Ciampino (LIRA) and from there on 17 December via Milano-Linate (LIML) and Nice (LFMN) to Zagreb (LDZA).

According to information from the operator, the aircraft was fully refuelled on arrival in Zagreb. The tank receipt shows that 359.8 US gallons (1362 l or 2389 lb) of fuel were filled up.

1.1.2.2 Flight information service

The Samedan airport Flight Information Service consisted basically of two working positions: one working position called "Samedan Information", which informed pilots by radio and one working position "Coordination", where flight plans of arriving and departing aircraft were coordinated, weather observations were encoded and automatic terminal information service (ATIS) reports were prepared for automatic transmission.

The flight information service officer (FISO A), working at the "Samedan Information" position at the time of the accident, had already been assigned to this position between 09:00 UTC and 10:30 UTC on the same day. According to the tower logbook, he took over again from his colleague, FISO B, at 13:56 UTC. Before this, he had been next to his colleague FISO B at the workstation for some considerable time.

[1] ATC flight plan Y: flight plans which are addressed to air traffic control (ATC) and which envisage the first part of the flight under instrument flight rules and the conclusion of the flight, including the landing, under visual flight rules.

FISO C was at the working position "Coordination". He was mainly busy with coordination tasks, operated the telephone, produced the meteorological aerodrome report (METAR) and was responsible for issuing the ATIS. As a former air traffic controller, in re-training to become a FISO, he carried out these tasks independently, i.e. without supervision (cf. chapter 1.5.2.3).

1.1.2.3 Air traffic with destination Samedan

On 19 December 2010 several operators had planned to make flights to Samedan airport. A total of 13 aircraft were notified. These had submitted either an ATC flight plan Y or a VFR flight plan. Eight of these flights were scheduled with business jets, four with turboprop aircraft and one with a single-engine piston aircraft.

A turboprop aircraft landed in Samedan at 12:00 UTC and a business jet aircraft at 13:14 UTC. Six other business jets, as well as three turboprop aircraft, either aborted their approach early or did not attempt an approach at all. A single-engine piston aircraft landed at 13:36 UTC (cf. chapter 1.18.1).

1.1.3 Flight preparations

For the preparation of the flight, the crew used the crew briefing information packet provided by the operator. Apart from the weather information (cf. chapter 1.7.8), this included a computer company flight log with a corresponding fuel calculation.

The fuel calculation was based on criteria defined by the operator in Operation Manual A (OM A) in section 8.1.7. The minimum block fuel was indicated as 3000 lb (1361 kg) and the take-off mass with this quantity of fuel was specified as 11 792 lb (5349 kg).

Since the aircraft had been fully refuelled on 17 December, it can be assumed that before the flight the crew had available 3670 lb (1665 kg) of fuel, equal to the maximum fuel capacity.

The take-off mass was 12 462 lb (5653 kg), which was closed to the maximum permissible take-off mass of 12 500 lb (5670 kg).

Before take-off in Zagreb the aircraft was de-iced between 12:33 UTC and 12:38 UTC with type I fluid 50%.

1.1.4 History of the flight

On 19 December 2010, the Raytheon 390 aircraft, registration D-IAYL, took off under flight number QGA 631V and radio callsign Quadriga 631V at 13:01 UTC from Zagreb (Croatia) on a commercial flight, which was to be flown for the majority of the flight under instrument flight rules and which envisaged an approach with landing under visual flight rules in Samedan (ATC flight plan Y). On board were two crew members. After an uneventful flight, the crew of D-IAYL reported at 13:45:02 UTC to the Zurich sector south air traffic controller (ATCO) as follows: *"Swiss Radar, grüezi, ah, Quadriga six three one Victor, flight level two hundred inbound RESIA"*.

The ATCO then informed the crew that he had identified their aircraft on the radar and instructed them to select a new transponder code. Shortly after the aircraft had passed waypoint RESIA, the ATCO informed the crew as follows: *"Quadriga six three one Victor, descend to flight level one seven zero, minimum IFR flight level in airspace Charlie, report when ready to cancel."* The crew confirmed this message and then requested: *"request ah heading north"*, which was granted by the ATCO (cf. Annex 1).

At 13:51:14 UTC, the ATCO gave the crew of D-IAYL the following clearance: *"Quadriga six three one Victor, you may navigate over the field at own convenience."* The crew answered then: *"That's copied, but we are still erm maintaining erm under Radar control, please"*, which was acknowledged by the ATCO with *"affirm"*. At this time, the aircraft was over the village of Bever at FL 186.

At 13:51:58 UTC, the crew of QGA 631V informed the ATCO as follows: *"And for information, Quadriga, take heading zero six zero"* and one minute later the crew requested a change of flight rules: *"And ah Quadriga six three one Victor, request to cancel IFR."* At this time, the aircraft was 10 km southwest of Zernez at FL 170. The ATCO confirmed this message and went on to inform the crew: *"(…), no reported IFR traffic below you, joining descent is approved."* The crew continued to fly for approximately 30 seconds on heading 060 degrees, before turning east for approximately 50 seconds. On this heading the ATCO requested the crew at 13:54:01 UTC to contact Samedan Information on the 135.325 MHz frequency. The crew answered then: *"(…), but we would like to maintain for the next ah two minutes on your frequency, if this is possible."* The ATCO granted this.

The crew then turned onto a north-easterly heading and made a 180 degree turn to the left in a south-westerly direction. The aircraft was on a south-westerly heading, approx. 5 km south of Zernez, when the crew informed the ATCO at 13:57:12 UTC that they would now switch to the Samedan Information frequency.

The crew of D-IAYL reported at 13:57:39 UTC to Samedan Information as follows: *"Samedan info from Quadriga six three one Victor, we are descending one hundred inbound Echo point."* The Samedan FISO A, who had taken over his workstation from his colleague, FISO B, shortly before, answered this call and requested the crew: *"(…), report one zero miles final runway two one."* The crew immediately reported as follows: *"Wilco, we have one zero miles runway emm…two one."* The aircraft was at this time approximately eight miles north-east of the threshold of runway 21 at an altitude of approximately 11 000 ft AMSL. FISO A then requested the crew to report at six miles distance from the threshold of the runway on final approach. At approximately the same time, at 13:58:04 UTC, the radar recordings end, since the airplane had left the radar coverage area. The last recorded flight level was FL 104.

At an earlier time, at 13:42:56 UTC, the crew of a Piaggio 180 had reported to Samedan Information and had inquired about the weather (cf. chapter 1.18.1). At this time this function was still being provided by FISO B.

At 13:58:16 UTC, FISO A then enquired about the position of the Piaggio 180. Its crew then reported that they were over the airfield at flight level 170, still flying under instrument flight rules and in contact with Zurich Radar.

FISO A then informed the crew of the Piaggio that QGA 631V was at a distance of between ten and six miles on final approach on runway 21. The crew of the Piaggio 180 then asked Samedan Information whether the conditions for an approach were still in order. Before FISO A was able to answer, the crew of QGA 631V provided the following information at 13:58:46 UTC:*"Yes, for the moment good condition, Quadriga six three one Victor."*

At 13:59:12 UTC, D-IAYL was at this time slightly north-east of Zuoz; the crew again reported to FISO A and asked: *"…Quadriga…actual weather on the airfield?"* FISO A did not understand the question and asked the crew to repeat the question, which the crew of QGA 631V did. FISO A then answered at 13:59:27 UTC:*"Quadriga six three one Victor, visibility three or four kilometres cloud base few at two thousand feet and overcast at five thousand or six thousand feet."* At this time, D-IAYL was slightly south-west of Zuoz at a height of approximately

1200 ft above ground and was flying at a speed of approx. 150 knots (cf. Annex 2).

FISO A, who had taken over the Samedan Information workstation from FISO B, had already been sitting next to FISO B for some time before the change-over. In the process, he noticed that FISO B was informing the crew of an approaching Cessna Citation C56X, at 13:40:00 UTC, on the basis of information from the Siai Marchetti SF260 approaching immediately ahead, that on the approach for the last three miles before the runway there was marginal visibility and a very low cloud ceiling: *"For information during the approach the last three miles the visibility is marginal, the ceiling is very low about 6300 feet".* This information caused the crew of the approaching Cessna Citation C56X to abort their approach, initiate a go-around and divert to their alternate airport (cf. chapter 1.18.1).

At 13:59:42 UTC, the crew of QGA 631V reported that they were at five miles on final approach. According to the recordings of the EGPWS, the aircraft was at this time over Madulein, approximately four miles before the threshold of runway 21. FISO A then said: *"Quadriga six three one Victor, wind two zero zero degrees one zero knots land at own discretion runway two one"*, to which the crew replied *"own discretion"*.

The crew subsequently increased their rate of descent (ROD) to an average of 2240 ft/min until the last recorded radio altitude (RA) of 247 ft above ground, which they reached directly over the runway threshold at 14:00:59 UTC (cf. point 1 in Annex 3). During this final approach the alerts of the EGPWS sounded in rapid succession *"sinkrate!", "pull up!"* and then again *"sinkrate!"* (cf. Annex 2). The speed was then approximately 160 knots. The crew stopped the descent and initiated a climb to an RA of approx. 600 ft above ground (cf. Annex 3). At this height and at an average speed of 115 to 120 knots the aircraft made a partial left turn to the south and then flew parallel to the runway centre line. The aircraft had extended its landing gear and the flaps were, with a high probability, set at 20 degrees. At this time FISO A had visual contact with the aircraft and when the Piaggio crew reported that they were now coming in for an approach FISO A responded at 14:01:12 UTC: *"(…) copied preceding traffic is short final…..is now just going around report final runway two one."*

Shortly afterwards, at 14:01:27 UTC, the crew of QGA 631V reported as follows: *"…and emm Quadriga six three one Victor turning right."* For the next 20 seconds or so the frequency remained blocked. The aircraft then initiated a right turn at the end of runway 21. The bank angle in this turn was up to 55 degrees and the speed increased from 110 KCAS[2] to 130 KCAS. In this phase the EGPWS triggered the alert *"bank angle!"* (cf. Annex 3).

A few seconds later, when the aircraft was on the downwind leg, abeam the threshold of runway 21, FISO A informed the crew of QGA 631V at 14:02:10 UTC as follows: *"Quadriga six three one Victor wind two two zero degrees eight knots you may land any time runway two one."* The crew of QGA 631V then answered *"yes"* and *"roger"*.

At the same time, aircraft D-IAYL turned onto the base leg of runway 21. The EGPWS again triggered the alert *"bank angle!"*. The bank angle in this turn was up to 62 degrees to the right and the recordings show that the aircraft then turned upside down. The airspeed in this phase was approximately 115 KCAS. The vast majority of the eye and ear witnesses did not notice any change in engine power

[2] KCAS: knots calibrated airspeed; corrected airspeed in knots. In the present case almost equal to the indicated airspeed in knots (knots indicated airspeed – KIAS).

during this turn. The airplane then fell almost vertically and impacted the ground between the perimeter fence of the Bever powerplant substation and the "Beverin" brook, a tributary of the En.

The crew suffered fatal injuries in the crash. The airplane burst into flame in an explosive manner and was destroyed.

1.1.5 Accident location

Accident location	Bever, municipality Bever/GR
Date and time	19 December 2010, 14:02 UTC
Lighting conditions	Daylight
Coordinates	787 897 / 158 221 (swiss grid 1903) N 46° 32' 55.93'' / E 009° 53' 20.11'' (WGS 84)
Elevation	1710 m/M 5610 ft AMSL
Final position of the wreckage	800 m north of the threshold of runway 21 of Samedan airport (LSZS), at the south-west boundary of the Bever powerplant substation
Map of Switzerland	Sheet no. 1257, St. Moritz, scale 1:25 000

1.2 Injuries to persons

1.2.1 Injured persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	2	0	2	0
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	Not applicable
Total	2	0	2	0

1.2.2 Nationality of the occupants of the aircraft

The two crew members were German citizens.

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

A power line from the Bever powerplant substation, owned by Repower Klosters AG and primarily used to supply power to the Upper Engadine valley and to feed the RhB electricity network, was severed. This led to a power failure in the affected area. The power failure at Samedan airport lasted from 14:02 UTC to 15:22 UTC.

The south perimeter fence of the powerplant substation in Bever was destroyed.

Approximately 20 cubic metres of soil were contaminated by fire and kerosene and had to be disposed of using special measures.

1.5 Personnel information

1.5.1 Flight crew

1.5.1.1 Commander

Person	German citizen, born 1962
Licence	Air transport pilot licence aeroplane (ATPL(A)) in accordance with the conventions of the International Civil Aviation Organisation (ICAO) first issued by the Austrian civil aviation authority Austro Control on 26 August 2009, valid till 20 November 2014.
Ratings	Type rating C525 as pilot in command, valid till 25 October 2011. Type rating RA390 as pilot in command, valid till 7 October 2011. Class rating for single engine piston (SEP), valid till 30 September 2011. Language proficiency: English level 4, valid till 25 February 2012 German level 6, valid unlimited
Instrument flying rating	Instrument flight aircraft IR(A), valid till 7 October 2011
Last proficiency check	Proficiency check RA390 PIC/RA on 26 August 2010
Medical fitness certificate	Class 1 restrictions VNL (shall have available corrective lenses) valid from 15 November 2010 till 29 November 2011
Last medical examination	15 November 2010
Commencement of pilot training	1994

The commander had first acquired a commercial pilot licence (CPL) on the aircraft types Piper PA-23, 30, 31, 34, 39 and 44 on 2 June 1997, issued to him by the German Federal Aviation Office.

The commercial pilot licence CPL (A) issued in 2003 by the German Federal Aviation Office was transferred to Ireland in 2005 and on 18 October 2005 the commander received from the Irish Aviation Authority a commercial pilot licence in accordance with joint aviation requirements (JAR).

1.5.1.1.1 Flying experience

Total	4306:17 hours
of which as commander	3506:17 hours
on the accident type	244:14 hours
of which as commander	244:14 hours
during the last 90 days	98:37 hours

of which on the accident type	81:12 hours

The commander was employed in 2005 as a commander by Windrose Air Jet-charter on a freelance basis.

According to information from the operator, the commander flew to Samedan three times in 2006 on a Citation C 525 aircraft. He flew to Samedan with the co-pilot involved in the accident once, on 8 February 2010, on a Raytheon 390.

1.5.1.1.2 Duty times

Start of duty in the 48 hours before the accident	on 17 December 2010, 06:25 UTC on 18 December 2010, off duty on 19 December 2010, 11:45 UTC
End of duty in the 48 hours before the accident	on 17 December 2010, 13:00 UTC on 18 December 2010, off duty
Flight duty times in the 48 hours before the accident	on 17 December 2010, 6:35 hours on 18 December 2010, off duty
Rest times in the 48 hours before the accident	over 24 hours
Flight duty time at the time of the accident	2:17 hours

1.5.1.2 Copilot

Person	German citizen, born 1981
Licence	Commercial pilot licence aeroplane (CPL(A)) according to joint aviation requirements (JAR), first issued by the German Federal Aviation Office on 3 January 2006, valid till 19 September 2015.
Ratings	Type rating RA390 as pilot in command, valid till 29 August 2011. Comments: ATPL theory credit, MCC radiotelephone privileges: german and english, flights according to IFR and VFR
Instrument flying rating	Instrument flight aircraft IR(A), valid till 29 August 2011
Last proficiency check	Proficiency check RA390 PIC/IR on 28 July 2010
Medical fitness certificate	Class 1 no restrictions, valid from 1 April 2010 to 31 March 2011.
Last medical examination	30 March 2010
Commencement of pilot training	2003

1.5.1.2.1 Flying experience

Total	1071:20 hours
on the accident type	567:34 hours

during the last 90 days	82:40 hours
of which on the accident type	82:40 hours

The copilot was taken on permanently in August 2008 as a copilot by the Windrose Air Jetcharter company. At the same time he was given approval to work for another operator. The copilot was employed as a freelance pilot with this company from 1 September 2008, on the same aircraft type (Premier 1). On 28 July 2010 the copilot was promoted to commander within this company on the occasion of a successful check flight. From this time, he was deployed within this company alternatively as commander in the left-hand seat and as copilot in the right-hand seat.

The copilot completed his last assignment for this operator on 23 November 2010. He had never made a flight to Samedan for this company.

The only known flight to Samedan by the copilot before the accident flight was on 8 February 2010, together with the commander who was also involved in the accident.

1.5.1.2.2 Duty times

Start of duty in the 48 hours before the accident	on 17 December 2010, off duty, travel to Zagreb on 18 December 2010, off duty on 19 December 2010, 11:45 UTC
End of duty in the 48 hours before the accident	on 17 December 2010, off duty on 18 December 2010, off duty
Flight duty times in the 48 hours before the accident	off duty
Rest times in the 48 hours before the accident	over 24 hours
Flight duty time at the time of the accident	2:17 hours

1.5.2 Flight Information Service Officer

1.5.2.1 FISO A

Person	Swiss citizen, born 1986
Start of duty on the day of the accident	07:58 UTC
Licence	Safety related task (SRT) licence, AFIS rating first issued by the Federal Office of Civil Aviation (FOCA) on 1 June 2009, valid till 31 May 2011. Language endorsements: English level 4, valid till 27 April 2012
Medical fitness certificate	Class SRT, issued on 28 September 2009, valid till 30 September 2011

The Engadin Airport AG employed FISO A on 14 April 2008. He completed his training as a FISO with the company Sky Watch AG, a subsidiary company of Engadin Airport AG.

1.5.2.2 FISO B

Person	Italien citizen, born 1978
Start of duty on the day of the accident	06:23 UTC
Licence	Safety related task (SRT) licence, AFIS rating first issued by the Federal Office of Civil Aviation (FOCA) on 1 June 2009, valid till 31 May 2011. Language endorsements: English level 4, valid till 29 June 2012
Medical fitness certificate	Class 3, issued on 5 October 2010, valid till 13 October 2012. Restrictions: VDL (shall wear corrective lenses)

1.5.2.3 FISO C

Person	Swiss citizen, born 1954
Start of duty on the day of the accident	06:43 UTC
Licence	Air traffic controller licence ADI (aerodrome control instrument) first issued by the FOCA on 9 August 1994, valid till 16 August 2010 Language endorsements: English level 5, valid till 1 December 2013
Medical fitness certificate	Class 3, issued on 30 November 2010, valid till 30 November 2011. Restrictions: VDL (shall wear corrective lenses)

FISO C was a trained air traffic controller who no longer possessed a valid licence. He was in re-training to become a FISO and therefore in principle had to work under supervision. He received the FISO license after passing the examination on 20 December 2010.

1.6 Aircraft information

1.6.1 General information

Registration	D-IAYL
Aircraft type	Raytheon 390 (Beech 390 Premier 1A)
Characteristics	Low-wing, twin-engine executive jet
Manufacturer	Hawker Beechcraft Corporation (formerly Raytheon Aircraft Company)
Year of manufacture	2008
Serial number	RB-249
Owner	SG Equipment Finance Schweiz AG

	Gladbacherstr. 105, 8044 Zurich, Switzerland
Operator	Windrose Air Jetcharter GmbH Berlin-Schönefeld Airport, GAT, 12521 Berlin, Germany
Engines	Williams International FJ-44-2A Left: Year of manufacture 2008, Serial number 105409 Right: Year of manufacture 2008, Serial number 105410
Operating hours	Airframe 1047:24 hours Engines 1047:24 hours
Number of landings	820
Max. permitted masses	Take-off mass 12 500 lb (5670 kg) Landing mass 11 600 lb (5262 kg)
Mass and centre of gravity	The mass of the aircraft at the time of departure was 12 462 lb (5653 kg). The mass of the aircraft at the time of the accident was approximately 10 900 lb (4944 kg). Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM).
Maintenance	The last scheduled maintenance work (200/1000-hour) took place on 9 November 2010 in Berlin at 1008:30 hours. On 10 December 2010, at 1042:50 hours and 815 landings, repairs were carried out on the electrical system in Milano.
Technical limitations	None registered
Permitted fuel grade	JET A1 kerosene
Fuel	According to the flight plan, take-off fuel was 3579 lb (1623 kg). Among other things, this included trip fuel of 1390 lb (630 kg). The remaining 2189 lb (993 kg) would have been sufficient for diverting to the alternate airport and for holding for 126 minutes, without having to use the final reserve of 349 lb (158 kg).
Registration certificate	Issued by the German Federal Republic on 27 January 2009, valid till removal from the aircraft register.
Airworthiness certificate	Issued by the German Federal Republic on 27 January 2009, valid till suspension or revocation.
Certification	Private / commercial
Category	VFR/IFR day and night

Icing Conditions
RVSM, MNPS
RNP 5, BRNAV
LVTO

1.6.2 Cockpit equipment

Aircraft D-IAYL was equipped among other things with an integrated flight information system (IFIS) of the Collins Proline 21 type, consisting of a file server unit (FSU) and a cursor control panel (CCP). This IFIS enabled the crew to display electronic charts (e-charts), enhanced maps (e-maps) and graphical weather information (GWX) on their multifunction display (MFD). In this context it has to be mentioned that the GWX function is not available in Europe.

This made it possible for the crew to display on their screens the Samedan approach charts as published by Jeppesen as electronic charts.

1.6.3 Ground proximity warning system

Aircraft D-IAYL was equipped with an enhanced ground proximity warning system (EGPWS) of the Allied signal MK V type.

The EGPWS produces visual and aural alerts when the aircraft comes dangerously close to the ground. The EGPWS also generates aural altitude information to inform the pilots about convergence with the runway during landing. In addition it warns of wind shear and generates enhanced information about the terrain surrounding the current position of the aircraft, among other things by means of a database.

The enhanced ground proximity warning computer (EGPWC) monitors and processes certain signals from the aircraft and correlates them with the above-mentioned data. If the aircraft, in terms of configuration and spatial position, is in a condition which without correction would lead to a critical situation within a short time, a corresponding alert is triggered. These alerts are sub-divided into seven different modes.

- *mode 1* *excessive descent rate*
- *mode 2* *excessive terrain closure rate*
- *mode 3* *altitude loss after take off*
- *mode 4* *unsafe terrain clearance*
- *mode 5* *descent below glideslope*
- *mode 6* *call outs*
- *mode 7* *windshear warning*

For each mode there are defined aural and visual alerts; the aural alerts are provided by a synthetic voice. If multiple aural alerts are triggered at the same time, they have different levels of urgency.

Furthermore, on aircraft D-IAYL in mode 6 call outs the "bank angle" alert was activated. The manufacturer describes this, among other things:

"Bank angle can be used to alert crews of excessive roll angles. The bank angle limit tightens from 40 degrees at 150 feet AGL to 10 degrees at 30 feet AGL to help alert the crew of excessive roll corrections on landing which might result in a wing tip or propeller scrape. The alert is also useful to help the pilot of severe overbanking which might occur from momentary disorientation…"

The alerts generated by the EGPWS can be partially suppressed. The point of this suppression is to prevent the corresponding alerts sounding continuously in the event of certain system faults. The suppression is explicitly addressed in the corresponding abnormal checklist. Thus, for example, the TAD (terrain alerting and display) and TCF (terrain clearance floor) can be switched off by pressing the TERR INHIB (terrain inhibit) push button such that the corresponding alerts and commands such as "caution terrain" – "terrain, terrain, pull up" or "caution obstacle" – "obstacle, obstacle, pull up" and "too low terrain" – "terrain, terrain, pull up" consequently do not sound.

If certain threshold values are exceeded, the EGPWS computer saves a data record which retains all the parameters monitored by the EGPWS for 40 seconds, i.e. from 20 seconds before until 20 seconds after the event, at a one second rate.

Therefore, for the final part of the flight, which was not recorded on the radar for technical reasons, accurate information on airspeed, heading, altitude, position and various other parameters in the EGPWS was recorded for about 120 seconds. It was possible to read this out after the accident and use it to reconstruct the flight path. It should be noted that there are gaps in the corresponding parameters in the presentation due to the time constraints of the recording (cf. Annexes 2 to 4).

On the flight in question, according to these recordings, the following alerts were triggered sequentially:

"caution terrain";

"sinkrate";

"sinkrate – pull up";

"sinkrate"; "bank angle" (cf. Annexes 2 - 4)

1.6.4 Limitations

In the manufacturer's airplane flight manual (AFM) the following airspeed values, among other things, are published in Section 2 Limitations (knots indicated airspeed – KIAS):

V_{FE}/V_{FO} (Flaps 10) (S.L. to 20,000 ft) 200
V_{FE}/V_{FO} (Flaps 20) (S.L. to 20,000 ft) 200
V_{FE}/V_{FO} (Flaps DN) (S.L. to 20,000 ft) 170
V_{LE} 200
V_{LO} (Extension) 200
V_{LO} (Retraction) 180
V_{MCA} (Flaps UP) 104
V_{MCA} (Flaps 10) 100
V_{MCA} (Flaps 20) 96
V_{MCA} (Flaps DN) 93

V_{FE}/V_{FO} maximum speed with flaps extended/maximum speed for flap operation
V_{LE} maximum speed with landing gear extended
V_{LO} maximum speed for landing gear operation
V_{MCA} minimum control speed in the take off configuration out of ground effect with one engine inoperative and the remaining engine at take off thrust

1.7 Meteorological information

1.7.1 General

The information in chapters 1.7.2 to 1.7.4 and 1.7.6 was provided by Meteo-Swiss. The information in chapter 1.7.5 originates from the Samedan airport recordings. The information in chapter 1.7.8 relies on observations of eye-witnesses. The information in chapter 1.7.9 was available to the crew for the preparation and execution of the flight.

1.7.2 General meteorological situation

[Translated from German]: The Alpine region was within the area of a strong west to south-west high-altitude airflow, causing a strong Föhn wind in the Alps. The northern parts of the country were affected in the morning by a warm front; in the afternoon Switzerland was in the warm sector.

1.7.3 Weather at the time and location of the accident

On the basis of the listed information, it is possible to conclude that the weather conditions at the time and in the area of the accident were as follows:

Cloud	*1-2/8 at 8100 ft AMSL, 7/8 at 9600 ft AMSL*
Weather	*Light snowfall*
Visibility	*Approx. 2-3 km*
Wind	*South-west wind at 5 kt, gusting to 10 km*
Temperature/dewpoint	*-06 °C / -10 °C*
Atmospheric pressure	*QNH LSZS 1002, LSZA 1011 hPa, LSZH 0998 hPa*
Hazards:	*Diffuse visibility due to light snowfall*

[Translated from German]: On the Corvatsch camera images the cloud can be seen extending to just above the summit. On the image of Samedan aerodrome, it is possible to see the reduced visibility conditions due to the light snowfall (Annexes 8 and 9).

1.7.4 Astronomical information

Position of the sun:	Azimuth: 218° elevation: 11°
Lighting conditions	Daylight

1.7.5 Aerodrome meteorological reports

In the period from 13:20 UTC up to the time of the accident, the following meteorological aviation routine weather report (METAR) applied:

LSZS 191320Z 21008KT 6000-SN BR FEW025 BKN040 M06/M11 Q1002 NOSIG=

LSZS 191350Z 20008KT 170V230 3000-SN BR FEW025 BKN040 M06/M10 Q1002 NOSIG=

LSZS 191420Z NIL=

In clear text, this means for the second METAR: on 19 December 2011, shortly before the 13:50 UTC issue time of the aerodrome weather report, the following weather conditions were observed:

Wind	From 200° at 8 kt, varying from 170° to 230°

Meteorological visibility	3 km with light snowfall and damp mist
Cloud	1-2 eighths at 2500 ft AAL
	5-7 eighths at 4000 ft AAL
Temperature/dewpoint	- 6 °C / - 10 °C
Atmospheric pressure	1002 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Trend forecast	No significant changes were expected over the next 2 hours

1.7.5.1 ATIS reports from Samedan Airport

On 19 December 2010 an ATIS was issued by Samedan airport at 06:50 UTC and hourly from 07:20 UTC.

LSZS 11:20 UTC, Information FOXTROT:

"Runway in use 21; wind 220 degrees, 6 knots; visibility 8000 meters; showers in the vicinity; clouds few at 2500 feet, broken at 6000 ft, overcast FL130; temperature minus 6, dewpoint minus 11; QNH 1002"

LSZS 12:20 UTC, Information GOLF:

"Runway in use 21; wind 220 degrees, 4 knots; visibility 7000 meters; light snow; clouds few at 2500 feet, broken at 6000 ft, temperature minus 6, dewpoint minus 11; QNH 1002"

LSZS 13:20 UTC, Information HOTEL:

"Runway in use 21; wind 210 degrees, 9 knots; visibility 5000 meters; light snow; clouds scattered at 2800 feet, broken at 6000 ft; temperature minus 6, dewpoint minus 10; QNH 1005"

At 13:45 UTC (overwritten by hand as 13:55 UTC) the following METAR/SPECI[3] was produced but not broadcast on the ATIS frequency:

WIND 200°/8 KTS VAR 170°/230°
VIS 3000 M
– SN, BR light snow, mist
FEW 2500 FT
BKN 4000 FT
-6/-11
QNH 1002 NOSIG

At 14:20 UTC no ATIS was issued, as the airport was closed due to power failure.

1.7.5.2 Reports on the condition of the runway

On the day of the accident Samedan airport published the following information on snow conditions in the area of the airport (SNOWTAM):

SNOW:

A) LSZS
B) 12191000
C) 03
F) 4/4/4

[3] SPECI: aerodrome special meteorological report; supplementary observations based on short-term, significant changes of the local weather.

G) 02/02/02
J) 50/3LR
T) RWY TWY APN HP CONT 100%

In clear text, this means:

The following runway condition was measured on 19 December 2010 at Samedan airport for runway 03 at 10:00 UTC:

- The entire length of the runway surface is covered with dry snow (observed on each third of the runway)
- For each third of the runway, the depth of the dry snow is 2 mm
- Banks of snow 50 cm high lie at a distance of 3 m to the left and right of the runway
- The runway, taxiways, apron and taxi holding positions are 100% contaminated.

This SNOWTAM was not amended during the course of the day. At the time of the accident the runway was free from snow and clearly visible.

Regarding amendments to the SNOWTAM due to changed conditions, ICAO DOC 8126 (Aeronautical Information Services Manual) states in section 6.6 SNOWTAM, among other things:

"(…). A new SNOWTAM is required whenever there is a significant change in conditions. (…)"

1.7.5.3 Aerodrome weather forecast

The following terminal aerodrome forecast (TAF) was valid for Samedan aerodrome:

LSZS 191125Z 1912/1921 20004KT 8000 FEW025 BKN060 PROB30 TEMPO 1912/1921 –SN=

In clear text, this means:

On 19 December 2010 at 11:25 UTC the following weather conditions were forecast for Samedan airport for the period between 12:00 UTC and 21:00 UTC:

Wind	from 200 degrees at 4 kt
Meteorological visibility	8 km
Cloud	1 – 2 eighths at 2500 ft AAL 5 – 7 eighths at 6000 ft AAL
Change	between 12:00 UTC and 21:00 UTC occasional light snowfall will occur, with a 30% probability.

1.7.6 Aviation weather reports, forecasts and warnings

Among other things, the following aviation weather reports, forecasts and warnings were issued for 19 December 2010:

1.7.6.1 General aviation meteorological information

General aviation meteorological information (GAMET) was forecast between 12 and 18 UTC for the "Eastern Alpine Switzerland" region:

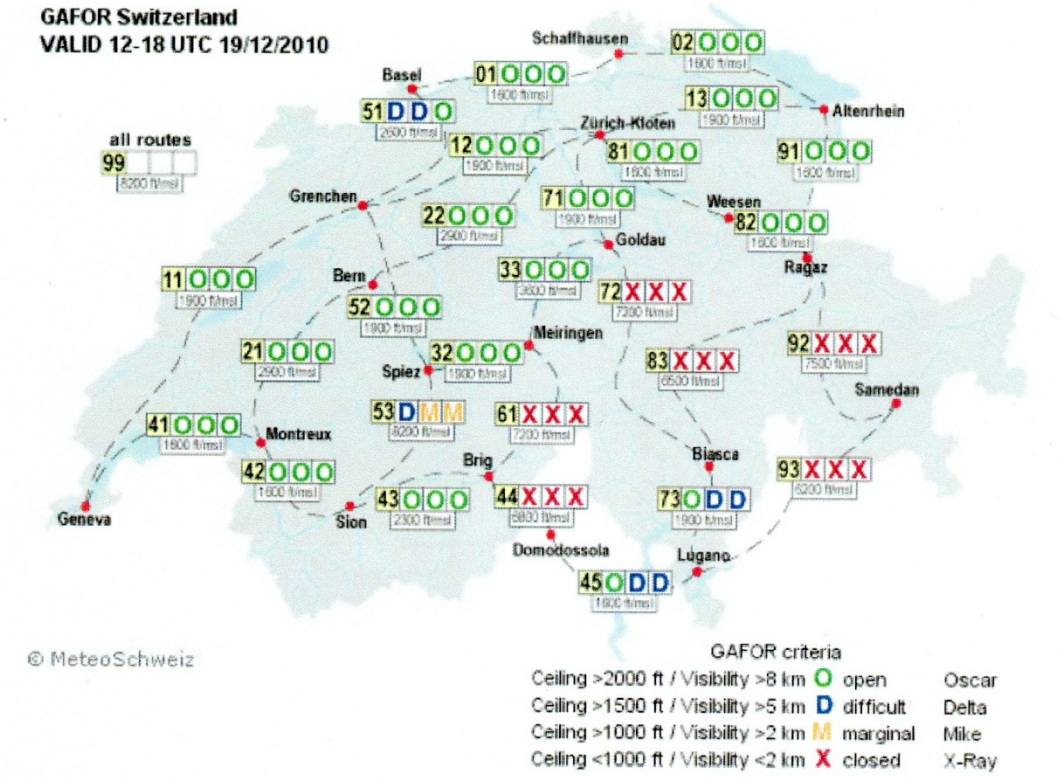
SFC GUSTS: 35KT
TURB: MOD SFC/FL140
Wind/Temperature at 13 000 ft AMSL 260/50kt MS16

Wind/Temperature at 8000 ft AMSL 210/30kt MS10
0°: SFC / 3500 FT/AMSL

1.7.6.2 General aviation forecast

General aviation forecasts (GAFOR) are published for certain routes. The location of the accident is in the vicinity of GAFOR routes 92 (Ragaz-Samedan) and 93 (Samedan-Lugano). The following forecasts were made for these routes:

GAFOR valid 12 – 18 UTC
Route 92: X X X
Route 93: X X X



Interpretation of weather categories:

O	open	no meteorological hindrance for visual flight
D	difficult	pilots trained in visual navigation can still fly
M	marginal	pilots highly trained in visual navigation and with precise knowledge of local conditions can still fly
X	closed	visual flight impossible

1.7.6.3 Airmen's meteorological information

The following airmen's meteorological information (AIRMET) was valid at the time of the accident:

LSAS AIRMET 5 VALID 191400 / 191700 LSZH-
LSAS SWITZERLAND FIR MOD TURB FCST ALPS AND N OF ALPS
SFC/FL140 STNR NC=

In clear text, this means:

In the period from 14:00 UTC to 17:00 UTC the following warning applied:

Name of the FIR	Flight information region (FIR) Switzerland
Weather phenomena	Moderate turbulence forecast
Area information	In the Alps and north of the Alps Gusts (ground wind) widespread (75%) ≥ 25 kt below flight level 140
Movement	Stationary
Intensity	No change

1.7.6.4 Significant meteorological warning

No significant meteorological warning (SIGMET) was issued on this day in the whole FIR/UIR Switzerland.

1.7.6.5 Aviation weather forecast

Regarding hazards, in the aviation weather forecast for Switzerland, valid from 12 to 18 UTC, the following was stated [translated from German]:

- *Alpine passes from the south mostly in cloud.*
- *On the north side of the Alps and above the Alps moderate to strong Föhnwind or south-westerly wind turbulence.*
- *In the event of precipitation moderate risk of icing between 4000 and 13 000 ft AMSL.*

1.7.7 Weather according to eye-witness statements

1.7.7.1 Statement of a helicopter pilot:

A helicopter pilot, whose homebase is located in Samedan and who was on the airport at the time of the accident, reported the following, among other things [translated from German]:

Weather: light snowfall with variable visibility. Cloud: broken approx. 2800-3000 m/M, ceiling not clearly detectable because of the snowclouds. Visibility outside of the dense snowcloud was less than 3 km. Inside the dense snowcloud approx. 800 m. The airplane was just visible on transition to the nose down attitude, which corresponds to a visibility of 2 km. NE of Bever there was a dense snow-cloud which seemed visually impenetrable. (…) The weather conditions on the flight to the site of the accident were characterised by light snowfall and diffuse lighting conditions, as usually found with driving snow.

1.7.7.2 Statement of a private pilot

A private pilot with an IFR rating, who had, before the time of the accident, been taking off and landing from Samedan airport for over 30 years, including 25 years as a flying instructor, and who spent several weeks every year in his holiday home in La Punt, stated the following about the weather, among other things [translated from German]:

(…). I was travelling in the car from the Lower Engadine to my appartment and arrived there a few minutes after the crash (…). So I was (…), so to say, driving behind the jet involved in the accident and the weather in approach sector 21 was as follows:

As is known, the Föhn wind prevailed, with an air mass flowing and descending down to the Lower Engadine, i.e. very dry, cloudless and with excellent visibility up to 20 km and more, but only towards the Lower Engadine. The Föhn had also forced heavy cloud, which filled the valley, from Maloja to behind the "Echo"

mandatory reporting point (in my experience somewhat unusually, generally only about as far as Sils). The cloud began exactly on the municipal border between Madulain and La Punt, like a tower, as if sliced vertically with a knife, ceiling easy to see from Zuoz, approx. 4000 ft above ground level. (…)

The weather below the cloud at the "Echo" mandatory reporting point: thick driving snow, sides of the valley only vaguely visible from the centre of the village, so generously speaking approx. 1 km visibility. Cloud base discernible with difficulty at 300-400 ft; I could detect wisps of fog. (…)

1.7.7.3 Statement of a meteorologist

The eye-witness is a professional meteorologist and lived in the immediate vicinity of Bever railway station. He saw the aircraft from his home shortly before the crash and stated the following, among other things [translated from German]:

(…). We came from Zernez about half an hour before. In Zuoz it began to snow and when we arrived in Bever it was snowing lightly. At the time of the accident, visibility was 500 to 1000 metres, in my opinion. Our house is about 200 to 300 metres from the site of the accident. The weather was very homogeneous. (…).

1.7.7.4 Statements of other eye witnesses around Samedan airport

A first eye-witness, who lived in Samedan, with a view of the airport, assessed the weather as follows [translated from German]: Towards St. Moritz visibility was good. You could see for about 3 km. Two thirds of the runway could be seen clearly. From Val Bever pronounced snowdrifts prevailed. From the Bever side, visibility was poor. In my estimation one could see about 1 km from the Bever side. In my view the weather was fairly stable for the half hour preceding the accident.

A second eye-witness, who was near the Bever schoolhouse, stated the following concerning the weather [translated from German]: There had been some light snowfall. Towards Samedan visibility was worse than towards La Punt. At this time there was very little wind. For half an hour before the crash the weather remained stable.

A third eye-witness, who at the time of the accident was approximately 300 m east of the threshold of runway 21, stated the following concerning weather [translated from German]: In the upper strata, the cloud was very thick. There had been heavy snowfall between Samedan and Bever. Nevertheless I would not describe visibility as poor. The wind was blowing from Maloja. However, it was not a constant wind. In my opinion the wind was blowing in gusts, before abating somewhat again. In the half hour preceding the accident I would describe the weather as stable.

Another eye-witness, who was at the same location, stated about the weather: *"It was snowing and the visibility was bad."*

1.7.8 Meteorological information available to the crew

The meteorological data provided by the contracted company included the following current weather report and weather forecast for Samedan, among other things:

SA 1911150Z 17009KT 6000 –SN FEW025 SCT035 OVC080 M06/M11 Q1002 NOSIG=

FC 191125Z 1915/1921 20004KT 8000 FEW025 BKN060 PROB30 TEMPO 1912/1921 –SN=

Moreover, the crew received a SIGMET for the FIR Milan and Rome, as well as a WIND/TEMPERATURE FL340 PROGNOSTIC CHART and a general chart relating to their flight route with information about the wind, temperature, tropopause, ice and turbulence.

GAMET, GAFOR, AIRMET and SNOWTAM data were not included in the documents provided.

1.8 Aids to navigation

No ground-based navigation aids were available on the airport. The airport could be approached only under visual flight rules (VFR).

1.9 Communications

Radiocommunications between the crew and the ground stations concerned took place without difficulties up to the time of the accident.

The recordings show a peculiarity: when turning onto the downwind leg, the crew of D-IAYL pressed the radio press-to-talk button for approximately 20 seconds without making any report.

From family members of the crew, it was possible to establish without doubt that the commander of D-IAYL had conducted the radio conversations with the FISO in Samedan.

1.10 Aerodrome information

1.10.1 General

Samedan airport is 5 km north-east of St. Moritz. The reference elevation is 1707 m, corresponding to 5600 ft AMSL and the reference temperature[4] was calculated at 17.8 °C. It is the highest airport in Europe. The airport reference point (ARP) has the coordinates N 46° 32’ 04” / E 009° 53’ 02”.

The licensed airport is used for public air transport and can be used by aircraft of all categories up to medium weight aircraft.

Samedan airport is an uncontrolled airport and may be used only under visual flight rules. Since the AIP does not publish any special visual flight minima for Samedan, among other things the following rules apply to Samedan airport for Class G airspace – uncontrolled airspace (VFR guide dated 13 March 2008, RAC 1-1, Airspace Classification, section 1.7) [translated from German]:

VMC minima	
Below FL 100 and up to 3000 ft AMSL	At or below 3000 ft AMSL or 1000 ft AGL (whichever is the greater):
Visibility 5 km Distance to cloud: horizontal 1500 m vertical 1000 ft	Visibility 5 km* Outside cloud with ground contact

*Regulation in Switzerland:
- Class G includes airspace from GND to 2000 ft/600 m AGL, outside TMA/CTR (for exception see RAC 1-1, page 33);

[4] The reference temperature used is the mean maximum temperature of the warmest month in the year.

- Visibility 5 km; if at any time airspeed allows a 180° turn within visibility distance and other aircraft or obstacles can be detected in good time, flight visibility down to 1.5 km may be permitted;
- (…)

For comparison, the daytime meteorological minima for military operation according to SAM 2 dated 23 October 2008 are a cloud base of 1300 ft AGL and visibility of 2000 m for aircraft with a mass of less than three tonnes, and a cloud base of 1300 ft AGL and visibility of 5000 m for a mass in excess of three tonnes.

The airport is open daily from 08:00 to 30 minutes after sunset or to 19:00 at the latest.

At present, there are no regular scheduled flights. In winter in particular, various aviation companies provide charter flights to Samedan using business aircraft.

In addition, various helicopter operators are accommodated and there is brisk glider traffic in the warmer months. The airport is also favoured by parachutists and flying schools.

1.10.2 Runway equipment

The asphalt runway of Samedan airport can be used only under visual flight rules (VFR) for take-offs and landings. Its dimensions are as follows:

Runway	Dimensions	Elevation of runway thresholds
03/21	1800 m (5906 ft) x 40 m	5601/5575 ft AMSL

The airport buildings and hangars and the majority of the stands for aircraft are located on the west side of the runway. The taxiway running parallel to the runway is on the east side of the runway. This can be reached from the tarmac via a taxiway which crosses runway 03/21.

As a result of previous military use of the airport, runways 03/21 have runway edge lights, approach lights and a precision approach path indicator (PAPI). According to information from the FOCA, these lighting systems could not be used for civil purposes, as they, at the time of the accident, were not in accordance with international standards and ICAO recommandations and therefore neither tested nor approved by the FOCA.

These systems are not listed in the Swiss Aeronautical Information Publication (AIP) or in the airport operating documents.

At the time of the accident, according to the FISO's statement, runway 21 was in service. On the printout of the computer records relating to traffic, runway 03 is listed as "in service".

1.10.3 Rescue and fire-fighting services

Samedan airport was equipped with Category 1 fire-fighting resources. A higher category, Category 4, for commercial traffic was possible on request within 3 hours of the scheduled arrival/departure time. Such requests had to be made 24 hours in advance.

A level 4 alarm was triggered on Samedan airport after the accident, i.e. an accident outside the airport. The airport's rescue and fire-fighting services were therefore not deployed. The cantonal police was informed by telephone at 14:07 UTC.

1.10.4 Aerodrome flight information service

In a letter dated 29 December 2006, Samedan airport received authorisation from the Federal Office for Civil Aviation (FOCA) to operate an aerodrome flight information service (AFIS) from 1 January 2007, valid initially for one year. On 1 June 2007 Samedan airport received from the FOCA the certificate as an air navigation service provider, valid until revoked.

In order to provide this aerodrome flight information service, Samedan airport employs flight information service officers (FISO), who require a licence to perform their duties. Unlike an air traffic controller (ATCO), the FISO is entitled only to transmit information to crews, but not to give them instructions. Their duties are specified in the ATMM (cf. chapter 1.17.3.2).

1.11 Flight recorders

1.11.1 Flight data recorder

Not prescribed, not installed.

1.11.2 Cockpit voice recorder

1.11.2.1 General information

Type	2100-1010-51
Manufacturer	L3-Communications
Year of manufacture	2008
Serial number	000535765
Recording	on 4 channels (one area microphone and three voice/audio channels)
Duration of recording	120 minutes

During the period from 14 to 26 September 2010 the cockpit voice recorder (CVR) was tested in the maintenance company's premises and found to be serviceable. According to the operator's statement, the CVR was installed in the aircraft at the time of the accident.

1.11.2.2 Search measures

Since there was snowfall immediately after the accident, securing of evidence and searching for important evidence such as the cockpit voice recorder (CVR) could not begin until the following day. The site of the accident was therefore guarded during the night.

All parts of the wreckage which were removed were sorted by hand and examined. The contaminated soil removed for disposal was washed, in order to recover any items of wreckage contained in it. In both cases neither the CVR nor parts of it were found.

In view of this, the search at the site of the accident was extended and the bed of the "Beverin" brook, which is a tributary of the En which flows past the location of the site of the accident, was included in the search. Since an underwater location device (ULD), attached to the CVR's memory unit, emits ultrasonic signals when immersed in water, the visual search was complemented by the use of appropriate devices which detect the ultrasonic signals from the ULD and make it possible to localise the source of the signal. The search ended without success.

A further visual search in the adjacent area could not be fully completed due to the snow situation. The workers at the adjacent powerplant substation and the police therefore searched the site of the accident at regular intervals and continued to find small individual parts of the wreckage. However, these regular searches were also fruitless with regard to the CVR.

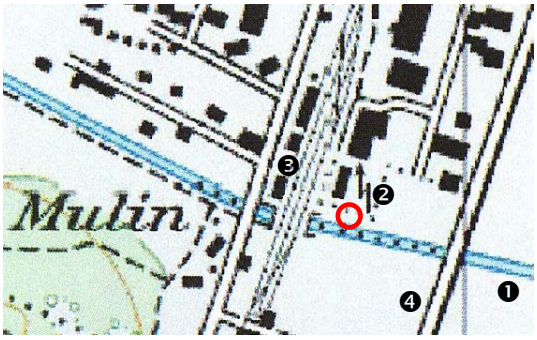
In a final attempt, the area was again searched intensively after the hay harvest. In addition to the visual search, a metal detector was also used. This search also ended without success.

1.12 Wreckage and impact information

1.12.1 Site of the accident

The accident site is located directly at the boundary between the river and the south fence of the Rätia Energie electricity company's Bever powerplant substation. The area was covered with snow and the river was partially frozen over (cf. Annex 11).

The accident location was secured by the Grisons cantonal police and guarded overnight, as securing of evidence and clearing of the site of the accident could not be performed until 20 December due to the snowfall and the impending dusk.



❶ Brook "Beverin", a tributary of the En
❷ Powerplant substation Bever (Repower)
❸ RhB railway station Bever
❹ Cantonal road Samedan-Bever

Figure 1: Map extract with the accident site ○

1.12.2 Impact

On the basis of the traces at the site of the accident and the statements of eyewitnesses it can be concluded that the aircraft crashed during a turn with an approximately vertical impact.

Analysis of the non-volatile memory of the EGPWS computer suggests an impact speed of approximately 125 kt (cf. chapter 1.16.2).

1.12.3 Wreckage

The debris field extended over a very small area, as a result of the virtually vertical dive before impact. The explosion-like fire which broke out therefore affected almost all the parts of the wreckage.

Figures 2 und 3: Horizontal stabilizer and tailcone (left); Debries after extinguishing the fire (right)

1.13 Medical and pathological information

The bodies of the pilots were subjected to an autopsy. It was found that both pilots suffered fatal injuries immediately. Also, no health restrictions which might have had an influence on the accident were found.

The toxicological analyses performed on both pilots gave no indications of alcohol, narcotic substances or medicines.

1.14 Fire

An explosion-like fire broke out on impact. According to the computations using the computer company flight log and the quantity of fuel refuelled before the flight, at the time of impact the aircraft still had approx. 2100 lb (953 kg) fuel on board.

1.15 Survival aspects

1.15.1 General

The accident was not survivable.

1.15.2 Emergency transmitter

The aircraft was equipped with an emergency locator beacon aircraft (ELBA), model C-406-2. The device was installed and was destroyed by the explosion-type fire on impact. However, the ELBA was able to send its address signal just once before it was destroyed. This was received on 19 December 2010 at 14:05 UTC by two COSPAS[5]-SARSAT[6] satellites.

1.15.3 Deployment of rescue and fire-fighting services

The emergency operations centre of the Chur cantonal police alerted the REGA at 14:05 UTC, which immediately sent a crew stationed on the airport in a helicopter to the site of the accident.

At the same time a FISO reported to the Chur cantonal police the triggering of alarm stage 4 in Samedan, which corresponds to an accident location outside the aerodrome.

[5] COSPAS – *Cosmicheskaya Sistyema Poiska Avariynich Sudov*: space-based system for searching for aircraft and vessels in distress.
[6] SARSAT - Search and Rescue Satellite Aided Tracking.

1.16 Tests and research

1.16.1 General

Since the aircraft was not equipped with a flight data recorder, the corresponding data was not available for analysis. However, new generations of computers contain so-called non-volatile memories (NVM), which record certain parameters, such that individual data are still available.

Furthermore, a surveillance camera set up for experimental purposes in the northern part of the village of Samedan recorded aircraft D-IAYL when, after the right turn over the end of runway 21, it flew from Samedan in the direction of Bever. It was possible to analyse the corresponding recordings (cf. chapter 1.19).

Because of the extent of the destruction, only two instruments could be forensically analysed (cf. chapter 1.16.5).

1.16.2 Behaviour of the engines

The engines were equipped with a new-generation engine control system. The N1 digital electronic engine control (DEEC) has a non-volatile memory (NVM), which records a limited number of engine data. The DEEC also categorises the limit exceedences of the N1[7], N2[8] and ITT[9] parameters. Because of the extent of the destruction, only the DEEC of engine number 1 could be analysed. This indicated that during the accident flight no limit values were exceeded or warnings recorded.

1.16.3 Behaviour in a turn

Aircraft D-IAYL was equipped with an enhanced ground proximity warning system (EGPWS) of the Allied Signal MK V type. If defined tolerance values were exceeded during the flight, the EGPWS computer recorded a data record of 40 seconds, i.e. 20 seconds before and 20 seconds after the event (cf. chapter 1.6.3). This data record contained among other things information concerning the bank angle and airspeed.

The recordings in the present case show that in the right turn at the end of runway 21, at a radio altitude (RA) of 550 ft, a maximum bank angle of 55 degrees was reached at an airspeed speed of 128 knots (cf. Annexes 3 and 4).

The stall speed is the speed at which the airflow breaks away from the wing surface causing an abrupt reduction in lift. This can result in loss of control of the aircraft. The stall speed is among other things dependent on the current mass of the aircraft, the bank angle and in particular of the position of the lift augmentation devices. The stall speed increases markedly as the bank angle increases.

According to the manufacturer (AFM, Section 5 Perf -2 and 3 Display), the stall speed of the Premier 1 aircraft with a mass of 10 900 lb and a flap setting of 20 degrees with no bank angle is 94 knots. At a bank angle of 55 degrees the stall speed is 124 knots.

At the beginning of the base turn at the end of the downwind leg at 14:02:09 UTC, a maximum bank angle of 62 degrees was recorded and at this time the

[7] N1: Revolutions per minute (RPM) of the low pressure compressor of a multi-shaft turbine engine, indicated in percent of the nominal speed.

[8] N2: Revolutions per minute (RPM) of the high pressure compressor of a multi-shaft turbine engine, indicated in percent of the nominal speed.

[9] ITT: Interstage turbine temperature: temperature between the high and low pressure turbine.

speed was 106 knots and reducing. The stall speed at this bank angle is 137 knots.

1.16.4 Level flight

It was possible to analyse the images from the surveillance camera to the extent that the aircraft's speed and its height above ground could be determined when it was on the downwind leg (cf. chapter 1.19). Within the area of the camera's viewing angle, the height above ground was 518 ft (□ 33 ft). The airspeed was between 140 and 143 knots.

These findings largely correspond to those recorded in the EGPWS. For the same period they indicate a radio altitude (RA) of between 530.5 ft and 570 ft and a groundspeed of between 140.4 and 145.5 knots.

The photographs taken by an eye-witness show that during this phase D-IAYL's landing gear was extended and the flaps were set at the 20 degree position.

1.16.5 Analysis of instruments

1.16.5.1 General

At the site of the accident only the standby airspeed indicator and the standby altimeter were found to be in a condition which permitted forensic investigation (cf. figures 4 and 5). Both instruments are situated in the centre of the forward panel and directly below the glareshield panel (cf. Annex 5).

Figure 4: *standby airspeed indicator*

Figure 5: *standby altimeter*

The method of stereomicroscopy using incident light at different, flat angles of incidence were applied, using among other things different excitation filters (fluorescence methods). Primarily, traces were sought which could have occurred on impact of the aircraft. In summary, the investigation produced the following results.

1.16.5.2 Airspeed indicator

The traces on the detached white pointer of the airspeed indicator indicate that the pointer touched the dial when it became detached. It was found that traces of abrasion are present which could have been produced by contact with a pointer on the one hand between the indicated values of 120 kt and 125 kt and on the other hand between the indicated values of 180 kt and 185 kt. The last airspeed recorded in the EGPWS before impact indicates a calibrated airspeed (CAS) of 122.2 kt, which approximately corresponded to the indicated airspeed (IAS) indi-

cated in the cockpit. It can therefore be assumed the marks between the indicated values of 120 kt and 125 kt occurred during the crash.

1.16.5.3 Pressure altimeter

There are no pointer marks on the dial; this can be explained by the fact that the pointer moved approximately 2 mm above the dial. The traces noted in connection with the indication show that the number drums concerned were indicating a value between 5700 ft and 5800 ft on impact. This does not correspond exactly with the tip of the pointer, which indicates a reading of 5830 ft. The point of impact is at an elevation of 5610 ft AMSL. In this context it must be borne in mind that the number drum for pressure indication must have read 1012 hPa on impact. It must be assumed the value was set at the standard pressure of 1013 hPa. This setting corresponds to a difference of 11 millibars from the local pressure at the time of the accident, which led to an altitude indication in the aircraft, which was 352 ft above the actual value. Since no pointer traces were found on the on the dial, however, no precise statements can be made concerning the actual pointer indication at the time of impact.

1.17 Organisational and management information

1.17.1 The operator

1.17.1.1 General

Windrose Air Jet charter was a German operator based in Berlin. It was founded in 1990. The operator's home airport was Berlin-Schönefeld. Windrose Air Jetcharter operated business and private charter flights, as well as cargo and ambulance flights.

At the time of the accident the operator had a fleet of different jet aircraft types, such as the Bombardier Challenger, Gulfstream, Cessna Citation and two Hawker Beechcraft RA390 Premier 1 aircraft, among them the D-IAYL involved in the accident.

1.17.1.2 Operational procedures

The operator's operational manual A (OM A) contained the relevant procedures for flight operations. With regard to the operation of the RA390 aircraft, which is licensed in principle for operation by only one pilot, the operator's philosophy was stated in section 4.2.1, among other things:

"Company aircraft shall be operated in principle by a minimum of two pilots."

In addition, in the OM B, in section 1.2.12 "*Minimum Flight Crew*" this was stated as follows:

"The minimum flight crew is one pilot and one copilot."

In section 8 "*Operating Procedures*", under 8.1.2 "*Criteria for determining the usability of aerodromes*", it was pointed out that aerodromes are divided into three categories. The classification of the individual aerodromes was given in the operator's OM B. According to this list Samedan aerodrome was in category C.

OM B, section 5, page 20 (identical to the publication in OM C, section 3.4.1, page 14):

IATA	***ICAO***	***Name***	***RWY length[ft]***	***TODA [ft]***	***LDA [ft]***	***ALS***	***APP***	***sp.climgradient required***	***Category***
SMV	*LSZS*	*Samedan*	*5906*	*5577*	*5577*		*VFR*	*YES High Terr. Airport elev 5600 ft*	***C***

In addition, in section 8.1.2 of the OM A, the criteria for the individual aerodrome categories were stated as follows:

"Airport Class A *(…)*

Airport Class B *Aerodromes not satisfying the category I[10] requirements or which requires extra consideration as:*

- *Non-standard approach aids and/or approach patterns or*
- *Unusual local weather conditions or*
- *Unusual characteristics of performance limitations or*
- *Any other relevant considerations including obstructions, physical layout, lighting, etc.*

Prior operating Class II[11] aerodromes:

The PIC has been in the cockpit within the last 12 months during an approach, or he has received a special briefing by supervisors or SV CPT for commanders, or he performed a self-briefing form before by using all means of programmed instructions (when available) concerned and should certify that he has carried out these instructions.

Airport Class C *Aerodromes which require additional considerations to Class II aerodromes:*
"Sachverständige" are authorized to supervise all other PIC after they have familiarized themselves with all airfield publications and after having performed one approach and departure to this airfield.

- *The PIC executes approaches and landings under supervision of a SV CPT or*
- *The PIC has received a special training where required, executed under supervision of a check captain (SV) or*
- *A flight training has been performed in a full-flight-simulator. After the supervision/training flight the SV CPT/instructor submits a written confirmation about the successful execution of the training.*

Approach and departure from Class III[12] aerodromes have to be performed by the commander only!"

Additionally, it was stated in the OM B, section 5.9.2 "*Aerodrome Competence*" that the following applies to a category C aerodrome:

"Category C is an aerodrome which requires in-flight familiarization."

The operator was unable to provide the corresponding evidence of compliance with the necessary criteria, as stated above for a category III or category C aerodrome, for the commander involved in the accident. The operator justified this with internal regulation valid within the company at that time which stated that the flight documents, which would include a corresponding confirmation, would only have had to be retained for three months.

Similar documents concerning the copilot, which confirm an introduction to operation at Sion (LSGS) aerodrome and which were more than one year old could be provided by the operator.

[10] Category I: The operator sometimes uses the therm "Class A" instead of "Category I" in their documents

[11] Class II: The operator sometimes uses the therm "Class B" instead of "Class II" in their documents

[12] Class III: The operator sometimes uses the therm "Class C" instead of "Class III" in their documents

In addition, the OM A, section 8.1.4, stated the following, among other things for operation under visual flight rules (VFR) in class G airspace, as it was the case in Samedan:

"Flight visibility
5 km (3 km for airplanes category A and B if granted by ATC)
[within Germany airspace 1,5 km and max IAS 140 kts
(2.+5. DVO LuftBO)]
Distance from clouds
permanent visual contact to the ground and clear of clouds"

With regard to flight procedures, in section 8.3 *"Flight Procedures"* sub-section 8.3.1 *"VFR/IFR policy"* the following was stated, among other things:

"Visual approach

- *General*
  1) *A visual approach with instrument flight rules where parts of the entire instrument approach procedure is not used and the approach is performed with ground sight.*
  2) *During a visual approach the pilot does not have to fly the entire published procedure if he has requested a visual approach or agrees to it and receives the respective clearance.*
- *Requirements*

  An IFR approach can be cleared as visual approach if:
  a) *The pilot flying can maintain ground in sight,*
  b) *The reported cloud base is in or above the initial approach altitude or the aircraft is already below the cloud base, and*
  c) *The pilot reports during the approach that weather conditions permit a visual approach and he is sure being able to perform a visual approach and landing or air traffic control suggests a visual approach and the pilot agrees under consideration of the conditions mentioned above.*

(…)

- *Minimum visibility*

  For the minimum visibility during a visual approach see the minima for airspace classes (OM Part A chapter 8.1.4)."

With regard to an ATC flight plan Y, as submitted for D-IAYL's flight from Zagreb to Samedan, OM B 8.3.1 additionally stated:

"IFR/VFR (Y-Flight plan)

1) *A flight in visual flight rules in controlled airspace immediately following an instrument flight has to be performed under consideration of following items:*
   - *The pilot has to have a visibility of at least 3 km,*
   - *The pilot has to have ground in sight,*
   - *The aircraft may not touch any clouds."*

1.17.1.3 Flight procedures

The crew of D-IAYL aborted their approach on runway 21 and climbed from 250 ft to about 600 ft above ground (cf. Annex 3). Subsequently they made a light left turn and transitioned to a level flight. Then, west of the end of the runway, they initiated a right turn over Samedan and flew in the direction of Bever, before they again made a right turn towards the threshold of runway 21. This procedure more or less corresponds to a so-called circling approach.

The operator itself did not publish any actual flight procedures. However, the opeartor states that its pilots were trained by the Flight Safety company and their flight procedures are applied.

In the published flight procedures of the Flight Safety company, the circling approach was performed as follows:

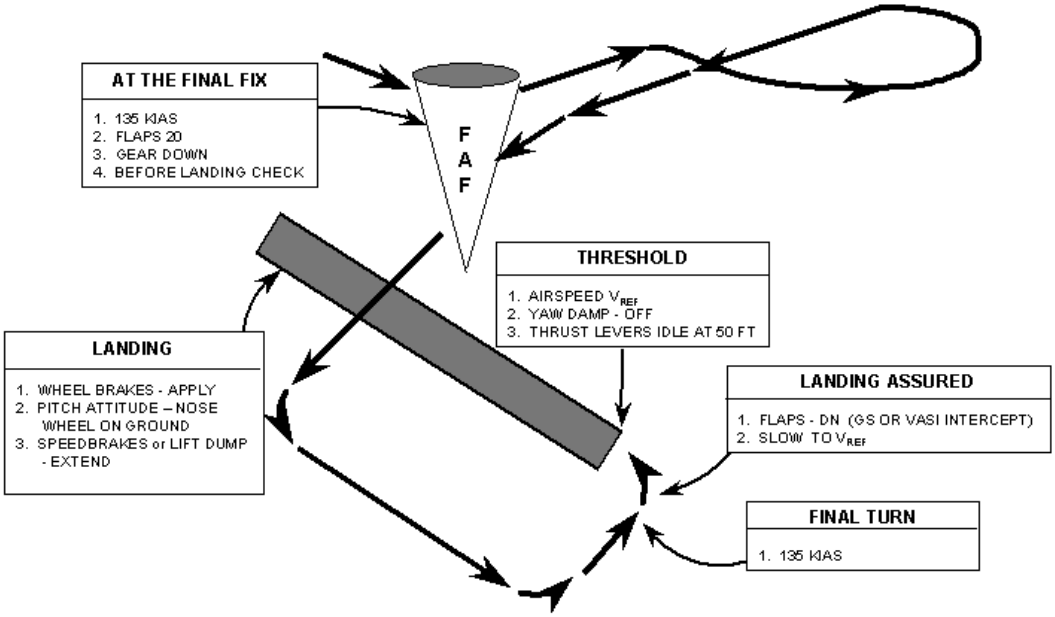


Figure 6: schematic presentation of the circling approach

As the figure shows, on transition to level flight and before the final turn (or base turn) is initiated, the airspeed must be 135 KIAS. It is expected that the flaps are set at the 20° position and the landing gear should be extended.

In this context it should be noted that at a speed of 135 knots and a bank angle of 30 degrees, a radius of 850 metres is needed to execute a 90 degree turn. This means that for a 180° turn from the downwind leg onto the runway centre line a minimum distance of 1700 metres is required between the downwind and the runway.

In the operator's OM B section 4.7.5 Procedures for operations at CHAMBERY airport (Premier 1), sub-section 4.7.5.2, an approach procedure was described, which corresponds approximately to a circling approach. Before the description of the procedure, there was in bold print: *"Check GPWS alarm is inhibit prior performing this procedure."* According to the operator, this refered to the TERR INHIB (terrain inhibit) function. The procedure itself recommended level flight with retracted landing gear, an airspeed of 160 KIAS and flaps set to the 20 degree position, and before initiating the base turn setting the flaps to the 30 degree position, extending the landing gear and reducing airspeed to 150 KIAS. The descent should then be continued and the flaps set to the 45° position. In this context, speed refered to the final approach speed.

It is noteworthy in the case of this procedure described expressly for the Premier 1 that first of all the TERR INHIB function has to be selected and secondly a flap position of 45° is required, corresponding to a position that does not exist on this aircraft. The TERR INHIB function suppresses various aural alerts and commands (cf. chapter 1.6.3).

The second operator for which the copilot worked as a freelance pilot confirmed that it consistently applied the flight procedures as trained by the Flight Safety company and published accordingly.

1.17.1.4 Checklists

The corresponding checklists were published in the operator's OM B, section 2.4.2 *"Hardcopy of Normal Procedure Checklist"*, as available for pilots on a laminated A4 sheet in the aircraft. These check lists were found at the site of the accident.

The checklists published by the operator contained substantially fewer points than those published by the aircraft manufacturer or by the Flight Safety company (cf. Annex 13).

The second operator for which the copilot worked as a freelance pilot stated that it does not use any abbreviated checklists and that the company works according to the checklists as published by the Flight Safety company.

1.17.2 The aircraft manufacturer

1.17.2.1 General

The Hawker Beechcraft company was an American aircraft manufacturer based in Wichita, Kansas. The products were predominantly sold under the Beechcraft and Hawker brand names. Other production facilities were located in Little Rock and Salina, Kansas and in the UK in Chester. World-wide, the company maintained over 100 of its own and authorized customer service centres.

Since February 1980 the Beech Aircraft Corporation had been owned by the American conglomerate, the Raytheon Company. In 1993 Raytheon also took over the business jets division of British Aerospace. The two acquisitions were merged in 1994 to become the new Raytheon Aircraft company.

After Raytheon took the decision to concentrate on military products, the holding company Hawker Beechcraft was formed; in March 2006 it acquired Raytheon Aircraft, renamed the Hawker Beechcraft Corporation.

1.17.2.2 Operational procedures

No explicit flight procedures were published in the aircraft manufacturer's operational instructions manual. The procedures as published by the Flight Safety company in close co-operation with the aircraft manufacturer in the "Pre Attendance Study Guide" applied. The same applied to the checklists.

1.17.3 The airport operator

1.17.3.1 General

In the course of the newly established organisational form of the airport operator, the individual functional responsibilities, with a specification, were listed in the air traffic management manual (ATMM). The definitive form of this ATMM was published in March 2007. The purpose of this publication was stated as follows in the ATMM:

"This Air Traffic Management (ATM) manual describes the operating procedures that have been defined to provide Aerodrome Flight Information Services (AFIS) at Samedan Airport. It also covers all aspects related to the involved personnel, infrastructure etc.

It serves as a working instruction for the FISO.

It has been written to prove that the requirements on an AFIS as specified by ICAO and EUROCONTROL are fulfilled."

1.17.3.2 Duties of the FISO

The duties of the FISO were described in detail in section 2, "*Responsibilities and Administration*", of the ATMM. Among other things, section 2.4, "*Responsibility of the FISO*", stated the following:

"Although FIS is an information service, it must be emphasised that the immediate passing of accurate information could be a vital safety factor when the FISO becomes aware of a dangerous situation developing within his area of competence."

Furthermore, section 2.6 of the ATMM entitled "*General Administration"* listed the various administrative tasks which the FISO must carry out. Among other things, these included runway condition checks and the compilation of weather reports.

With regard to the compilation of weather reports, section 10 of the ATMM entitled Meteorological Services contained the following, among other things:

"FISO shall study the weather reports and forecasts in relation to their areas of competence valid for their period of watch prior to taking an operational position."

To this end Samedan airport concluded a contract with MeteoSwiss. MeteoSwiss provided the airport with weather data and weather forecasts via the internet, for the attention of the FISO. Section 10.2 of the ATMM entitled "*Source of Weather Data*" also contained the following:

"Other weather data such as type of precipitation, visibilities, cloud layers have to be obtained by the FISO through observation. For that purpose the FISO shall be a certified weather observer."

Section 10.5, Aerodrome Meteorological Reports, stated that Samedan airport operates an automatic terminal information service (ATIS). The FISO was responsible for this operation.

1.17.3.3 Weather observation

In Samedan, at the full hour plus 20 minutes and at the full hour plus 50 minutes, an meteorological aviation routine weather report (METAR) was published on the internationally accessible information platforms for meteorological data. The inputs into this system were completed 10 minutes beforehand in each case. The METAR input mask in Samedan did not permit any information relating to the trend forecast (TREND) at the time of the accident. All METAR messages had therefore to be terminated with the message NOSIG. The expression NOSIG means "no significant change", i.e. no substantial change in the two hours following the time of issue of the aerodrome weather report.

Short-term significant changes which occured between the METAR deadlines were published as an aerodrome special meteorological report (SPECI). The ATIS was issued on an hourly basis. SPECIs were not disseminated via ATIS.

According to information from the FISO, information on meteorological visibility was concentrated along the centre of the valley on the two approach sectors onto runways 21 and 03. The visual range along the centre line of the runway took priority. A photo panorama was available to the FISO for estimating the visual ranges; in it the distances to salient points on the terrain were entered. The panorama hanged on the rear wall in the tower. It was also available as a catalogue. Together with meteorological visibility, various visual ranges in the approach sectors could be assessed separately by radio.

The view from the tower allowed a viewing angle of a little over 180 degrees. The FISO's view to the north-west towards the residential area was blocked by a wall.

The cloud base over the aerodrome was determined on the basis of the topography. A sketch drawn in 1944 with height data and digital images provided assistance.

Pilots had the possibility of obtaining information about the weather conditions at Samedan airport before an approach using the ATIS; this information could be over an hour old. It was also possible to request weather information by radio directly from Samedan Information, as soon as radio contact was possible on approaching Samedan, which was dependent on altitude and distance.

According to the visual approach chart, during his first radio call the pilot should mention the ATIS code and thereby confirm to the FISO that he was informed of the latest ATIS code (cf. Annex 6). According to the FISO's statement, this was hardly ever performed by crews of jet aircraft. For this reason FISOs communicate the current weather to approaching crews without being prompted. In the present case this procedure was not applied for the aircraft involved in the accident.

Since the local weather conditions can change rapidly, the main part of the weather briefing was provided by radio. The FISO assumed that pilots were not acquainted with local conditions. The objective was to facilitate decision-making in the cockpit by the most comprehensive description possible of the prevailing weather conditions.

1.17.3.4 FISO training

The duty FISO at the time of the accident was trained at the Sky Watch AG company. The Sky Watch AG Air Traffic Service company was a provider of training for air navigation services personnel in the aerodrome information service and offers modular courses for prospective FISOs. The company was founded in 2008 as a subsidiary of Engadin Airport AG and was based in Samedan. The first training course was offered in 2008 in cooperation with the Federal Office of Civil Aviation (FOCA) and under its supervision. On 25 June 2009 Sky Watch AG was certificated by the FOCA as *"a training provider for aerodrome flight information services controller (AFIS) in accordance with article 6, 11 and 42 et seq. of the VAPF"*.

The Sky Watch AG company worked closely with the "*Entry Point North AB"* school in Malmö, where FISOs had previously been trained. This school describeed itself as a Northern European air traffic services (ATS) academy, offering training for all air navigation service providers.

Among other things, prospective FISOs were trained for two weeks in the tower simulator in Samedan. The prospective FISO then worked under supervision in Samedan.

This deployment could last for several months. If the supervising coach found the prospective FISO qualified for independent deployment, he applied to the FOCA for the final examination for granting of the licence.

According to information from the FOCA, this final examination included a written test with specific questions on operation in Samedan and in addition the work of the future FISO was assessed in Samedan for a whole day by the FOCA inspector, together with the coach.

The FISOs were also trained as weather observers. This training was provided by MeteoSwiss and included one week of training, followed by a one-day refresher

every two years. The training also took place occasionally at Samedan airport and once a year a senior observer was present in Samedan.

1.18 Additional information

1.18.1 Traffic in the hour preceding the accident

In the following description of radio traffic, FISO B was on duty. FISO A, who took over FISO B's workstation shortly before the accident, had been next to FISO A since 13:30 UTC at the latest and from this point in time was able to monitor the corresponding radio reports.

When at 13:14:10 UTC the crew of a Citation C56X inquired about traffic and the cloud base, FISO B answered as follows, among other things: *"(…) and visibility five to six kilometres, light snowing, six knots ahead of runway two one, scattered three thousand, broken four thousand to four thousand five hundred feet".*

When at 13:24:59 UTC the crew of another aircraft, a Citation C525, asked Samedan Information: *"do you see the sky above, is there any chance to come in to Samedan"*, FISO B answered at 13:25:04 UTC as follows: *"yes I can see but it's not very clear because I have some mist in the valley, I think the layer is very thin".*

At 13:31:50 UTC, the pilot of another aircraft, a Siai Marchetti SF260, received notification that he could land at his own discretion. The pilot acknowledged this notification as follows: *"(…) to land at own discretion, runway not in sight yet and if someone wants to come into the valley, via Zernez south side is wide open"*. When at 13:33:32 UTC, FISO B asked the pilot whether he could see reporting point ECHO (La Punt), the latter answered immediately at 13:33:36 UTC: *"we have no visibility to ECHO."*

When at 13:34:06 UTC the crew of the Citation C525 gave a position report, FISO B answered at 13:34:20 UTC: "*preceding traffic is now passing ECHO, just reported, just reported is good visibility from Zernez to ECHO; runway two one, report six miles final."*

At 13:34:35 UTC, the pilot of the Siai Marchetti SF260, registration N266SF, reported: *"very low at ECHO because ECHO is er bit blocked at six thousand two hundred feet".* FISO B asked whether cloud ceiling over ECHO really was very low. The pilot repeated immediately: *"ceiling is very low it's horrible at six thousand two hundred feet."* Immediately afterwards, the crew of the Citation C525 reported at 13:34:54 UTC that in this case they would initiate a go-around and fly on to their alternate airport. According to his statement, though FISO A recalls this discussion, he does not exactly know what information the crew gave.

The pilot of N266SF, stated that he also possessed an American IFR licence and a jet rating. He mentioned to have over 2000 hours' experience over many years and meant that most of this time was accumulated on flights to and from Samedan. Regarding his experience on 19 December 2010 he stated the following, among other things [translated from German]: (…) I was in Zernez, there was an enormous hole there. No problem, but I heard on the radio that several aircraft were approaching Samedan. In the south the weather and visibility were better. However, this would work only for experienced pilots who know the area between Zernez and Zuoz very well. You had to go low in Zernez and then fly along the valley. (…). I recall that I said on the radio that visibility was very bad, in order to warn the pilots behind me.

At 13:35:10 UTC, FISO B reported to the pilot of the Siai Marchetti SF260 that he had the aircraft in sight and informed him of wind from 240 degrees at 8 knots. The aircraft landed at 13:36 UTC.

Immediately beforehand, at 13:35:40 UTC, the crew of the Citation C56X reported again to Samedan Information for a visual approach on runway 21 and inquired about the traffic ahead of them. FISO B then informed them at 13:39:32 UTC that a first aircraft was on approach to land and that a second had gone around and was flying to its alternate airport. In response to the request from the crew of the Citation C56X, FISO B repeated that the second aircraft would be diverting to its alternate airport and additionally informed them at 13:40:00 UTC as follows: *"for information, during the approach the last three miles the visibility is marginal, the ceiling is very low about six thousand three hundred feet"*. About 20 seconds later, the crew of the Citation C56X reported that they were going around and diverting to the alternate aerodrome. According to the statement of FISO B, he gave this weather information on the basis of the report from the pilot of the Siai Marchetti SF260.

At 13:42:56 UTC, the crew of a Piaggio P180, which was still in contact with Zurich radar, asked Samedan Information about the weather in Samedan: *"is it possible to make an attempt to come in".* At 13:48:18 UTC the FISO B replied as follows: "*condition for the airport is now marginal, we have two diversions, Jets, two minutes ago, we have light snow, visibility about four up to five kilometres maximum and scattered three thousand feet, four thousand five hundred feet broken, QNH one zero zero two, wind for the runway two one six knots*". This weather report differed considerably from the one which he had issued to the pilot of the C56X three minutes before. FISO B justified this as follows: *"This information was based on the situation over the airport at the moment, taking into account the GND references (surrounding mountains) and as we usually do in the ATIS and given in feet over the airport. The meteo report from the "Marchetti" was referred only in the approach sector 21, however MSL and only over a specific point where I couldn't see and estimate the real ceiling because of light snow precipitation in the vicinity."*

The commander of the P180 stated the following, among other things, about this flight:

"(…) During our flight we received ATIS information Hotel 1320 UTC (…). Given this ATIS information we prepared and discussed the approach to runway 21 at LSZS. We decided to attempt one approach and to divert to St. Gallen Altenrhein airport (LSZR) if VMC could not be maintained (…).

Samedan Info reported "marginal conditions, visibility 4-5 km, -SN, SCT030, BKN045, QNH1002. On that track (north-easterly heading), we heard the preceding aircraft [the D-IAYL aircraft] *reporting 6 to 10 miles final. Moments later as we had flown ¾ of our north-easterly track, we heard that this aircraft reported a go-around and that they would come back via a visual circuit for another attempt to land on runway 21.*

Shortly before turning into the base leg valley, we noticed a sticking microphone on the frequency for a short while (…).

We turned into the valley for the final track, on course to point E, in VMC. Closing in to point E, we were about to start a go-around due to deteriorating visibility beyond point E. Just at that very moment, Samedan Info advised that they suffered a power failure and suggested to divert (…)."

1.19 Useful or effective investigation techniques

1.19.1 General

In the northern part of Samedan, a private individual had installed for experimental purposes a surveillance camera which was in operation at the time of the accident. On the video recordings, aircraft D-IAYL is clearly recognisable when it was on the downwind leg. Due to the distance from the aircraft, its size and the diffuse horizontal visibility, the aircraft could not be identified on the video recordings after overflying the runway threshold and during its subsequent level flight parallel to the runway centre line.

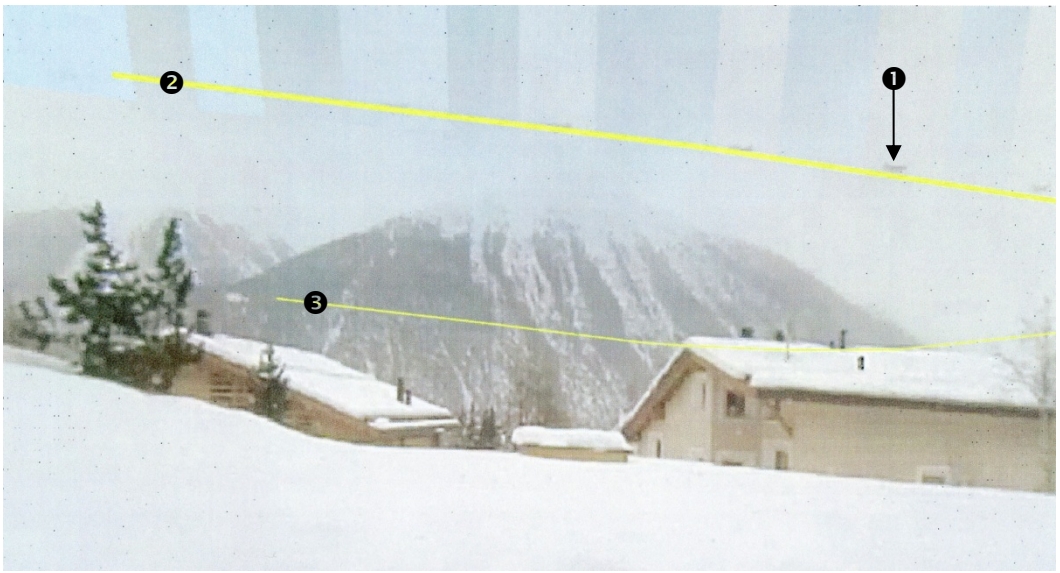


Figure 7: Snapshot from the viedeo recordings

❶ Aircraft D-IAYL

❷ D-IAYL flight path on downwind

❸ D-IAYL flight path after overflying the runway threshold according to EGPWS recordings (not recognisable on the video)

Since aircraft D-IAYL was not equipped with a digital flight data recorder (DFDR) and since there was as yet no certainty about any recordings by other devices, these video recordings were the only clues concerning the actual flight path of D-IAYL. A corresponding analysis was therefore urgent.

1.19.2 Basis of the analysis

In an initial phase, marker plates were positioned in front of the house from which the video recordings were made. Then, relevant distances were measured. Also, the environment of the house and the camera perspective from the inside of the office concerned were measured using a 3D laser scanner.

In a second phase, additional marker plates were positioned and surveyed at Samedan airport. Then, the camera location, its environs and Samedan airport were photographed from a helicopter using multi-image photogrammetry[13] in order to subsequently be able to carry out relevant analyses and image/object correlations on the computer.

[13] Multi-image photogrammetry describes a photographic or rather photogrammetric method of taking pictures and analysis. A situation to be recorded with different objects in a spatial environment is photographed from multiple locations from different lines of sight.

In addition, on the 3D terrain model of Samedan airport and its environs, defined using coordinates, 3D-CA software was used to lay down a scaled map, which was "partially blended" with a scaled orthophoto.

A Premier 1 was also measured with the 3D laser scanner, in order to subsequently insert the aircraft true to scale into the photographically documented (deskewed) situation.

Finally, all the analyses performed using the 3D laser scans and the photogrammetry were combined in the 3D terrain model.

It should also be mentioned that the accurate quartz electronic clock built into the video camera was synchronised every hour over the internet. This ensured a high degree of accuracy of the clock and therefore of the recordings.

1.19.3 Results of the analysis

In the sector in which the aircraft was observed, in the period between 14:01:48 UTC and 14:01:52 UTC, working with the prepared 3D overall situation scaled to match the aircraft (3D laser scans, multi-image photogrammetry, 3D terrain model), airspeed, height and flight path were analysed (cf. chapter 1.16.4).

In relation to airspeed, taking into account the analysis tolerances, a flight distance of between 289 m and 294 m resulted, corresponding to an airspeed between 140 and 143 kt.

In relation to the height of the aircraft, the expertice established the following, among other things [translated from German]: On the basis of a straight flightpath, according to our analyses, (...) the aircraft was at a height of (…) approximately 1865 m (□ 5 m) or approximately 6118 ft (□16.4 ft) above sea level, or approximately 158 m (□ 5 m) (approximately 1865 m above sea level less the official airfield elevation of 1707 m above sea level) or 518 ft (□16,4 ft) above the runway. Since the camera location was at an elevation of approximately 1750 m above sea level, there results a "diagonally upward" line of sight at an inclination of about 33% in relation to the aircraft (approximately 115 m difference in height / approximately 350 m horizontal distance). From this there ensue additional tolerances concerning the flight altitude. (…)

The flight path was analysed as a straight line with reference to the centre line of the runway. In this regard, it was established that the aircraft was at 14:01:48 UTC approximately 520 m and at 14:01:52 UTC approximately 565 m north-west of the centre line of the runway. This information corresponds to the data from the EGPWS which was analysed subsequently (cf. Annex 4).

In the following figure the flight path recorded by the video camera (in red) was transferred into the terrain model, in which the flight path reconstructed from the EGPWS data is shown in yellow.

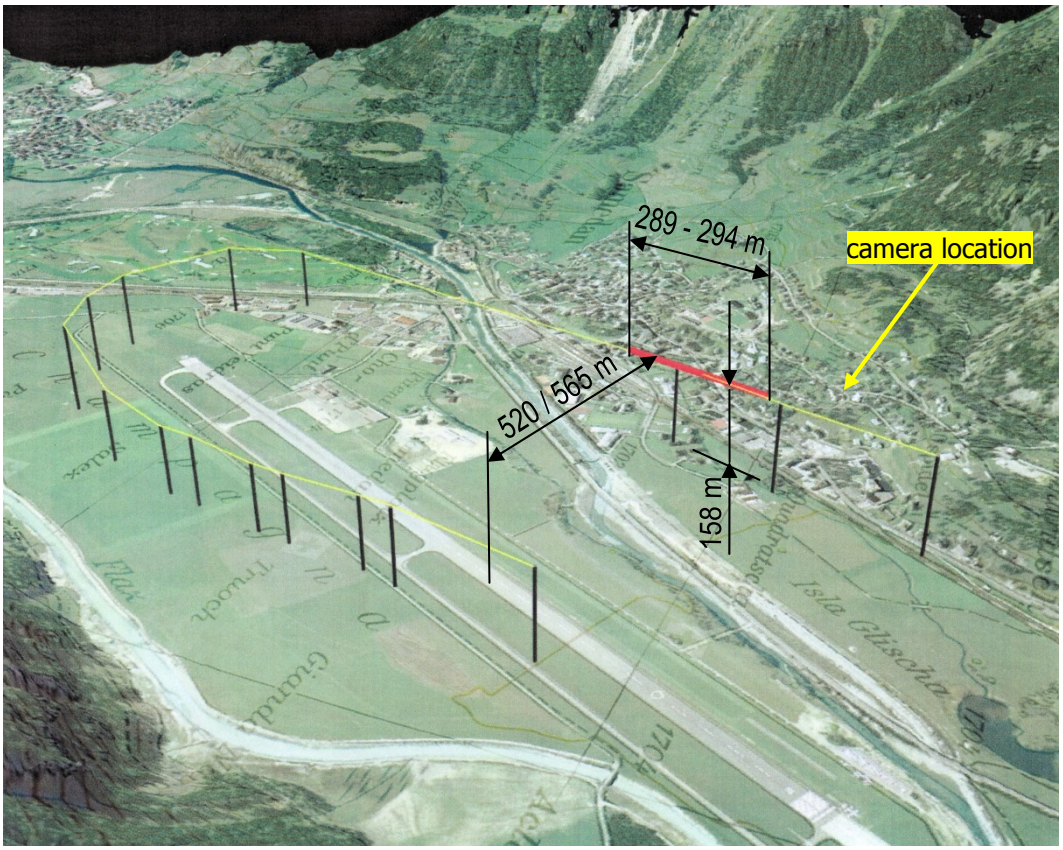


Figure 8: Analysed flight path between 14:01:48 UTC and 14:01:52 UTC

2 Analysis

2.1 Technical aspects

According to the entries in the journey log and the maintenance work performed on the D-IAYL aircraft as certified on the work orders, no defects or damage occurred in operation immediately before the accident which were related to the accident. Furthermore, it is a fact that during the accident flight the crew at no time mentioned any technical problems to the air navigation services.

In summary, it can be stated that there are no indications of any pre-existing technical defects which could have caused the accident.

2.2 Human and operational aspects

2.2.1 The operator

In its documents (OM A and OM B), the operator stated that the Hawker Beechcraft RA390 Premier 1 aircraft, which is certified as a single pilot aircraft, was in principle operated by two pilots and therefore required a commander and a copilot as a minimum crew.

Moreover, the operator produced its own checklists, not approved by the German Federal Aviation Office, for operation of the Premier 1 which differed markedly from those of the manufacturer (cf. Annex 13). Thus, for example, various points which the manufacturer required in the descent check were not addressed by the operator until the approach check and vice versa. Switching on the ignition, which according to the manufacturer was required in the approach check, was not required by the operator until the check before landing. Other points were not explicitly mentioned at all.

It should also be noted that setting the altimeter pressure was not required by the operator until the approach check, in contrast with the manufacturer's checklist, where this point was addressed in the descent checklist. On the standby altimeter found at the site of the accident, the standard pressure was still set, not the pressure of 1002 hPa which was valid for Samedan. This allows the conclusion that the crew did not implement the approach checklist completely, at the very least. If the altimeter had been addressed during the descent check, it is conceivable that the crew would have set the correct pressure. In the present case, the crew could have had a false sense of safety, since the altitude indicated in the cockpit on the pressure altimeter was 107 m above the altitude at which they were actually flying.

For the approach check, the reference in the manufacturer's checklist concerning airspeeds and landing distance ($V_{REF,}$ $V_{AC,}$ *N1 REF, Landing Distance*) was not mentioned in the operator's checklist.

The operator further stated in its documentation that the relevant commander requires an introduction for a first flight to Samedan. The evidence of such an introduction for the commander involved in the accident could not be furnished by the operator. This was justified by the fact that the corresponding documents are kept only for three months. Remarkable in this connection, however, is the fact that corresponding documents for an introduction of the copilot for Sion (LSGS) aerodrome were still available after more than a year. Thus it is doubtful whether the commander of D-IAYL ever received a specific introduction to operation at Samedan airport.

It is incomprehensible why the operator, in its OM B, described an approach procedure for Chambery, specifically for the Premier 1 aircraft type, which required

that the TERR INHIB function be selected and which specifies a flap position of 45 degrees, which is not available on this aircraft type because of its design.

The operator's recommendation to select the TERR INHIB function in certain cases is dangerous. This means that the terrain alerting and display, obstacle alerting and display(TAD) and terrain clearance floor (TCF) functions are switched off and the corresponding visual and aural alerts and commands are suppressed. This action, intended by the manufacturer only for abnormal procedures in the event of faults and mentioned in the abnormal checklist, deprives the pilot of essential warnings about possible dangers. If the crew in the accident currently under investigation also switched off the TERR INHIB function, following the published procedures for Chambery, the essential aural "*caution terrain!"* alert would have been suppressed.

2.2.2 Flight crew

2.2.2.1 Cooperation

Although the Hawker Beechcraft RA390 Premier 1 aircraft type is certified for operation by only one pilot, the operator specified that the Premier 1 had to be operated by two pilots, a commander and a copilot.

As could be determined on the standby altimeter found after the accident, the crew had not set the pressure of 1002 hPa which was valid for Samedan. It cannot be said for certain whether the pilots also did not perform this function on the pilots' display control panel. The arrangement of the corresponding barometric correction knobs (cf. Annex5), however, allows the conclusion that either all three altimeters were corrected or none of them was. It is noteworthy that the crew, after the first call at 13:57:50 UTC, when they received the QNH of 1002 hPa from the FISO, did not acknowledge this; this is a further indication that they did not implement the setting on the three pressure altimeters. It is conceivable that the crew, subject to an increasing workload due to the bad weather, did not implement this point, or possibly the entire approach check, which includes setting the pressure.

After initially good visibility and below the main cloud base, the crew flew between Madulain and La Punt into an area with snowfall and greatly reduced visibility of less than one kilometre. Thus in any event they could not meet the criteria laid down in OM B 8.3.1 by the operator with regard to a minimum visibility of 3 km, constant visual contact with the ground and no cloud contact.

Since the CVR could not be found, nothing very concrete can be said about the order of events in the cockpit. The fact that at least the standby altimeter was not set and that the crew did not obey rules with which they were certainly familiar indicates that co-operation in the cockpit was not functioning optimally. The following facts, however, permit the conclusion that the copilot was pilot flying for the approach in Samedan. The copilot's family members confirmed that the voice of the crew member who was conducting radiocommunications with Samedan was certainly that of the commander. It is therefore improbable that the commander was pilot flying and at the same time conducted radiocommunications.

It would not correspond to the operator's procedures if the commander allowed the copilot to fly the approach to Samedan airport. This distribution of labour might nevertheless have made sense, because the commander could have retained a better overview and could have increased his ability to assess the situation and make decisions.

Also the fact that the aircraft initiated a partial left turn after passing the threshold of runway 21 and then flew parallel to the runway centre line indicates that the

copilot was in control of the aircraft. As a result of this manoeuvre the view of the runway from the right-hand seat was assured. The runway was free of snow and therefore highly visible. In addition, contrary to the published procedures for Samedan airport, at the end of runway 21 a right turn was initiated, which again improved the view of the runway from the right-hand seat.

In addition, according to family members the two pilots got along well with each another. The copilot was also employed by another operator as a commander on the Premier 1 that could have favoured the decision to let him fly the aircraft.

2.2.2.2 History of the flight

Since the CVR could not be found, only the recordings of the radiotelephony allow clear conclusions to be drawn. It can be assumed that the crew listened to the ATIS before they reported to Samedan Information for the first time at 13:57:39 UTC. Therefore it is probable that the crew was informed in particular about the weather conditions, which were broadcast on ATIS H timed at 13:20 UTC.

When the aircraft was at flight level 186 over Bever, the crew asked air traffic control to allow them to continue under radar control. This suggests that they did not have sufficient visual references in this area to continue the flight under visual flight rules. The satellite images at this time also show a largely closed cloud layer and visibility to Samedan airport was significantly restricted by cloud, if it existed at all (cf. Annex 12).

Over Zernez visibility to the ground tended to be better, which may also have led the crew, at 13:53:02 UTC, to request a change to visual flight rules with *“request to cancel IFR*.”

A further indication of the marginal visibility to the ground is the fact that the crew, when they were asked to switch to the Samedan Information frequency at 13:54:01 UTC, wanted to remain on the Zurich radar frequency.

On the basis of the weather conditions, it can be assumed that the crew had visual contact with the ground when they reported at 13:57:39 UTC: *"(…) we are descending one hundred inbound Echo point."*

It is noteworthy that at 13:58:46 UTC the crew of D-IAYL said to the crew of a Piaggio 180, concerning the weather, that for the moment good conditions were prevailing. However, only 26 seconds later they themselves asked Samedan Information about the weather conditions on the airport, which indicates that the weather conditions were obviously deteriorating.

Between Zuoz and La Punt, D-IAYL was flying at a height of approximately 1000 ft above ground level, approximately in the centre of the valley, at a speed of approx. 160 knots. Initially the visibility was good and the aircraft was below the main cloud base. Between Madulain and La Punt, the aircraft flew into an area with snowfall and greatly reduced visibility of less than one kilometre. Somewhat to the north-east of Bever, D-IAYL exited the area of reduced visibility and the crew may then have seen the runway of Samedan airport for the first time. The distance to the runway was then approximately 0.5 NM; the aircraft was at approx. 1000 ft AGL and flying at approximately 165 kt. This explains why the crew subsequently increased their rate of descent to over 2200 ft/min and maintained this until a radio altitude (RA) of just under 250 ft was attained. During this steep descent, several EGPWS alerts sounded. When the aircraft reached just under 250 ft RA, it was over the threshold of runway 21. Its airspeed was approximately 150 kt, the gear was extended and the flaps were, with a high probability, set at 20 degrees. In this situation, out of a not stabilized final approach, a safe landing

would have been doubtful. This was apparent to the crew; they stopped the descent and initiated a climb to approx. 600 ft RA.

A go-around in the runway direction, i.e. a missed-approach procedure with a climb above the highest points of the terrain, would have been possible at any time, given the performance of the aircraft. The crew actually decided on a circuit of the aerodrome and a renewed approach on runway 21. It has to be assumed that the crew performed this manoeuvre following the procedure of a so-called circling approach which was known to them (cf. chapter 1.17.1.3). They were obviously not aware that at Samedan airport such a procedure is prescribed neither for jet aircraft nor for multi-engine aircraft (cf. Annex 6). At a speed of 135 kt and a bank angle of 30 degrees, a distance of approximately 1700 m between the runway and the downwind leg is required for a circling approach. The topographical conditions do not permit such a procedure because of the required turning radius, which is why it is not published (cf. Annex 6). Aerodrome circuits on Samedan airport are intended only for single-engine aircraft and the circuit for runway 21 should be flown to the south of the airport.

On initiation of the first right turn onto the downwind leg at the latest, the crew must have realised that the space for the intended manoeuvre was very tight. This explains why they were finally forced to fly the turn at a bank angle of up to 55°. A turn at such high values of bank angle is unusual in the operation of a business aircraft and is therefore also for the crew very demanding. The fact that their airspeed in the first part of the turn dropped to 110 KCAS, also shows that the crew was only marginally in control of the aircraft already during this unusual manoeuvre and in this phase of the flight. Nevertheless, in this turn, by means of a corresponding increase in power, the crew managed to bring the aircraft out of the range of the impending stall and was able to complete the turn at approx. 135 KCAS. Towards the end of this turn, the radio push-to-talk button was pressed by at least one crew member for approximately 20 seconds, without any message being transmitted. This action might have been an indication that during this turn, in which the EGPWS *"bank angle"* alert also sounded, the crew was under great pressure.

When the crew was on the downwind leg, they must have seen the area with snowfall and greatly restricted visual conditions over Bever, on the eastern side of the runway centre line; this probably led them to turn onto the runway again. In this turn, the aircraft reached a bank angle of up to 62 degrees and the EGPWS "*bank angle*" alert sounded again. The speed of 115 knots was not increased. The stall speed at this bank angle is 137 knots. Thus airflow over the wing became detached and control of the aircraft was lost. The aircraft then turned upside down and crashed almost vertically.

2.2.3 Airport operator

2.2.3.1 Weather observations

The flight information service officer (FISO) fulfils an important function on an airport such as Samedan. Even though the official documentation for Samedan airport notes that the FISO only transmits information, there is a risk that he is perceived by crews as an air traffic controller. This perception may induce them not to question his information sufficiently. This has a particular significance with regard to weather information which is transmitted by the FISO after a change from instrument flight rules to visual flight rules up to a landing.

2.2.3.2 Transmission of weather reports

According to the visual approach chart for Samedan, crews were required to confirm the ATIS code during the first radio call. According to the FISO's statement, this was rarely performed, especially by crews of jet aircraft. This fact was not a matter for further concern, as FISOs would communicate unprompted the current weather to approaching crews during the first radio call. In this regard it must be stated that in the radio traffic during the hour before the accident this occurred only once. In the other cases weather information was provided only at the request of the crews concerned. The crew of D-IAYL did not request weather information on their first call, nor was the relevant information communicated to them by the FISO. Only the QNH of 1002 hPa was communicated to them after the first call.

The fact that the FISO could not provide any information relating to the trend forecast on the airport's METAR input mask represented a safety risk. Since in Samedan it was only possible to terminate the entry with NOSIG, there was the potential for crews to be wrongly informed. NOSIG means that in the two hours which follow the time of issue of the aerodrome weather report no substantial changes are to be expected. If this is not the case, crews may proceed on the basis of false assumptions when assessing the weather.

A further deficiency is the fact that the ATIS recording was renewed only every hour (HH+20), even though it was produced every thirty minutes. Though these reports on the internationally accessible information platforms for meteorological data were up-to-date, the pilot listening to the ATIS in the aircraft was deprived of the latest ATIS reports once every hour.

In the accident under investigation, this deficiency was particularly apparent, as the ATIS report with the 13:50 UTC weather observation would have been very informative for approaching crews, in that it indicated a distinct worsening of the situation in relation to visibility and cloud base (cf. chapter 1.7.5).

In addition, it must be stated that the ATIS reports, which according to the FISO's statements correspond to the METAR at the same point in time, actually contained different information. Thus the METAR and the ATIS of 13:20 UTC on the day of the accident differed markedly with regard to visibility and cloud base.

An examination of the Samedan airport ATIS and METAR performed after the accident for purposes of comparison indicates that differences occasionally occur. Furthermore, ATIS information which was over two hours old was transmitted, indicating that a systematic approach was lacking.

At 13:34:35 UTC on the day of the accident, the pilot of a Siai Marchetti SF260 reported in relation to the weather: *“very low at ECHO because ECHO is er bit blocked at six thousand two hundred feet”.* FISO B enquired whether cloud cover over ECHO really was very low. The pilot repeated immediately: *“ceiling is very low it's horrible at six thousand two hundred feet”.*

On the basis of this weather report FISO B informed the crew of a following Citation C56X at 13:40:00 UTC as follows: *"for information, during the approach the last three miles the visibility is marginal, the ceiling is very low about six thousand three hundred feet"*. The fact that FISO B reported *"six thousand three hundred feet"* and not *"six thousand two hundred feet"* as transmitted by the pilot of the Siai Machetti may indicate a communication problem. Some 20 seconds later, the crew of the Citation C56X reported that they were going around and diverting to the alternative aerodrome.

Only three minutes later, FISO B responded to the crew of a Piaggio P180, who asked: *"is it possible to make an attempt to come in"* as follows: *"condition for the*

airport is now marginal, we have two diversions, jets, two minutes ago, we have light snow, visibility about four up to five kilometres maximum and scattered three thousand feet, four thousand five hundred feet broken, QNH one zero zero two, wind for the runway two one six knots". FISO B justified this distinctly better weather report by the fact that he had taken conditions observed over the aerodrome as a basis. He stated that the poor visibility and cloud base reported by the pilot of the Siai Marchetti SF260 referred only to approach sector 21; in addition, he had not been able to verify these values from his workstation because visibility had been affected by light snowfall. This consideration indicates a poor situational awareness, since for an approaching crew it is precisely this information about weather conditions in the approach sector from a crew flying ahead of them which is of great importance and which provides a basis for their decisions.

In addition it can be concluded that an adequate briefing did not take place between FISO B and FISO A, who was replacing him. This is the only explanation as to why FISO A also reported to the approaching crew of D-IAYL better weather conditions than those actually prevailing on the approach.

2.2.3.3 Weather minimums

The present accident highlights the fact that the legal provision allowing a mountain aerodrome such as Samedan airport to be approached with such low weather minimums[14] entails considerable risks.

By comparison, in daytime military operation, for aircraft with a maximum take-off mass of up to 3 t, a cloud base of 1300 ft AGL and a visibility of 2000 m are required; a cloud base of 1300 ft AGL and a visibility of 5000 m are required for maximum take-off masses in excess of 3 t.

It is incomprehensible that at least the same minimums did not apply to civil air traffic.

2.3 Meteorological aspects

2.3.1 General

Over Central Europe on 19 December 2010 the high-altitude wind was blowing from the west sector. The 12 UTC ground analysis showed a depression over the English Channel and a wedge of high pressure over the river Po plain. At the Alpine ridge and in the valleys on the northern side of the Alps, a southerly Föhn wind prevailed. The northern and Central Graubünden regions had some sunny weather. In the remaining parts of Switzerland the sky remained cloudy.

2.3.2 Weather in the Engadine

In the Upper Engadine, the day began with light cloud. The cloud increased from mid-morning onwards. The cloud base descended from an initial 18 600 ft AMSL at 08:50 UTC to 11 600 ft AMSL at 10:50 UTC. From the 09:50 UTC METAR report onwards, Samedan had regular snowfalls, mostly of low intensity. From 13:20 UTC the cloud base was at 9600 ft AMSL. Cloud cover was indicated as BKN, corresponding to 5 to 7 eighths.

The animation of Meteosat images indicated that from the Surselva to the Lower Engadine there were standing waves in the cloud. The wavelengths were between 4 and 8 km. The waves were triggered by the more or less north-south

[14] Class G airspace: minimum visibility 1.5 km, outside of cloud, with visual contact with the ground or water and the possibility of performing a 180 degree turn.

running ridges between the Rheinwaldhorn and Piz Kesch, the flow from south-west to west, a stable temperature stratification and an increase in wind speed above approximately 3100 m/M (cf. Figure 12).

The standing waves were virtually stationary. This made it possible to incorporate the polar orbiting Aqua satellites in the analysis.

The Aqua satellite passed over Central Europe in the early afternoon on a SSE-NNW trajectory. At 12:35 UTC it passed over Corsica. At 12:40 UTC the satellite was at 60° N over the Greenwich meridian. The Engadine was just east of the nadir track.

The mid-day ascent of the Milano Linate (WMO 16080) radiosonde balloon indicated an inversion between 3000 and 3300 metres above sea level. The upper limit of the inversion also corresponded to the upper limit of the cloud banks. The relative humidity decreased with increasing height. The MeteoSwiss webcam images from the Corvatsch station showed this cloud ceiling in the form of a constant cycling from broken cloud to sun. The thermal stratification indicated by the radiosonde profile over Milano Linate was also representative of the Upper Engadine, as an initial approximation.

There were differences in relation to the thickness of the cloud. Over Milano Linate the base of the main cloud layer was at approx. 1800 m/M; in Samedan it was approx. 2900 m/M (approx. 9500 ft AMSL). Therefore the layer of cloud over the Engadine was on average 400 m thick. Waves within the layer caused thinning of the cloud in the wave troughs due to descending air and thickening of the cloud below the wave crests. The maximum rise occurred between the wave trough and crest.

In Samedan the temperature in the afternoon remained approximately constant at -6 °C. At a comparable altitude over Milano Linate it was -8 °C. This illustrates the fact that the coldest air from the river Po plain was not able to penetrate completely into the Upper Engadine. It is possible that the temperature difference was also partly due to the effects of the Föhn wind.

2.3.3 Weather in the runway 21 approach sector in Samedan

At the time of the accident, above 3000 m/M there was a wind from WSW at 30 to 45 knots. On the floor of the valley the wind speed fell to 6 knots. Between Samedan and the Lower Engadine, the satellite images reveal gaps in the cloud caused by standing waves and the effects of the Föhn. The temperature stratification was stable. The cloud thickness was 400 metres at the crest of the waves, possibly even a little more. In the troughs of the waves the cloud was considerably thinner. Between La Punt and Zernez there were sections where the cloud cleared completely. This is confirmed by figures in Annex 12, as well as by statements from eye witnesses.

At the time of the accident there was an area with intensive snowfall between Bever and La Punt. This band of precipitation was 3 to 4 kilometres wide.

Because of the stable thermal stratification, there was no convection. The intense snowfall was triggered in particular by vertical movement on the upwind side of the wave and by the topography. The wind from Val Bever mentioned by one witness corresponded to the flow of cool air below the driving snow, guided by the topography.

The figure below outlines the approach to Samedan and the significant weather between Zernez and the threshold of runway 21.

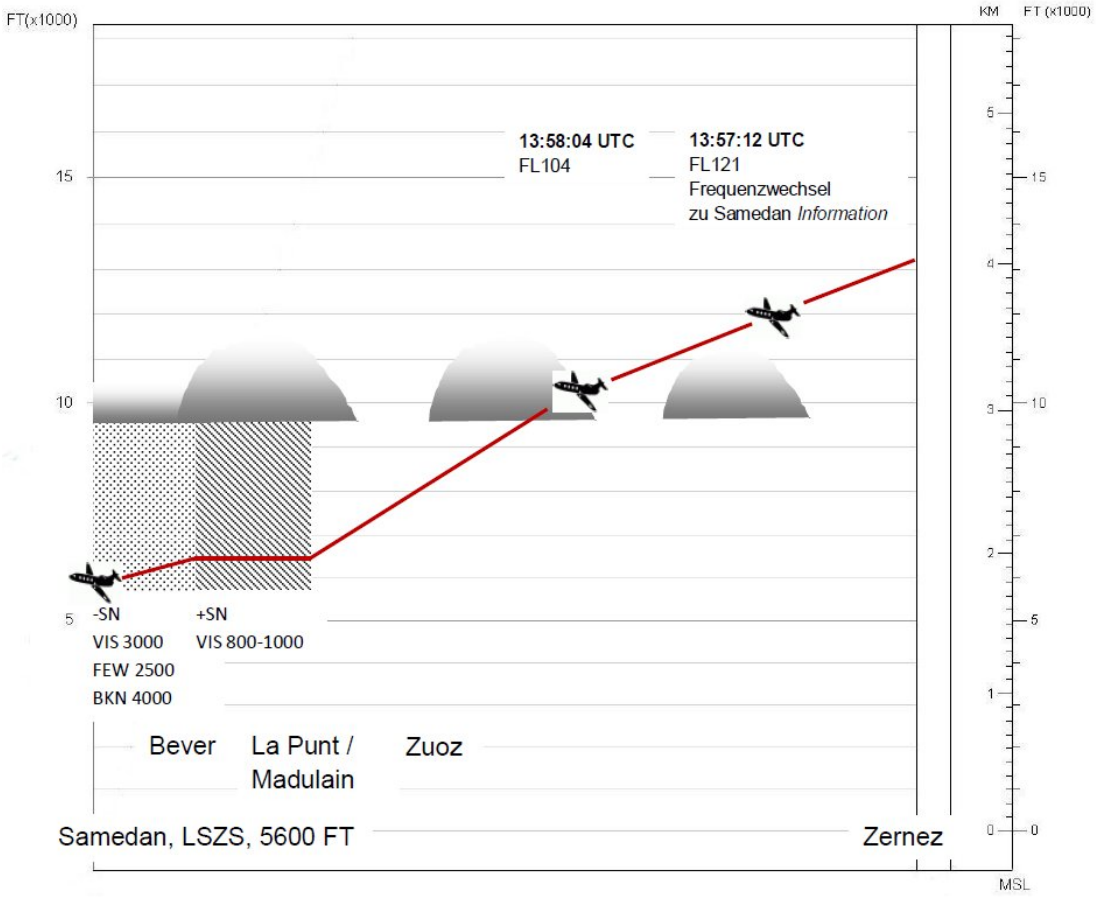


Figure 9: Flightprofile oft he D-IAYL durig approach to runway 21

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was licensed for VFR/IFR transport.
- Both the mass and centre of gravity of the aircraft were within the permitted limits at the time of the accident according to the AFM.
- The investigation produced no indications of any pre-existing technical faults which might have caused/influenced the accident.
- The last 200/1000-hour inspection was performed at 1008:30 operating hours.

3.1.2 Crew

- The pilots were in possession of the necessary licences for the flight.
- There are no indications of any of the pilots suffering health problems during the flight involved in the accident.
- The toxicological analyses performed on both pilots gave no indications of alcohol, narcotic substances or medicines.
- The commander had flown to Samedan three times in 2006 and once on 8 February 2010.
- It was the copilot's second flight to Samedan. He had flown to Samedan once before, on 8 February 2010, with the commander involved in the accident.
- The copilot was also working for another operator.
- With this other operator, the copilot had been assigned since 28 July 2010 alternatively as commander in the left-hand seat and as copilot in the right-hand seat.

3.1.3 Flight information service

- FISO A and B were in possession of the necessary licences.
- The values concerning visibility and cloud base reported by an approaching crew were not consistently passed on.
- The values indicated in the ATIS did not coincide in every case with those in the corresponding METAR and were not systematically updated.
- The ATIS was newly recorded only once an hour, even though the METAR report was produced every half hour.
- The SNOWTAM was not adapted to the new conditions.
- The 13:45 UTC SPECI was neither broadcast via the ATIS nor transmitted over the radio.

3.1.4 History of the flight

- Shortly after aircraft D-IAYL had passed waypoint RESIA, the crew received clearance to descend to flight level 170 from the Zurich sector south ATCO.
- When aircraft D-IAYL was at flight level 186 over Bever, the crew received the following clearance at 13:51:14 UTC: *"(…) you may navigate over the field at own convenience."*
- The crew then immediately asked to continue under radar control; this was confirmed by the ATCO.
- At 13:53:02 UTC the crew requested: *"(...) to cancel IFR."*
- The aircraft then flew on an easterly heading, turned north-east and after a 180 degree turn flew south-west towards Samedan airport.
- During this phase, at 13:54:01 UTC, the ATCO instructed the crew to switch to the Samedan Information frequency.
- The crew immediately asked to remain for a further two minutes on their current frequency, which was accepted by the ATCO.
- At 13:57:39 UTC the crew reported to the FISO in Samedan: *"(…) we are descending one hundred inbound Echo point."*
- The QNH of 1002 hPa reported by the FISO at 13:57:50 UTC was not read back by the crew and was not set on the standby altimeter at least.
- When the crew of a Piaggio 180 inquired at 13:58:40 UTC about the weather for an approach, the crew of D-IAYL responded, before the FISO could answer: *"Yes for the moment good condition, Quadriga six three one Victor."*
- At 13:59:12 UTC, the crew of D-IAYL inquired about the weather over the airport.
- After a repeated inquiry they received the following answer at 13:59:27 UTC: *"(…) visibility three or four kilometres cloud base few at two thousand feet and overcast at five thousand or six thousand feet."*
- At 13:59:42 UTC, the crew reported that they were at five miles on final, whereupon the FISO said, among other things: *"(…) land at own discretion runway two one."*
- At the same time, the crew increased their rate of descent to over 2240 ft/min on average and descended to a final recorded radio altitude (RA) of just under 250 ft, which they reached over the threshold of runway 21.
- The crew then stopped the descent and climbed at an average rate of climb of 730 ft/min up to an RA of approximately 600 ft, which they then maintained.
- At this altitude and at an average airspeed of 115 to 120 knots the aircraft made a partial left turn to the south and then flew parallel to the runway centre line.
- At this time, aircraft D-IAYL had extended its landing gear and the flaps were, with a high probability, set at 20 degrees.

- At the end of runway 21 the crew of D-IAYL informed the FISO that they would make a right turn.
- The bank angle in this turn was up to 55 degrees and the airspeed was increased from 110 to 130 knots. The stall speed at a bank angle of 55 degrees is 124 knots.
- On the downwind leg to runway 21, when approaching Bever, the crew of D-IAYL again initiated a right turn (base turn).
- The bank angle in this base turn was up to 62 degrees; the airspeed in this phase was 115 knots. The stall speed at a bank angle of 62 degrees is 137 knots.
- The aircraft then turned upside down and crashed almost vertically.

3.1.5 General conditions

- The operator had published procedures which allowed essential warnings to be suppressed.
- The legal stipulation which allowed approaches at Samedan airport under the weather minimums applicable at the time of the accident, involved considerable risks.
- The weather situation was stable for hours and was marked by gaps in the cloud in the aera of Zernez and also by reduced visibility of less than one kilometer in the aerea west of Zuoz.

3.2 Causes

The accident is attributable to the fact that the aircraft collided with the ground, because control of the aircraft was lost due to a stall.

The following causal factors have been identified for the accident:

- The crew continued the approach under weather conditions that no longer permitted safe control of the aircraft.
- The crew performed a risky manoeuvre close to ground instead of a consistent missed-approach procedure.

The fact that the flight information service did not consistently communicate to the crew relevant weather information from another aircraft was a contributing factor to the genesis of the accident.

As a systemic factor that contributed to the genesis of the accident, the following point was identified:

- The visibility and cloud bases determined on Samedan airport were not representative for an approach from Zernez, because they did not correspond to the actual conditions in the approach sector.

4 Safety recommendations and measures taken since the accident

In accordance with Annex 13 of the ICAO, all safety recommendations listed in this report are addressed to the supervisory authority of the competent State, which must decide on the extent to which these recommendations are to be implemented. However, every agency, undertaking and individual is invited to attempt to improve aviation safety in the sense of the issued safety recommendations.

In the Ordinance on the Investigation of Air Accidents and Serious Incidents, Swiss legislation provides for the following regulation:

"Art. 32 Safety recommendations

[1] DETEC shall address implementation assignments or recommendations to FOCA, based on the safety recommendations in the reports from SAIB or on the foreign reports.

[2] FOCA shall inform DETEC regularly about the implementation of the assignments or recommendations.

[3] DETEC shall inform the SAIB at least twice a year about the progress made by FOCA with implementation."

4.1 Safety recommendations

4.1.1 Safety deficit

As a result of various accidents and serious incidents on Samedan airport in which the weather played a part, a safety report with various recommendations was produced in March 2010 by the AAIB for the FOCA. Among other things the following two suggestions were made [translated from German]:

- The meteorological minimums for military operation are also to be applied to civil operation.
  (In daytime military operation, for aircraft with a maximum take-off mass of up to 3 t, a cloud base of 1300 ft AGL and a visibility of 2000 m are required; a cloud base of 1300 ft AGL and a visibility of 5000 m are required for a maximum take-off mass in excess of 3 t).
- Runways 03 and 21 at Samedan airport are to be equipped with certified runway lights and the approach sectors are to be equipped with approach lighting (high-intensity strobe lights, also known as running rabbit) and a precision approach path indicator (PAPI).

On 19 December 2010 several operators had planned to make flights to Samedan airport. A total of 13 aircraft were notified. These had submitted either an ATC flight Y plan or a VFR flight plan. Eight of these flights were scheduled with business jets, four with turboprop aircraft and one with a single-engine piston aircraft.

As the analysis of the weather conditions on this day showed, the conditions for an approach at Samedan airport were not particularly changeable throughout the day but were characterised by cloud layers at different heights and more or less restricted visibility in the runway 21 approach sector.

A turboprop aircraft landed at 12:00 UTC in Samedan and an executive jet aircraft landed at 13:14 UTC. In view of the prevailing weather conditions, six other business jets, as well as three turboprop aircraft, either aborted their approach

early or did not attempt an approach at all. A single-engine piston aircraft landed at 13:36 UTC, but reported very challenging weather conditions during the approach.

The crew of a Raytheon 390 executive aircraft, registered as D-IAYL, arriving from Zagreb, began a visual approach on runway 21 in the early afternoon. On final approach, the aircraft crossed areas with greatly reduced visibility and then saw the runway so late that a landing was no longer possible. Instead of a missed-approach procedure, the crew decided on an improvised circuit to the north of the airport. This manoeuvre was so challenging, because of the topography and the characteristics of the jet aircraft involved, that it was no longer managable by the crew, leading to loss of control and a collision with the terrain. Both crew members suffered fatal injuries in this accident.

Even though the primary cause of this accident lies in the risky conduct of the crew, the investigation indicated other safety deficiencies which either contributed to the accident or at least favoured its genesis:

- The visibility and cloud bases determined on Samedan airport were not representative for an approach from Zernez, because they did not correspond to the actual conditions in the approach sector.
- The values concerning visibility and cloud base reported by an approaching crew were not consistently passed on by the flight information service.
- The legal stipulation which allowed approaches at Samedan airport under the weather minimums applicable at the time of the accident, involved a considerable risk.
- The values indicated in the ATIS did not coincide in every case with those in the corresponding METAR and were not systematically updated.
- The ATIS was only updated once an hour, even though the METAR report was produced every half hour.
- A SPECI was neither broadcast via ATIS nor transmitted over the radio.
- The employees of the flight information service could not provide information in the airport's METAR input mask regarding the trend weather forecast. Since in Samedan it was only possible to terminate the entry with NOSIG, there was the potential for crews to be wrongly informed.

Part of these safety deficiencies have been known for some time and have played a role in earlier accidents. For this reason consistent improvement measures are necessary, in the view of the accident investigation authority; these should be implemented without delay.

4.1.2 Safety recommendation No. 443

[Translated from German]: The Federal Office of Civil Aviation, together with the operator of Samedan airport should improve weather observation and transmission of important weather information so that approaching crews have all necessary information at their disposal for decision-making.

4.2 Measures taken since the accident

4.2.1 By the Federal Office of Civil Aviation (FOCA)

On 22 December 2010, inspectors from the Federal Office of Civil Aviation (FOCA) visited Samedan airport and on 23 December 2010 the following decision was published by the FOCA in the appropriate media [translated from German]:

Publication concerning a Samedan decree

As of 23 December 2010 the Federal Office of Civil Aviation (FOCA) has issued new regulations for approaches to Samedan aerodrome. The following rules apply to pilots flying to Samedan in the immediate future:

1. The obligation on jet and multi-engine pilots relating to prior completion of a briefing including an online test continues to be valid, with no changes. The briefing, like the subsequent test, can be consulted via the internet on the following website: http://www.engadin-airport.ch/Fuer-Piloten.7.0.html. The confirmation that the test has been successfully completed must be carried along by the responsible pilot.
2. The obligation regarding prior completion of a familiarisation flight is not yet in force. The aerodrome is instructed to submit to the FOCA by 31 January 2011 a concept for the implementation of this familiarisation training. On approval of this concept by the FOCA and its publication, the obligation relating to the prior completion of a familiarisation flight in accordance with the provisions of the concept will apply. The publication of the date of introduction and the detailed provisions will appear in the NOTAM and in the AIP. In accordance with the currently valid publication in the AIP, a briefing on the aerodrome conditions is already urgently recommended.
3. For aircraft in approach category B and higher, the following meteorological minimum values apply with immediate effect:

   Visibility: 5 km
   Cloud ceiling: 2200 ft

   If these values are not met, the runway will be closed to the aircraft categories concerned. Approach category B covers all aircraft with an approach speed of 91 to 120 kt. The higher categories cover aircraft with an approach speed in excess of 120 kt. The approach speed is defined as follows, in accordance with PANS OPS (Doc 8168, Volume I): "Speed at threshold based on 1.3 times stall speed in the landing configuration at maximum certificated landing mass."
4. Before every flight, the applicable publications of the AIP (including Supplements), as well as the current NOTAMs, must be consulted.

Although these measures have been taken subsequently to the accident on Sunday 19 December 2010, they permit no conclusions as to the cause of Sunday's accident. The FOCA is convinced that by means of these measures in collaboration with the aerodrome a contribution can be made to improving the safety of operations in Samedan.

In addition the Swiss FOCA has checked the installed PAPI 03 and 21 by means of control flights on 8 December 2011 and has released the system by 15 December 2011.

4.2.2 By the operator

On 27 December 2010 the operator published a temporary crew bulletin, which was published in the OM C with Revision 3 on 15 January 2011 as follows:

3.4.4 Engadin Samedan Airport

Temporary crew bulletin 03, 27.12.2010

Preliminary Company Procedure for flights into Engadin Airport (Samedan / LSZS)

Complying with the requirements of issued computer based interactive familiarization briefing for jet and multiengine aircraft crews by the representatives of Engadin Airport following procedure for WINDROSE AIR Jetcharter GmbH has to be applied:

- ⇨ Prior commencing any further flight into Engadin Airport both, PIC and SIC have to present an airport familiarization by passing successfully the mentioned briefing following the questionnaire linking to website http://www.engadin-airport.ch/fileadmin/qdb/QDB/QDB.swf?RemoteLaunch=7
  Record of passed test will be stored in the pilot files
- ⇨ The extended restricting weather minima for aircraft category B and up in airspace class G (visibility 5km or more and ceiling of 2200 ft ore more) are applicable for departure of all WINDROSE AIR Jetcharter GmbH aircraft.
- ⇨ For approach and landing following practice has to be executed: in addition to ATIS obtaining actual weather information by FISO (Flight Information Service Officer) / overflight of the valley at minimum IFR radar altitude / positive visual contact with the field prior canceling IFR and positive radio contact with Samedan Info at second radio set
- ⇨ In case of Go-around the published procedure strictly has to be adhere.
- ⇨ REMINDER: As Engadin airport is classified as Category C airport, take off's and landings has to be performed by PIC only!

The Operational Manual Part C "Route and Aerodrome Instructions and Information" will be supplemented by adding a more substantial airport and procedure description as soon as possible.

In addition, the operator informed the investigation authority in a letter dated 18 February 2011 that its evidence and filing system had gaps and that it had added a section on *"Airport familiarisation"* to the pilot files of all pilots. This is intended to ensure that evidence of familiarisation is also available over the actual 12-month validity period.

The operator also communicated the following in this letter, among other things [translated from German]: (…) As a result of what has happened, appropriate requirements for familiarisation have also been formulated for Samedan for copi-lots and will also be extended to copilots within our company for all category C airports.

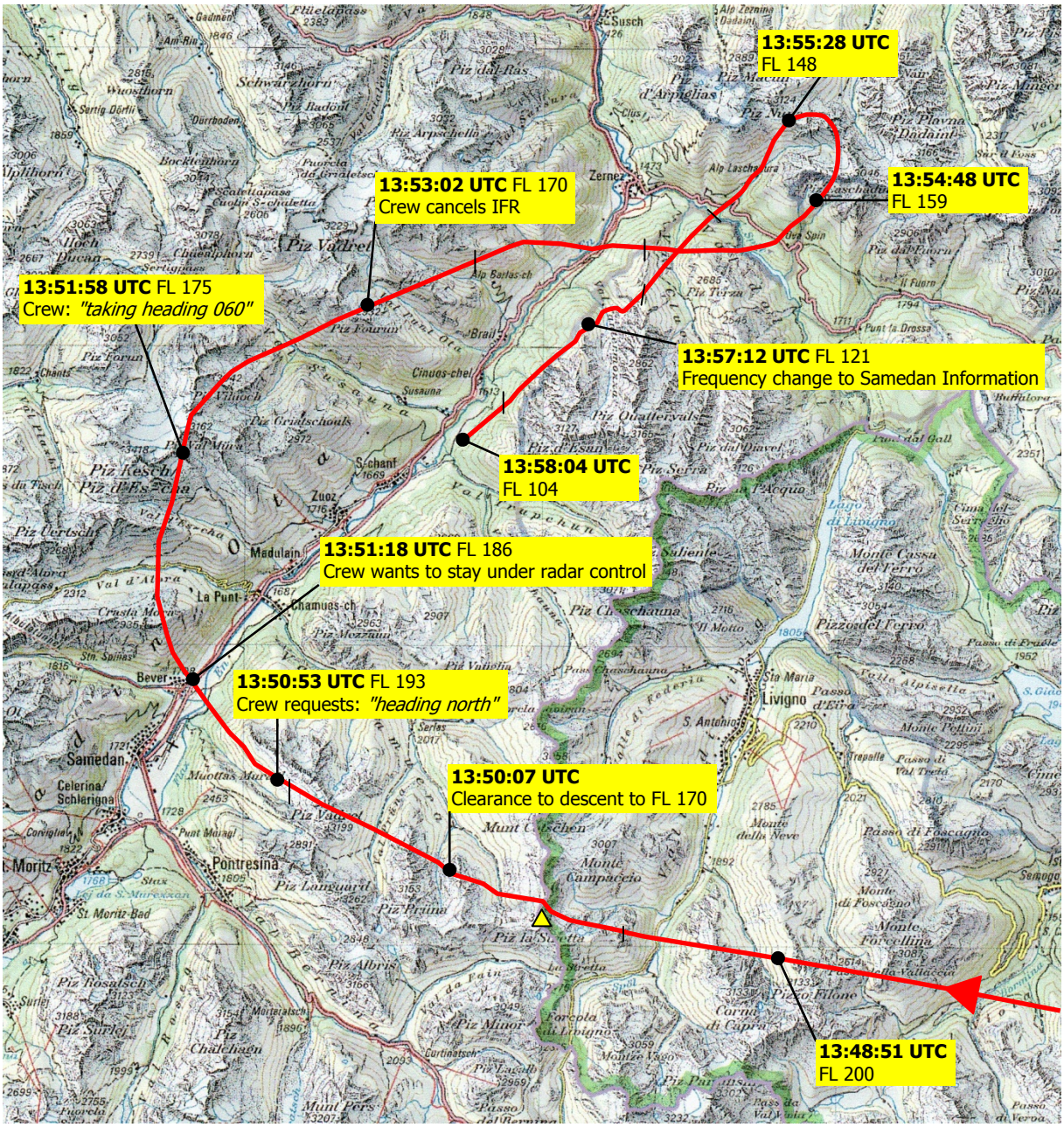
Payerne, 23 April 2012 Swiss Accident Investigation Board

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, 12 June 2012

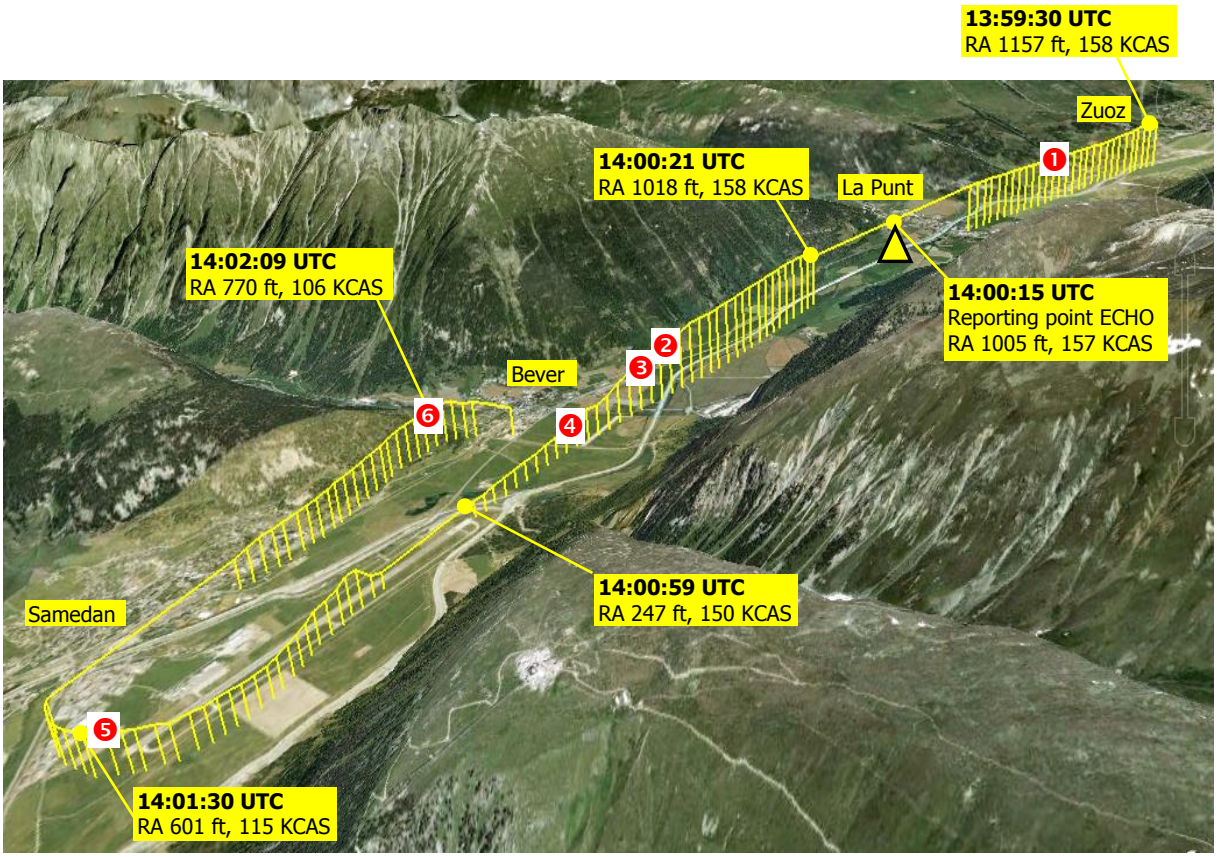
Annexes

Annex 1: Flight path according radar data



△ Waypoint RESIA

Annex 2: Flight path according EGPWS recordings



RA recorded radio-altitude (RA)

KCAS knots calibrated airspeed: corrected airspeed in knots. In the present case almost equal to the indicated airspeed in knots (knots indicated airspeed – KIAS).

❶ EPWGS alert *"caution terrain!"* sounds (only if TERR INHIB is not deactivated)

❷ EPWGS alert *"sink rate!"* sounds

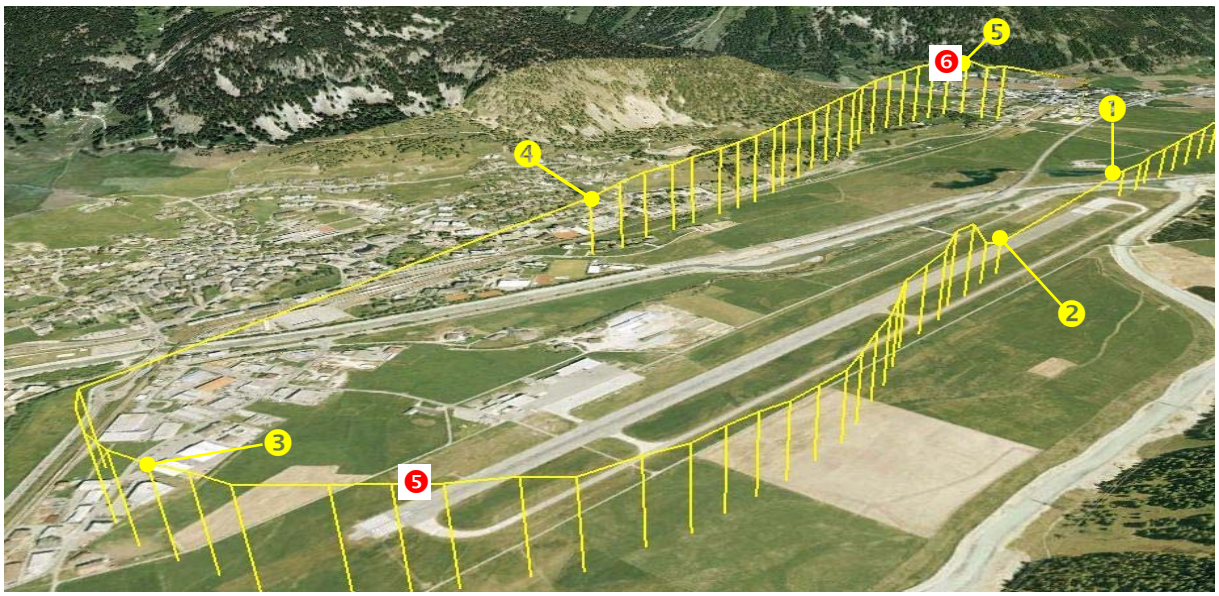
❸ EPWGS alert *"pull up!"* sounds

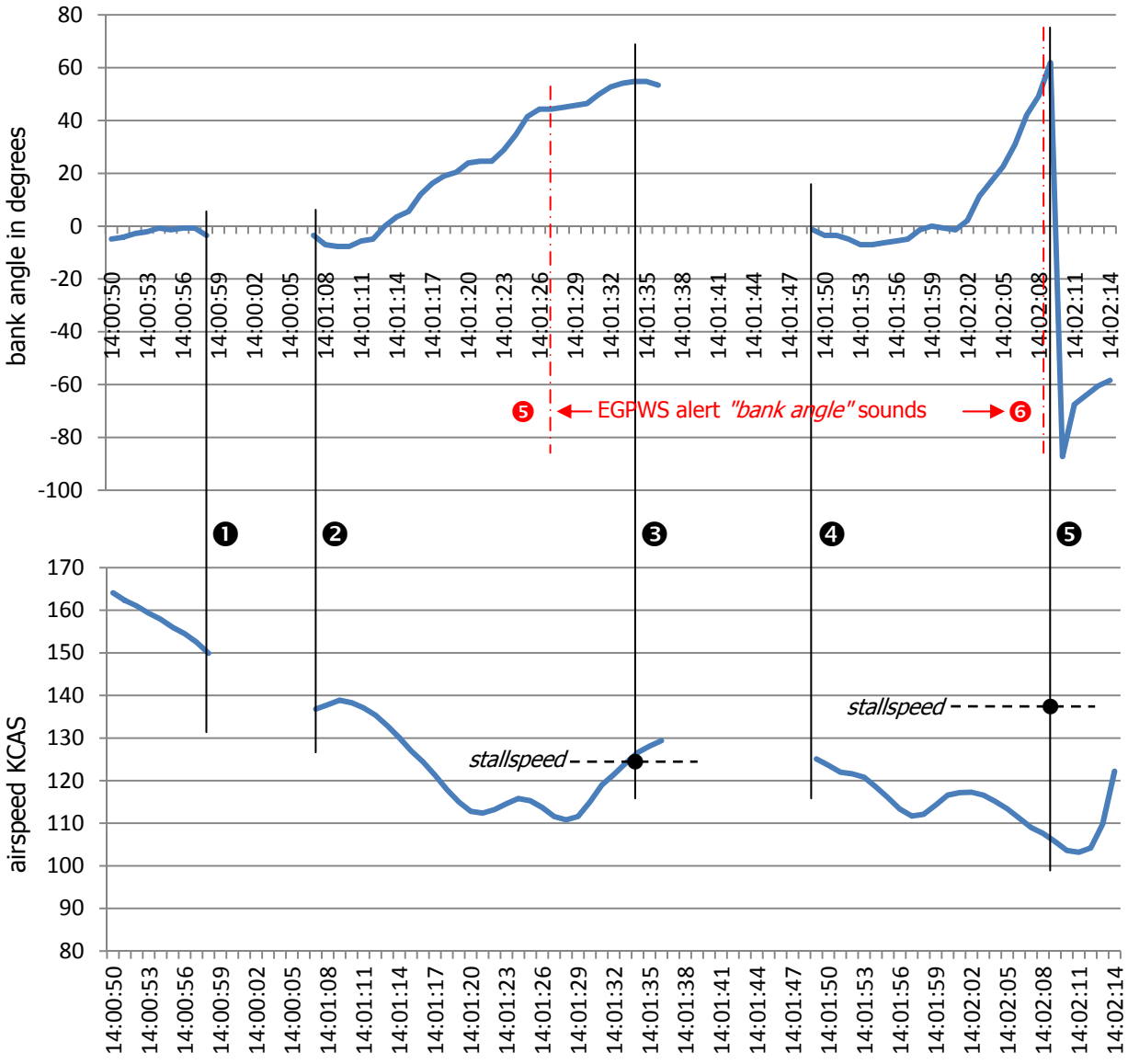
❹ EPWGS alert *"sink rate!"* sounds

❺ EPWGS alert *"bank angle!"* sounds

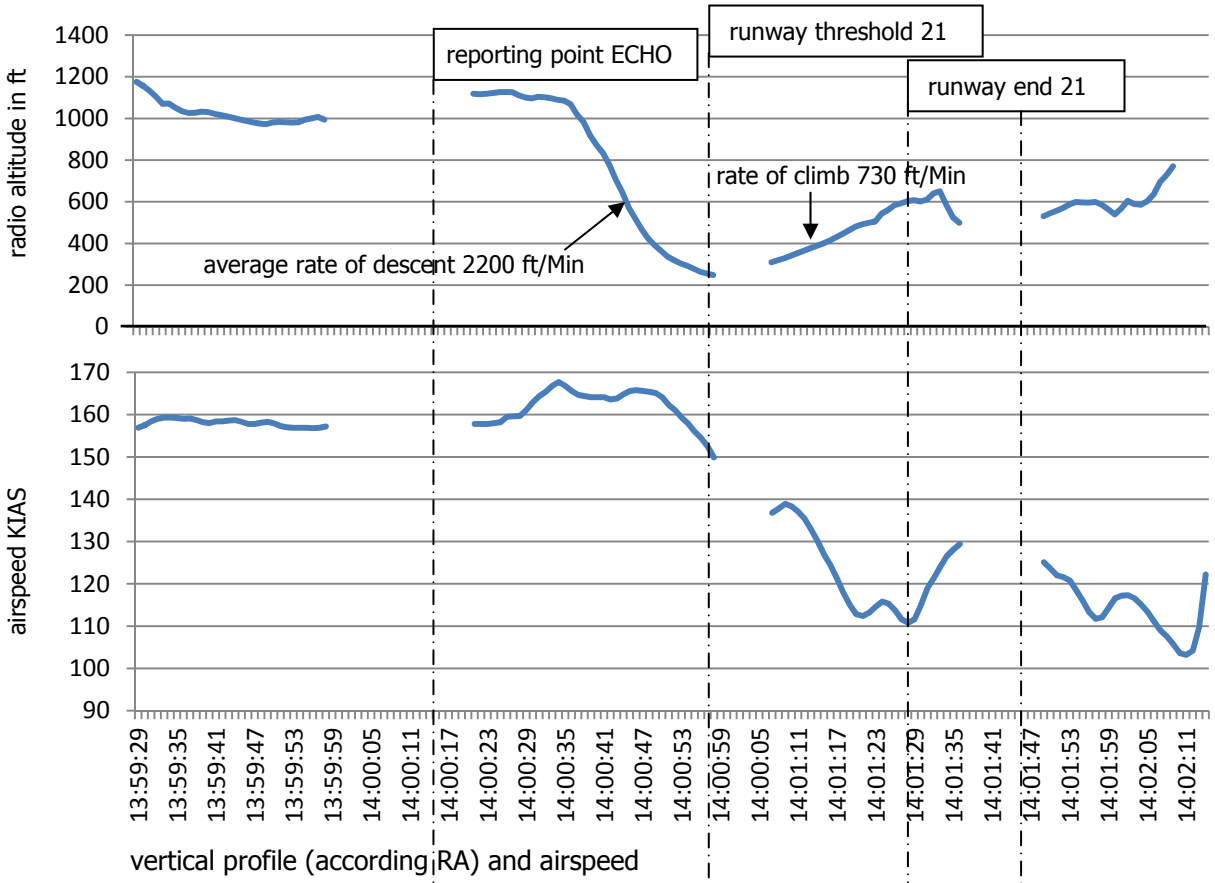
❻ EPWGS alert *"bank angle!"* sounds

Annex 3: Flight path in the Samedan airport aerea

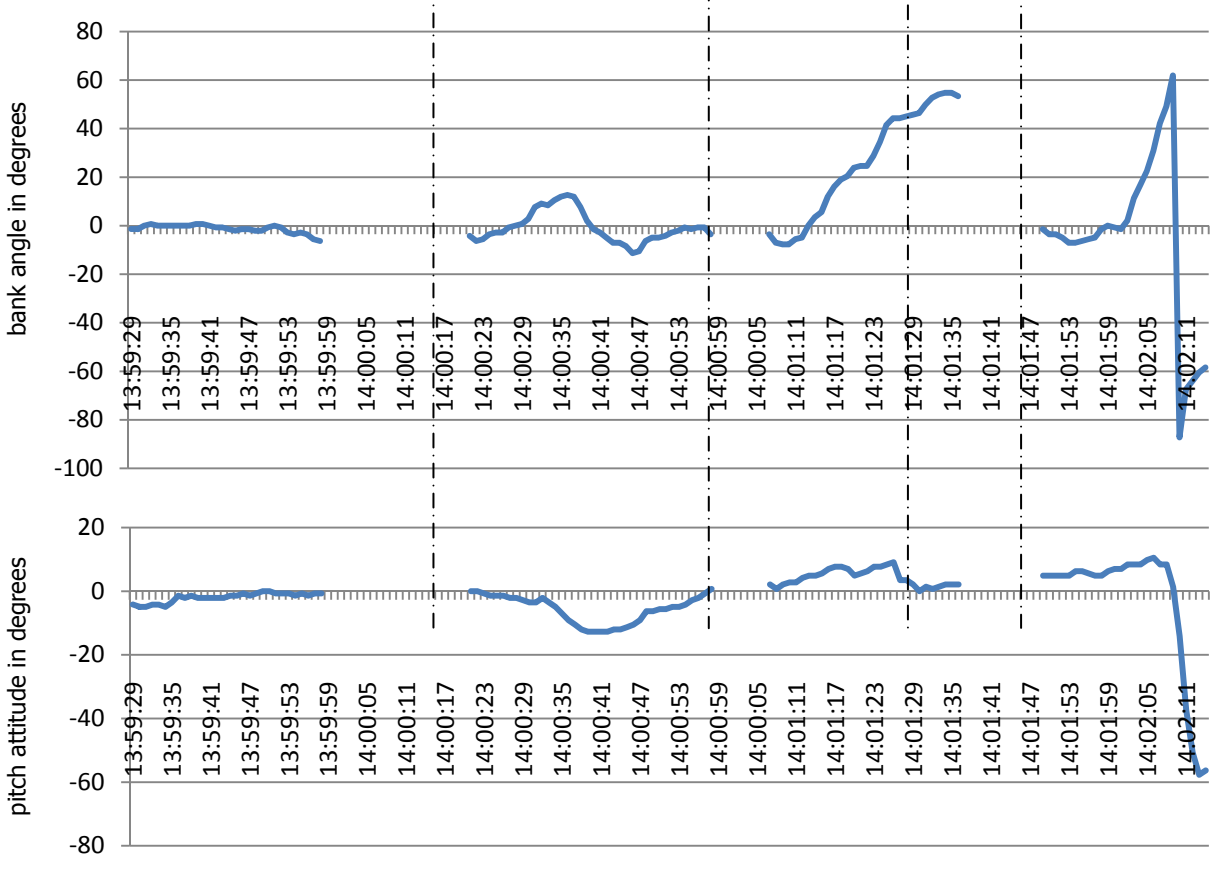




Annex 4: EGPWS recordings

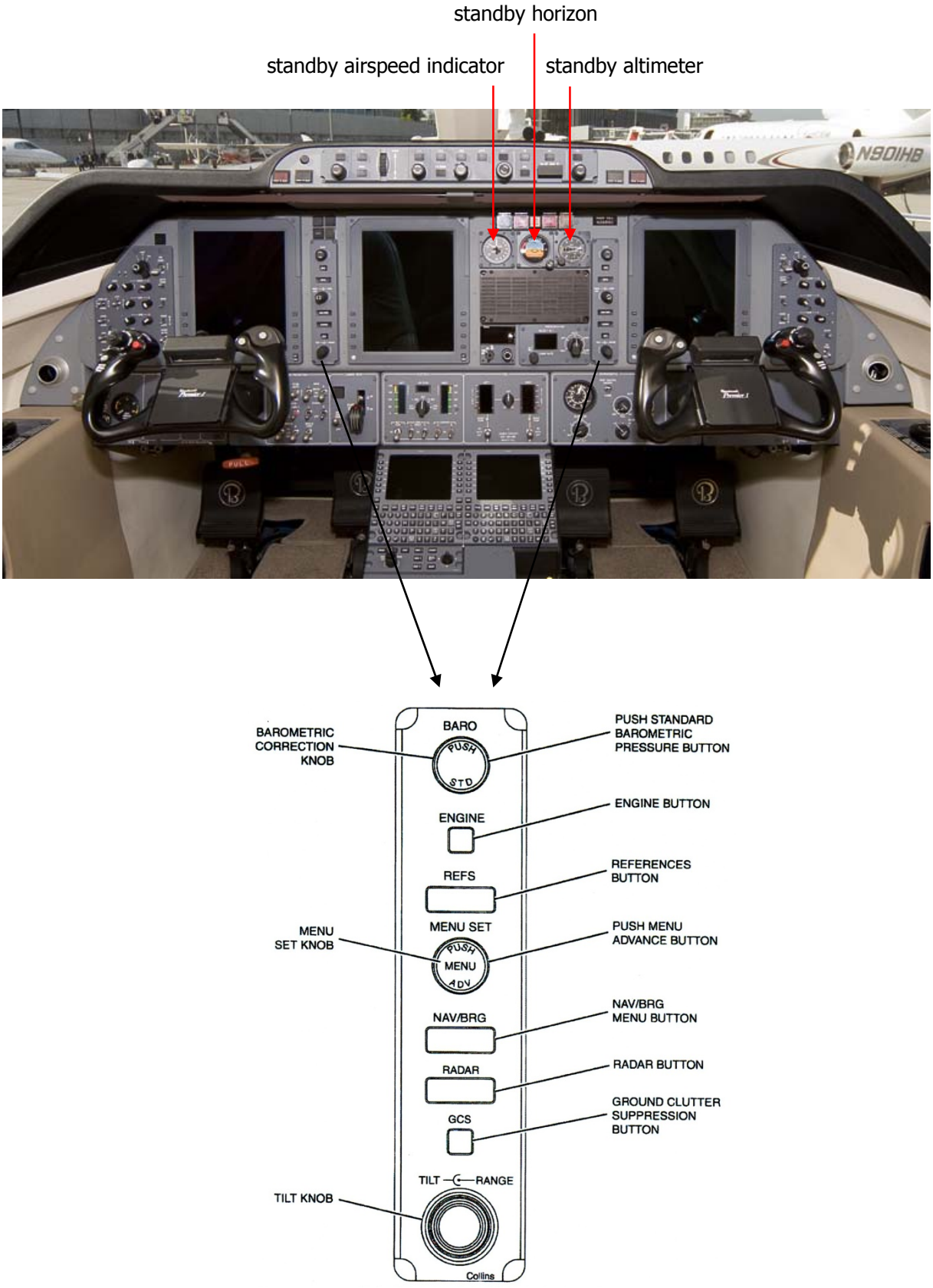


vertical profile (according RA) and airspeed



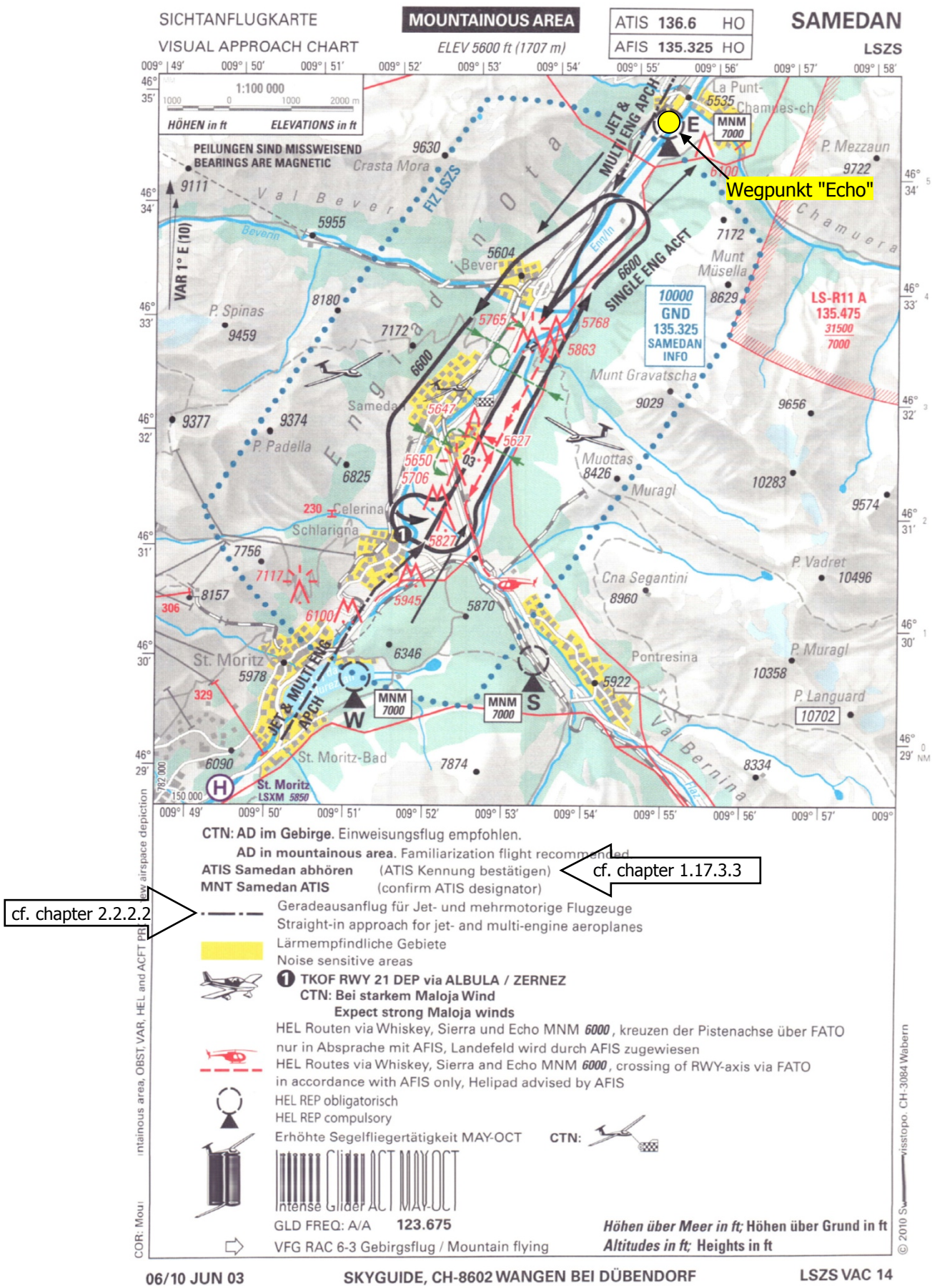
Bank angle and pitch attitude

Annex 5: Cockpit layout

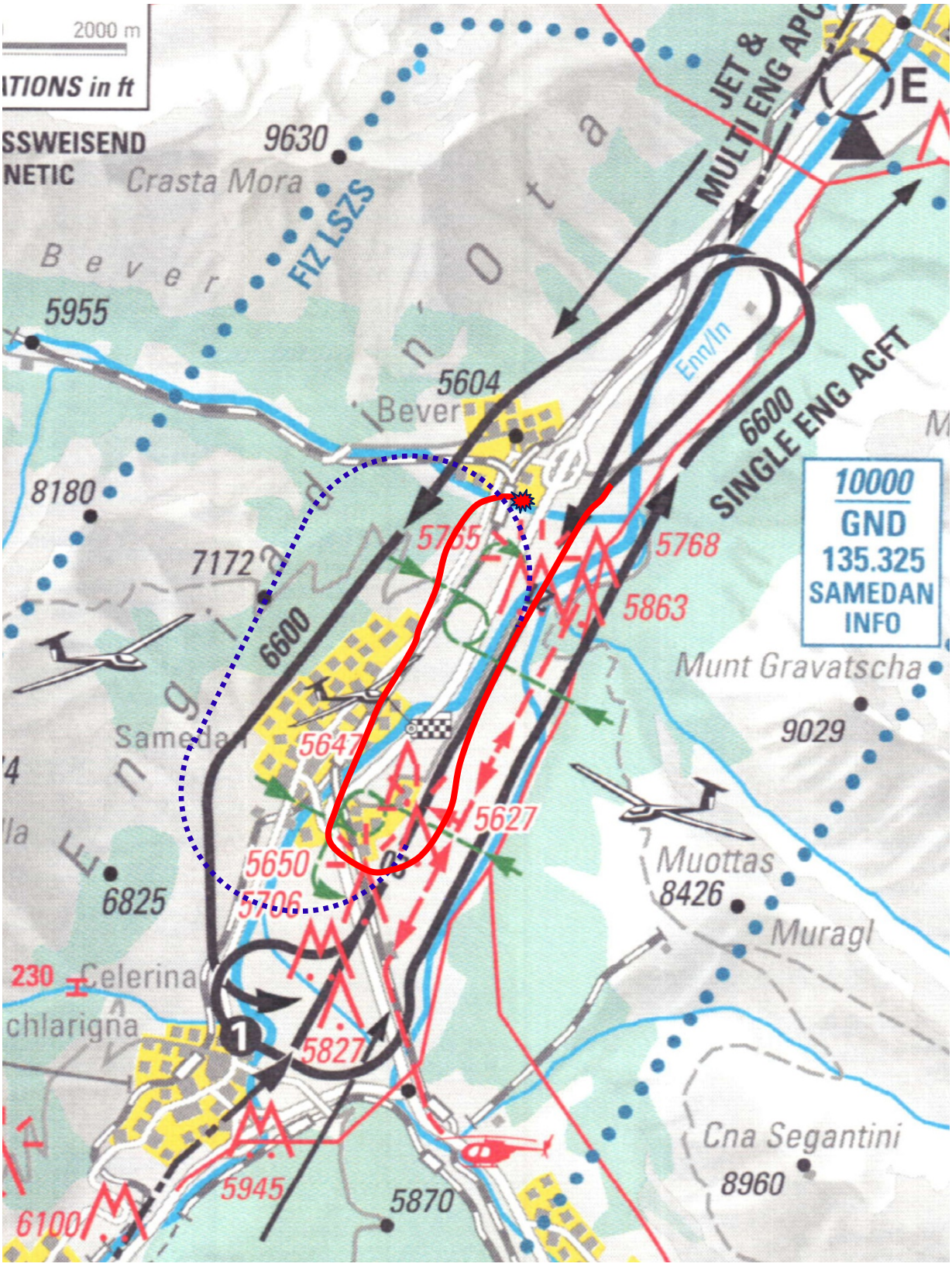


display control panel (DCP), figure 34-22
from the maintenance training manual
of Flight Safety International, page 43-52

Annex 6: Visual approach chart Samedan



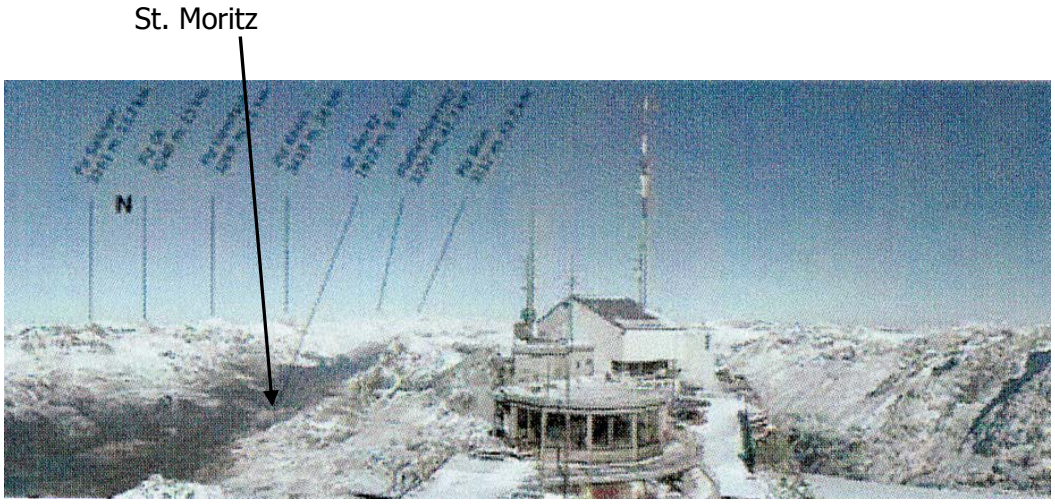
Annex 7: Extract from visual approach chart Samedan with flight path D-IAYL



flight path D-IAYL according EGPWS recordings with crash site

for comparison a fictitious circling approach is drawn. The turn radiuses are based on a bank angle of 30 degrees and a airspeed of 135 knots.

Annex 8: Camera images provided by MeteoSwiss from location Corvatsch



As comparison: view from Corvatsch direction St. Moritz on 19 Oktober 2009

19 Dezember 2010 UTC: Thin out of cloud is clearly recognisable.

Annex 9: Images of the Samedan airport webcam

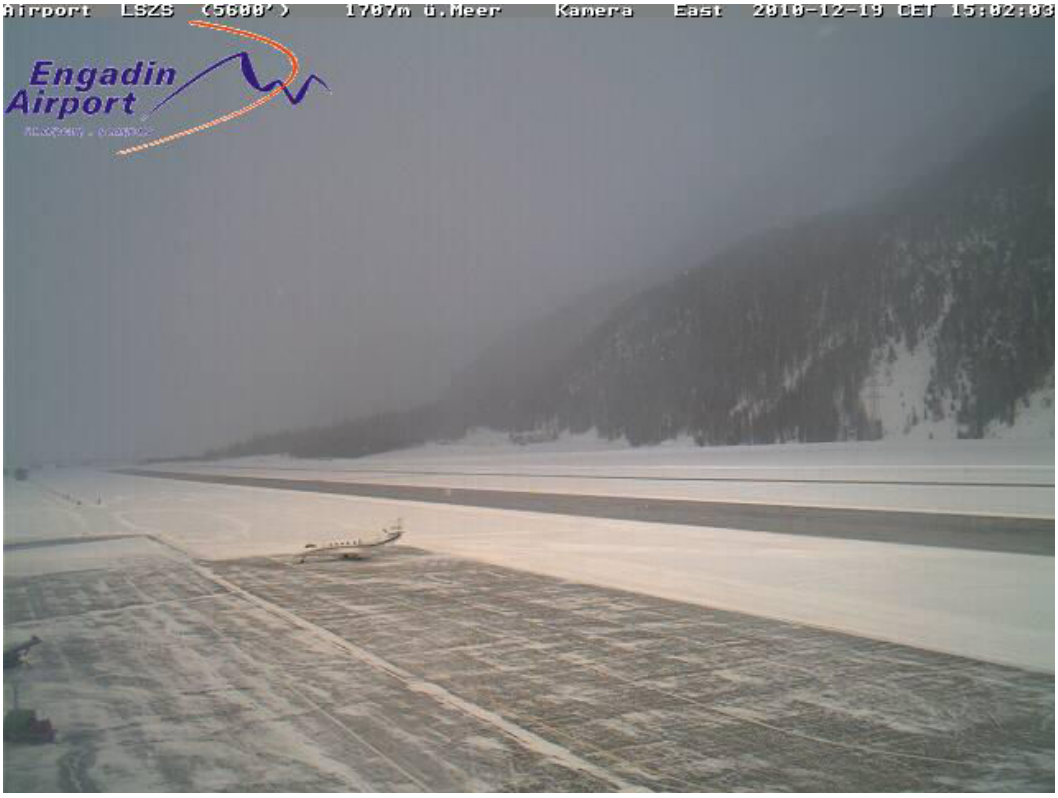
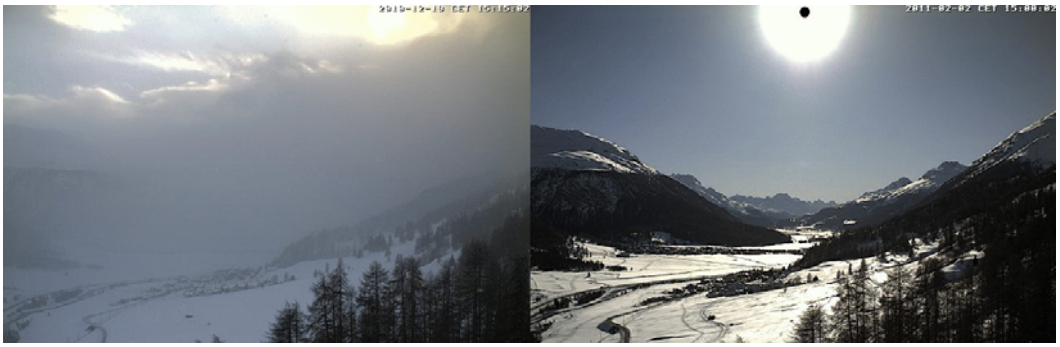


Image from 19 Dezember 2010 at 14:02:03 UTC, view direction runway threshold 21. On top left the grey wall with blowing snow extending to the ground is visible. At the same time west of the airport, at the rear of the observer, gaps in cloud are standing out, brightening the tarmac. Those gaps belong to the wave trough in the cloud between Samedan and Celerina.

Annex 10: Images of a webcam in Zuoz



Both images come from the webcam on the Hotel Castell in Zuoz. On the left image the north edge of the cloud band with +SN on 19 December 2010 at 14:15 UTC is visible. The image to the right shows the same detail in a cloudless situation. The village in the foreground is Madulain.

Annex 11: Accident site

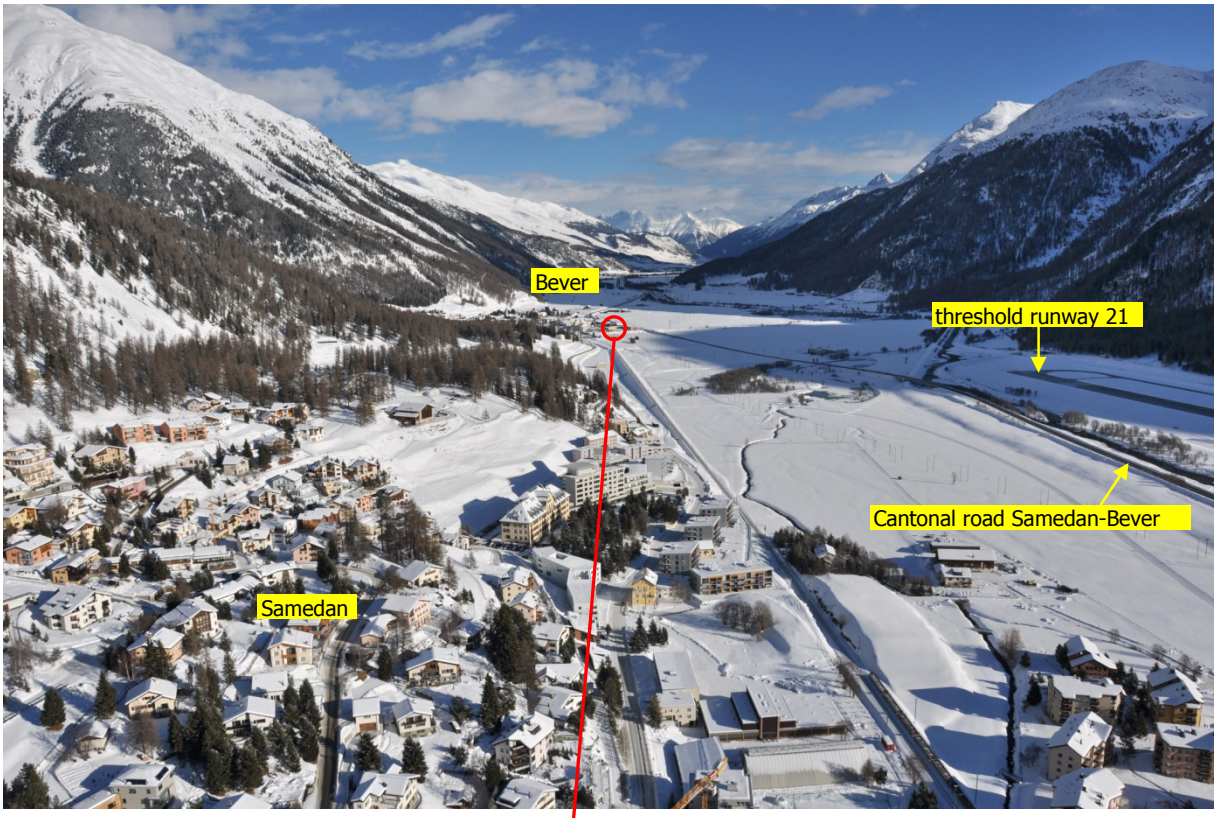


Figure 1: view direction north east

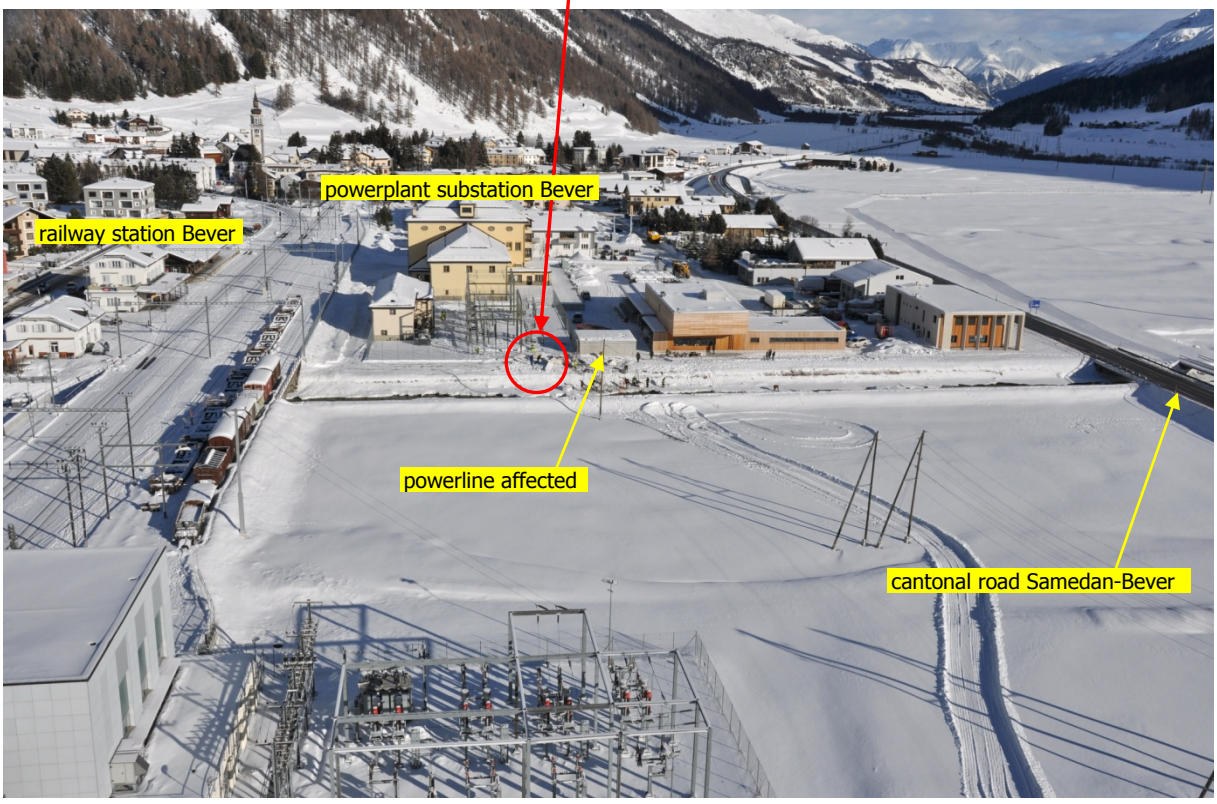
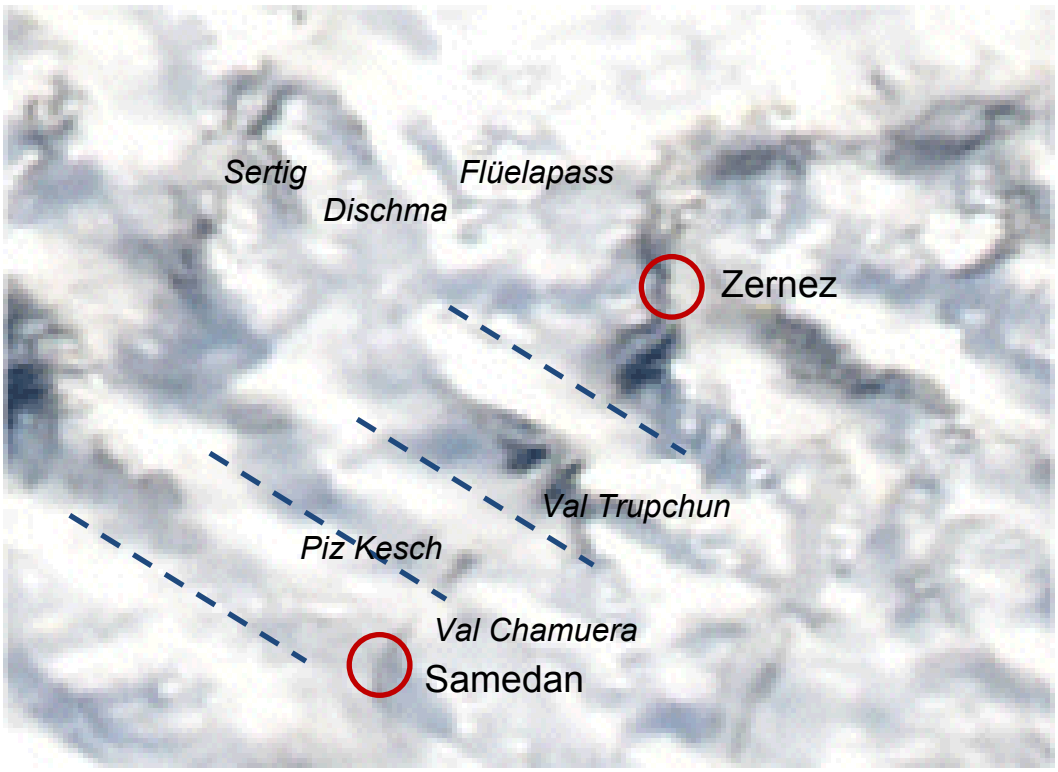


Figure 2: accident site ○ at the powerplant substation Bever (Repower)

Annex 12: Weather in the Engadin

MODIS Aqua Image, taken at 12:35 UTC. Clearly visible are the mountain waves, running crossways to the wind. The cloud gaps over "Nord- und Mittelbünden" and in the lower Engadin are also visible.



Extract of the above figure. The wave axes are drawn in blue. Snow covered mountain ridges and cloud are in part difficult to tell apart. The wave axes are much better to make out where they cross the river En valley and covering in white the dark tree-coverd valleyflanks.

Annex 13: Checlist comparison

Manufacturer Checklist

Hawker Beechcraft — FlightSafety international

DESCENT

1. Seat Belts/Shoulder Harnesses .....FASTENED
2. Cabin Signs .....AS REQUIRED
3. Recognition Light.....AS REQUIRED
4. Ice Protection.....AS REQUIRED
5. Pressurization.....CHECK/SET LANDING ALTITUDE
6. Windshield Defrost .....AS REQUIRED
7. Windshield Heat .....AS REQUIRED
8. Altimeters .....SET
9. TERR INHIB .....AS REQUIRED
10. TERR DISPLAY.....AS REQUIRED
11. N_1 Ref Display.....AUTO

APPROACH

1. V_{REF}, V_{AC}, N_1 Ref, Landing Distance.....CONFIRM/SET
2. Crew Briefing .....COMPLETE
3. Seats .....POSITION FOR LANDING
4. Fuel Balance .....WITHIN LIMITS
5. Landing Lights.....ON
6. Recognition Light.....AS DESIRED
7. Cabin Signs.....NO SMOKE/SEAT BELTS
8. Ignitions.....ON
9. Engine Sync .....OFF
10. Flaps.....10
11. TCAS .....AS REQUIRED

APPROACH AND LANDING AIRSPEEDS

WEIGHT ~ POUNDS	PFD		COPILOT OR STANDBY	
	V_{REF}	V_{AC}	V_{REF}	V_{AC}
12,500	121	135	120	134
11,600	117	131	116	129
11,000	114	127	113	126
10,000	109	122	108	120
9,000	104	116	102	114
8,000	98	109	96	107

BEFORE LANDING

1. Landing Gear .....DN
2. Lift Dump.....UNLOCK, HANDLE ILLUMINATED, J-HOOK CLEAR

WARNING

Do not extend lift dump in flight. Extending lift dump in flight could result in loss of airplane control leading to airplane damage and injury to personnel.

3. Flaps .....DN
4. Autopilot .....DISENGAGE
5. Yaw Damp.....OFF

Operator Checklist

DESCENT (FL100)	
Land. / Rec. Lights	ON
Ice Protection	AS REQUIRED
Pressurization	CHECK LDD ALT
Crew Briefing	COMPLETE

APPROACH	
Altimeters	SET
Fuel Balance	WITHIN LIMITS
Engine Sync	OFF

APPROACH SPEEDS		
Weight	VREF	VAC
12.500	121	135
11.600	117	131
11.000	114	127
10.000	109	122
9.000	104	116

BEFORE LANDING	
Landing Gear	DOWN
Lift Dump	UNLOCK/CLEAR
Flaps	DOWN
Ignitions	ON
Autopilot / YD	OFF

Annex 14: timeline of the essential events

UTC	event / weather / remarks	FISO A / B	approach traffic to Samedan
06:23		Start of duty FISO B	
07:58		Start of duty FISO A	
09:00		FISO A on position "Samedan Information“	
10:00	Last valid SNOWTAM (snow conditions on the airport)		
10:30		FISO A on position "Samedan Information“	
11:20	Information FOXTROT broadcast		
11:25	Forecast (TAF) for Samefan airport		
12:00	6 business jet aircraft, 3 turboprop aircraft, either aborted their approach early or did not attempt an approach at all.		A turboprop aircraft lands in Samedan
12:20	Information GOLF broadcast		
12:33-12:38	Deicing of **D-IAYL**		
13:01	Take-off of **D-IAYL** in Zagreb (LDZA)		
13:14:10			Citation C56X inquires about traffic and cloud base
13:14:20		Weather information given by FISO B to the crew of C56X: *"(…) and visibility five to six kilometers, light snowing, six knots ahead of runway two one, scattered three thousand, broken for thousand to for thousand five hundred feet"*	
13:14			A business jet aircraft lands in Samedan
13:20	Information HOTEL broadcast		
13:24:59			Citation C525 asks: *"do you see the sky above, is there any chance to come in to Samedan"*
13:25:04		Answer from FISO B to the C525: *"yes I can see but it's not very clear because I have some mist in the valley, I think the layer is very thin"*	
from 13:30	Latest from this point in time, FISO A was able to monitor the corresponding radio reports done by FISO B	FISO A was next to the workstation of FISO B.	
13:31:50		Message from FISO B to the crew of a Siai Marchetti SF260, to land at own discretion.	SF 260 acknowledges this message immediately as follows: *"(…) to land at own discretion, runway not in sight yet and if someone wants to come into the valley, via Zernez south side is wide open".*

13:33:32		FISO B asks SF260, whether they could see reporting point ECHO (La Punt).	
13:33:36			Answer by the SF260: *"we have no visibility to ECHO"*
13:34:06	The Citation C525 was the following traffic behind the SF260 to Samedan airport.		Message by the C525: *"inbound the valley we try to make a landing on runway two one."*
13:34:20		Weather report from FISO B to the crew of the C525: *"preceding traffic is now passing ECHO, just reported is good visibility from Zernez to ECHO; runway two one, report six miles final"*	
13:34:35	According to his statement, though FISO A recalls this conversation, he does not exactly know what information the crew gave.		Answer from SF260: *"very low at ECHO because ECHO is äh bit blocked at six thousand two hundred feet"*
13:34:50			Answer of the SF260 to the FISO B's question about the cloud ceiling over ECHO: *"ceiling is very low it's horrible at six thousand two hundred feet".*
13:34:54			C525: Message about go around and diversion to the alternate aeroport.
13:35:10		FISO B to SF260, visual contact to C525 and wind information	
13:35:40			C56X calls again FISO B in Samedan, is ready for a visual approach on runway 21.
13:39:32		FISO B informs: a first aircraft in approach and a second made a go around and diverts to the alternate airport.	
13:36			The SF260 lands in Samedan
13:40:00	This report was heard by FISO A, since he had already spent some time sitting next to FISO B before taking over the "Samedan Information" position. According to the statement of FISO B, he provided this weather information on the basis of the report from the pilot of the Siai Marchetti SF260.	FISO B reports to the C56X the following: *"for information, during the approach the last three miles the visibility is marginal, the ceiling is very low 6300 feet"*	
13:40:23			C56X: reports go around and flight to the alternate airport.
13:42:56			First contact established by a Piaggio P180 as follows: *"is it possible to make an attempt to come in?"*

13:43:18	This weather report differs considerably from the one which FISO B had provided to the crew of the C56X three minutes before.	Answer from FISO B to the crew of the P180: *"condition for the airport is now marginal, we have two diversions, Jets, two minutes ago, we have light snow, visibility about four up to five kilometers maximum and scattered three thousand feet, four thousand five hundred feet broken, QNH one zero zero two, wind for the runway two one six knots"*	
13:45:02			First contact of the **QGA 631V** with ZRH ACC South Sector
13:45:17			New transponder code set by the **QGA 631V**.
13:50	New METAR for Samedan airport (LSZS) created, but not broadcast.		
13:50:07	FL 170 is equal to the lowest possible IFR level		Descend clearance to FL 170 given to **QGA 631V** with the request to call for cancelling the IFR flightplan.
13:50:53	**D-IAYL** approaches Samedan on a north-westerly course at this time.		**QGA 631V** requests *"heading north"*
13:51:14			**QGA 631V** gets the clearance to overfly Samedan airport at own convenience.
13:51:18	**D-IAYL** is over the airport Samedan at FL 186 at this time.		**QGA 631V** acknowledges this message and requests continuing radar control.
13:51:58			**QGA 631V** informs ACC *south sector*, that they were taking a heading of 060.
13:53:02	**D-IAYL** is approaching the village of Zernez at this time on heading 060 from a south-westerly direction at FL 170.		**QGA 631V** requests cancelling the IFR-flight plan
13:53:09		Cancellation of IFR flight is granted to **QGA 631V** with the information that there was no other IFR traffic below **QGA 631V**.	
13:54:01			Request to **QGA 631V** to switch to the Samedan Information frequency.
13:54:06	This is approved by ACC *south sector*.		The crew of **QGA 631V** immediately asks to remain for a further two minutes on the frequency.
13:54:48	**D-IAYL** is in a left turn on FL 159 for the final approach to runway 21.		
13:55	New SPECI for LSZS, created at 13:45 (handcorrected to 13:55) but not broadcast on the ATIS frequency.		
13:55:28	**D-IAYL** north-east of Zernez in a long final on FL 148.		
13:56		After a short briefing, FISO A takes over position “Samedan Information“ from FISO B.	

13:57:12	**D-IAYL**: on FL 121.		**QGA 631V:** Reports to ZRH ACC south sector frequency change to "Samedan Information".
13:57:39			First call of the **QGA 631V** to "Samedan Information"
13:57:50	The reported QNH was not read back by the crew of **QGA 631V** and at least not set on the standby altimeter.		FISO A: Reports the QNH of 1002 hPa to **QGA 631V**
13:58:04	Last radar contact of **D-IAYL** on FL 104 on a south-westerly heading.		
13:58:16		FISO A inquires about the position of the P180.	
13:58:25			P180: reports position
13:58:40			P180: Question about the weather situation in the Samedan approach area.
13:58:46			Answer by the **QGA 631V** before the FISO A was able to answer: *"Yes, fort he moment good condition Quadriga six three one Victor"*
13:59:12	**D-IAYL**: north-east of Zuoz		**QGA 631V**: repeated question about the weather over the airport.
13:59:27	**D-IAYL**: south-west of Zuoz at a height of approximately 1200 ft AGL and an air-speed of approximately 150 kt	Answer from FISO A to **QGA 631V**: *"Quadriga six three one Victor, visibility three or four kilometres cloud base few at two thousand feet and overcast at five thousand or six thousand feet."*	
13:59:42	According to the recordings of the EGPWS, **D-IAYL** is at this time over Madulein, approximately four miles before the runway 21 threshold.		The crew of **QGA 631V** reports that they were at five miles on final approach.
13:59:46	Increasing the rate of descend to an average of 2240 ft/min down to an RA of 247 ft (directly over the threshold of runway 21) Alerts of the EGPWS *"sinkrate!", "pull up!"* (cf. Annex 2)	Report from FISO A to **QGA 631V**: *"Quadriga six three one Victor, wind two zero zero degrees one zero knots land at own discretion runway two one"*	Is acknowledged by **QGA 631V**
14:00:59	**D-IAYL** passes threshold of runway 21 at this time		
14:01:12	At this time FISO A has visual contact to **D-IAYL.**	FISO A: reports go around of **QGA 631V** to P180	
14:01:27	**D-IAYL:** Initiating a right turn after the end of runway 21 with a max. bank angle of 55° (corresponding stall speed: 124 kt). Alert of the EGPWS *"bank angle!"*		**QGA 631V** reports a right turn During the next 20 seconds the frequency remains blocked.
14:02:09	**D-IAYL** Initiating the base turn to the right at the end oft he downwind leg with a max. bank angle of 62° at a decreasing speed of 106 kt (corresponding stall speed: 137 kt). Alert of the EGPWS: *"bank angle!"*		
14:02:10		FISO A gives **QGA 631V** a wind information and says**:** *"(…) may land anytime runway two one."*	Is acknowledged by **QGA 631V**

14:02	Time oft he accident; From this point in time there is a power loss on the airport Samedan until 15:22		
14:05	One-time signal transmission from the ELBA		
14:05	Alerting of REGA		
14:07	Informing the cantonal police by tele-phone		
14:19	Accident notification comes in		
17:30	Opening of the investigation by the BFU		