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Aircraft accident investigation bureau AAIB

Final Report No. 2074 by the Aircraft Accident Investigation Bureau

concerning the accident involving
the Marcel Dassault/Bréguet Aviation Falcon 10/100, registration VP-BAF
operated by Laret Aviation Ltd.
on 12 February 2009
Samedan Airport, municipality Samedan/GR

Aéropôle 1, Route de Morens, CH-1530 Payerne

Ursachen

Der Unfall ist darauf zurückzuführen, dass die Besatzung des Flugzeuges bei unzureichenden Sichtreferenzen aus einer ungünstigen Ausgangslage eine Landung durchführen wollte, was dazu führte, dass das Flugzeug nach dem Aufsetzen mit einem entlang der Piste verlaufenden Schneewall kollidierte.

Folgende Faktoren haben zur Entstehung des Unfalls beigetragen:

- Die sich rasch verändernden Wetterbedingungen auf dem Gebirgsflugplatz Samedan wurden von der Besatzung falsch beurteilt.
- Eine koordinierte Arbeitsweise der Besatzung im Sinne von *crew resource management* fehlte.
- Die Deaktivierung des EGPWS, die dazu führte, dass akustische Hinweise bezüglich Höhe über Grund und Querlage des Flugzeuges in der letzten Phase des Anfluges bis zum ersten Kontakt mit der Piste nicht mehr zur Verfügung standen.
- Entlang des Pistenrandes verlief ein bis zu vier Meter hoher Schneewall.

General information on this report

This report contains the conclusions of the Aircraft Accident Investigation Bureau (AAIB) on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with art 3.1 of the 9th edition, applicable from 1 November 2001, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

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

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

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the 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.

Contents

Final Report

Synopsis

Owner	Laret Aviation Limited, Clarendon House, 2, Church Street, Hamilton HM 11, Bermuda
Operator	Laret Aviation Limited, Clarendon House, 2, Church Street, Hamilton HM 11, Bermuda
Manufacturer	Avions Marcel Dassault/Bréguet Aviation
Aircraft type	Falcon 10/100
Country of registration	Bermuda
Registration	VP-BAF
Location	Samedan Airport (LSZS), municipality Samedan /GR
Date and time	12 February 2009, 15:12 UTC

Investigation

The accident occurred on 12 February 2009 at 15:12 UTC. The operations centre of the Grisons cantonal police was alerted immediately. The alert reached the Aircraft Accident Investigation Bureau (AAIB) immediately afterwards and the investigation was opened on the same day at approximately 20:30 UTC, in cooperation with the Grisons cantonal police.

Summary

On 12 February 2009, the Marcel Dassault/Bréguet Aviation Falcon 10 aircraft, registration VP-BAF, took off at 14:06 UTC from Vienna (LOWW) on a private flight under instrument flight rules (IFR) and an ATC flight plan Y, to Samedan (LSZS). Two crew members and one passenger were on board. After an uneventful flight, the IFR flight plan was cancelled at 14:56:32 UTC and the flight continued under visual flight rules (VFR). Over Samedan the crew were informed by the Samedan airport flight information service officer (FISO) that snow clearance work would be taking place on the runway and that they should expect a ten-minute delay. After approximately 15 minutes the crew initiated the approach. On landing, the aircraft made first contact with the ground by scraping the right wing on the left half of the runway and subsequently touched down with the right, and then the left main landing gear. It then drifted to the left and the left wing tip scraped a bank of snow running parallel to the runway. As a result it rotated anti-clockwise around its vertical axis and crashed into a frozen bank of snow about four metres high. The aircraft broke into two pieces as a result of the force of the impact.

The two pilots suffered fatal injuries on the impact. The passenger was seriously injured. The aircraft was destroyed. Fire did not break out.

Causes

The accident is attributable to the fact that the crew wanted to make a landing with inadequate visual references from an unfavourable initial position and as a result, after touchdown the aircraft collided with a snowbank running along the runway.

The following factors contributed to the accident:

- The rapidly changing weather conditions on the mountain aerodrome of Samedan were misjudged by the crew.
- A coordinated crew working method in terms of crew resource management was missing.
- The deactivation of the EGPWS, which meant that acoustic messages concerning the aircraft's height above ground and bank angle were no longer available in the final phase of the approach up to the first contact with the runway.
- A snowbank up to four metres high ran along the edge of the runway.

1 Factual information

1.1 Pre-history and history of the flight

1.1.1 General

For the following description of the history of the flight, the recordings of the radio communication, conversations and noises in the cockpit, radar data and the data from an onboard mobile GPS device were used. Throughout the whole flight the commander was pilot flying (PF) and the copilot was pilot not flying (PNF).

The time information in the transcript of the radio communication in Samedan and the time information in the CVR (cockpit voice recorder) were synchronised with the transcription of the ATC radio telephone conversations.

Up to the Samedan area, the flight took place under instrument flight rules (IFR) according to an ATC flight plan Y. The subsequent 180° turns and the holding patterns, the final approach and the landing in Samedan were carried out according to visual flight rules (VFR).

Analysis of the CVR, flight path and flight attitude led to the conclusion that at least after completion of the flight under instrument flight rules the autopilot was no longer used.

1.1.2 Pre-history

Aircraft VP-BAF was in private ownership and was operated by the owner through a company belonging to him. This company had employed three pilots for this purpose, the two pilots involved in the accident and an additional, third pilot. The pilots regularly flew to Samedan airport. The commander had flown to Samedan thirty times in 2008 and the copilot six times.

On 18 January 2009, the aircraft made a ferry flight to Paris, to the manufacturer's maintenance facility, where it was repainted. On 9 February 2009, the aircraft was flown from Paris to Samedan and on 10 February 2009 from Samedan to Vienna. On these two flights the crew consisted of the commander involved in the accident and the third pilot.

1.1.3 Flight preparations

At approximately 13:00 UTC on 12 February 2009, aircraft VP-BAF was moved from the hangar to the apron at Vienna-Schwechat (LOWW). At 13:15 UTC, the aircraft was refuelled in the presence of the pilot with 1201 l of fuel, corresponding to 2100 lb.

According to the aircraft flight log, after the flight from Samedan to Vienna on 10 February 2009 there was still 2500 lb of fuel on board. After refuelling, the aircraft therefore had 4600 lb of fuel on board.

For flight planning purposes, the crew received by fax, from a company commissioned with the task, various documents such as an ATC flight plan, an operational flight plan (OFP), weather and wind information.

For the flight to Samedan, with Zurich as the alternate airport, the OFP specified a minimum block fuel of 2099 lb. The quantity of fuel actually on board and the actual take-off mass of the aircraft were not entered in the OFP by the crew.

According to the third pilot's statement, the take-off mass and centre of gravity calculations were made in each case according to the manufacturer's guidelines.

Such a pre-printed sheet was found among the papers found on the aircraft. On this paper, dated 18 December 2008, the basic operating weight (2 crew members, local flights) is specified as 12 454 lb.

Since the aircraft had been repainted in January/February 2009, it was weighed on 6 February 2009. This produced a basic empty weight which was 21 lb above the weight established on 18 December 2006.

Among other things, the documentation received for flight preparations, valid from 12 February 2009 12:47 UTC to 14 February 12:47 UTC, stated:

"Briefing includes SNOWTAM [1] NOTAM DOCINFO excluding NOTAM that are valid for more than 90 days."

According to the owner's statement, he wanted to stay in Celerina over the week-end and prior to departure from Vienna he had let it up to the crew flying the aircraft back to Vienna that same evening.

1.1.4 History of the flight

On 12 February 2009, the Falcon 10 aircraft, registration VP-BAF, took off at 14:06 UTC from Vienna on a private flight which, for the majority of the flight path, was to be made according to instrument flight rules and which envisaged an approach and landing in Samedan according to visual flight rules (ATC flight plan Y). Two crew members and the owner of the aircraft, as a passenger, were on board. After an uneventful flight, the crew of VP-BAF reported at 14:53:10 UTC to the Zurich sector south air traffic control officer (ATCO) as follows: *"Swiss Radar Victor Papa Bravo Alfa Foxtrot good afternoon down to level two hundred still IFR inbound RESIA"*. The ATCO reported to the crew at 14:53:18 UTC that he had identified the aircraft on radar and cleared them to fly direct to the destination airport. At this time the aircraft was 23 NM south-east of waypoint RESIA. Just under four minutes previously, the crew had listened on the Samedan airport information frequency to the 14:20 UTC weather information (ATIS) "JULIETT", which reported, among other things, visibility of 3000 m, complete cloud cover at 3000 ft and light snowfall.

When the crew asked the ATCO at 14:53:26 UTC whether they could cancel the flight under instrument flight rules in order to continue it under visual flight rules, he replied that he would first have to coordinate this request with Padua. While the crew awaited the corresponding clearance, they made contact using the second radio with the Samedan airport information service officer (FISO) and reported to him at 14:54:00 UTC that their position was around 30 miles south-east of the airport. They asked about the conditions prevailing at the airport. At 14:54:09 UTC the FISO issued the following information, which was acknowledged by the crew: *"Victor Papa Bravo Alfa Foxtrot at the moment we have overcast three thousand feet with snow but in the region Maloja it makes open so you can expect high visibility until Maloja, then reduce up to three thousand meters before threshold zero three. We have runway zero three in use and the QNH is one zero zero six for landing, report ten miles for straight in zero three next."*

In the meantime, the crew had received a clearance from the Zurich sector south ATCO to descend to flight level (FL) 170.

[1] The SNOWTAM in the documentation corresponds to the 07:45 UTC SNOWTAM which Samedan had published (cf. section 1.7.5.1).

After the Samedan FISO had again called the crew, he informed them as follows at 14:55:33 UTC: *"Victor Papa Bravo Alfa Foxtrot at the moment they are sweeping the runway so you can expect black strip later on. Give us a little bit more time, approximately 10 minutes for snow removing."* The crew acknowledged this report.

The Zurich sector south ATCO then called the crew and asked whether they were ready to cancel the flight according to IFR. They confirmed this and the ATCO informed them at 14:56:32 UTC: *"IFR cancelled time one four five six."* At this time the aircraft was approximately 6 NM south-east of waypoint RESIA and descending to FL 170.

The flight continued under visual flight rules and the crew initiated a wide left turn south of the airport in a south-westerly direction. After the crew had signed off from the Zurich ATCO, there followed discussion in the cockpit about snow clearance from the runway in Samedan and it was noted that this would take another ten minutes. Shortly afterwards, at 14:59:55 UTC, the following acoustic warning sounded in the cockpit: *"Caution terrain, caution terrain"*. At this time the aircraft was descending, at 10 536 ft[2] and on a south-westerly heading direction Piz Nair. The aircraft's speed was 264 knots (kt) and the mobile GPS recordings indicate that the rate of descent was approximately 1500 feet per minute (ft/min) (Annex 2 and 3). The descent was then interrupted and the crew initiated a gentle climb to approximately 11 000 ft. During this period the aircraft's speed fell to 205 kt. The commander then ordered extension of the slats and flaps and he initiated another counter-clockwise 360° turn and a gentle descent. The subsequent conversations in the cockpit are difficult to understand. In view of the airstream noise it can be assumed that the landing gear was extended at 15:00:40 UTC at a speed of around 220 kt.

Shortly afterwards, the commander instructed the copilot to ask about the state of the runway. At 15:01:24 UTC, the FISO provided the following information: *"We have ah … one black strip, the snow remover car is only one length removed so can you wait another ten minutes and we can make another strip and ah … Cessna five ten departure runway zero three so with the jet blast we can remove the snow very well."*

In the meantime, the crew flew the 360° turn they had begun with a tighter radius and at 15:01:53 UTC turned between St. Moritz-Bad and Champfèr onto a south-westerly heading. At this time the aircraft was passing 8000 ft in descent with a speed of 147 kt. The commander responded to the passenger's question about the continuation of the flight by saying that the runway was being prepared for landing.

Over the south-west shore of the Silvaplana lake, the crew turned onto an easterly heading before initiating a 180° turn to the left. During this turn, the aircraft's speed was about 180 kt and the altitude varied between 8000 and 9000 ft. A calculation based on speed and the radius of the turn indicates that the aircraft's bank angle was about 40 degrees during this phase.

The aircraft then turned to the east and the crew seamlessly initiated a further 180° turn to the left in a southerly direction. At 15:04:24 UTC the crew again asked the FISO about the state of the runway. The FISO asked the crew to be patient, as he was about to clear a Cessna Citation for take off from runway 03.

[2] All altitude information in ft corresponds to the calculated altitude provided by the mobile GPS unit.

The 180° turn to the south was initiated just short of 2000 m west of Piz Rosatsch. At the same time the pilot of the Cessna which had taken off reported by radio at 15:05:07 UTC as follows: *"Oh, by the way. For Zernez just departing threshold runway two one is clear weather, nice... no showers, beautiful weather."*

At the northernmost point of the 180° turn to the south, above Champfèr, the aircraft's speed was 165 kt and the altitude about 8700 ft. On a south south-westerly heading direction Silvaplana, the crew of VP-BAF received the following message from the FISO at 15:06:05 UTC: *"Victor Alfa Foxtrot the Schörling* [a snow clearance vehicle] *on the runway makes another strip and they leave the runway at the end of the threshold two one. Expect approximately five minutes delay. Report ten miles final for straight in runway zero three."* In the cockpit there was a brief discussion about the snow clearance and at 15:06:24 UTC the crew reported: *"Expect five minutes, we will report ten miles Victor Alfa Foxtrot."*

At this time, coming out of the 180 degree turn to the south, the crew seamlessly initiated a further 360° turn to the left. Above the hamlet Surlej, one of the two pilots mentioned that he could see a snow clearance vehicle and had the runway in sight. During this 360° turn, the passenger approached the commander and informed him that this circling was very unpleasant for him and enquired whether they could exit. The commander calmed the passenger and informed him that they would soon be down and that he was limited to flying 360° turns for the time being.

The passenger later spoke about this as follows [translated from German]: *"On the one hand the poor visibility was to blame for my not feeling so well, and then there was the circling in the valley."*

Over Silvaplana a third 360° turn to the left was initiated, this time with an even tighter radius. The calculation based on speed and the radius of the turn indicates that during this 360° turn the aircraft's bank angle was about 45 degrees. At the same time, at 15:07:58 UTC, an air rescue helicopter pilot asked on the radio whether the FISO was sure that the reported jet was actually in the Maloja area, as he had heard a jet in the St. Moritz area. The crew of aircraft VP-BAF then reported their position at 15:08:11 UTC: *"Victor Alfa Fox is Silvaplana."*

The FISO acknowledged this position report and at 15:08:14 UTC issued the crew the following information: *"Victor Alfa Fox that's copied. Report three miles final straight in runway zero three. Expect blowing snow on the runway and the wind zero three zero degrees four knots. Report three miles next."* The crew acknowledged this report. At 15:08:33 UTC, the helicopter pilot asked the crew of VP-BAF for their altitude. The latter replied: *"We are nine thousand three hundred Victor Alfa Fox."* The helicopter pilot acknowledged this report and said that he was approaching the St. Moritz clinic. According to the mobile GPS unit recordings, at this time the aircraft was at an altitude of just under 9000 ft and descending.

Some 40 seconds later, at 15:09:10 UTC, the crew of VP-BAF informed the FISO that they were over St. Moritz and were again flying a 360° turn. This fourth 360° turn was flown immediately after the third 360° turn. At this time the aircraft was between Champfèr and Silvaplana at an altitude of around 7800 ft and flying at a speed of 136 kt.

In this fourth 360° turn, with an even tighter radius, the crew received the following information from the FISO at 15:09:21 UTC: *"Victor Alfa Fox eh the shh*

the sweepercar just vacated the runway. Runway zero three land at your own discretion wind three five zero degrees three knots. For your information we have light snow on the complete runway 03." At this time the speed of the aircraft was approximately 160 kt, tendency increasing, and its altitude was nearly 8000 ft. The calculation based on speed and the radius of the turn indicates that in this 360° turn the aircraft's bank angle was about 50 degrees. The crew lined up the aircraft on the extended runway centreline for runway 03. At 15:10:07 UTC the copilot asked whether the flaps should be extended to the full down position. The commander confirmed this. At this time the aircraft was at an altitude of approximately 7500 ft and slowly descending. Its speed was approximately 170 kt, tendency decreasing.

At 15:10:23 UTC, the helicopter pilot again asked the crew of VP-BAF for their position. They replied as follows: *"We are two miles."* At this time the aircraft was on the extended runway 03 centreline about seven kilometres (3.6 NM) from the runway threshold. At 15:10:29 UTC the acoustic traffic collision avoidance warning system (TCAS) warning sounded in the cockpit: *"Traffic, traffic"*. Nine seconds later the helicopter pilot reported to the FISO: *"Ah ...no. Is still over St. Moritz-Bad. Just contact now. Low altitude."* At 15:10:42 UTC the TCAS warning again sounded in the cockpit of VP-BAF: *"Traffic, traffic"*. At this time the aircraft was approximately six kilometres (3.2 NM) from the runway 03 threshold at an altitude of approximately 6700 ft, corresponding to a height of approximately 1100 ft above aerodrome level.

At 15:11:19 UTC, the air rescue helicopter pilot reported to the FISO as follows: *"It's St. Moritz, Klinik Gut* [Name of the clinic]*. Very low visibility."* A short time afterwards, at 15:11:32 UTC, the crew of VP-BAF reported that they were on final approach, whereupon the FISO issued the following information: *"Victor Alfa Fox runway zero three land at your own discretion, wind at the moment three three zero degrees three knots."* The crew confirmed this report six seconds later: *"At own discretion Victor Alfa Fox."*

At 15:11:49 UTC one of the pilots asked the question: *"Can you see the runway?"* The other replied immediately: *"Negative".* Five seconds later one of the pilots said: *"There on the left"* to which the other replied immediately: *"Got it, yes".* At this time the aircraft's speed was 120 kt, it was 700 m from the runway threshold and 50 m to the right of the runway centreline. The recordings of the mobile GPS unit indicate that a course correction to the left was made, followed by a correction to the right.

Just under ten seconds after the runway was reported in sight, the aircraft touched down on the runway 135 m after the threshold. When it did so, the longitudinal axis of the aircraft was not parallel to the runway axis. It was pointing 6 to 8 degrees to the right. The aircraft made first contact when its right wingtip scraped runway 03 some 195 cm left of the centreline (Annex 4). After approximately 20 metres the right gear touched down and the left gear touched down after a further 68 metres. Despite the alignment of the aircraft's longitudinal axis to the right of the runway centreline, it drifted to the left, until after 35 metres the left wingtip scraped a bank of snow running parallel to the runway. As a result of the ensuing braking effect, the aircraft rotated counter-clockwise around its vertical axis. In the area of the taxiway linking the apron with the runway, the right side of the fuselage hit the corner of a bank of frozen snow about four metres high. At this time the mobile GPS unit indicated a speed of 107 kt (198 km/h). The aircraft broke into two pieces as a result of the force of the impact.

The two pilots suffered fatal injuries on the impact. The passenger was seriously injured. Fire did not break out.

1.1.5 Accident location

Accident location	Samedan Airport Northern corner of the intersection of the taxi-way linking the apron with runway 03/21
Date and time	12 February 2009, 15:12 UTC
Lighting conditions	Daylight
Coordinates	787 289 / 156 105 (swiss grid 1903) N 46° 31' 48.05'' / E 009° 52' 48.50'' (WGS 84)
Elevation	1710 m AMSL 5610 ft AMSL
Final position of the wreck	Cockpit: 158 m from the point of impact, on the right edge of runway 03 Rest of the airframe: 135 m from the point of impact, on the left edge of runway 03
National 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	1	1	0
Minor	0	0	0	0
None	0	0	0	Not applicable
Total	2	1	3	0

1.2.2 Nationality of the occupants of the aircraft

The two crew members who were fatally injured possessed Austrian citizenship.

The seriously injured passenger possessed Austrian citizenship.

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

The fire brigade was able to contain leaking kerosene. There was no material damage to the runway.

1.5 Personnel information

1.5.1 Commander

Person	Austrian citizen, born 1940
Licence	Air transport pilot licence aeroplane – ATPL(A) according to ICAO regulations, first issued by Austro Control GmbH on 10 September 1991, valid till 19 September 2013.
	Certificate of Validation by Department of Civil Aviation Bermuda, 1 December 2008
Ratings	Type rating DA 10/100, valid until 18 September 2009.
	Radiotelephony rating English (level 4, valid till 25 February 2012) / German (level 6, no time limit).
Expired ratings	CL60 Series DA 20 Lear jet 35/36 Cessna C500 Series
Last proficiency check	Proficiency check on 18 September 2008 according to JAR-FCL 1.425(2)
Instrument flying rating	Instrument flight aircraft IR(A)
	Instrument approaches Cat. 1 on Falcon 10/100, valid till 18 September 2009
Medical fitness certificate	Class 1, VNL Shall have available corrective lenses
	Valid till 17 March 2009
Last medical examination	17 September 2008

Trainings and checks were completed at the "CAE SimuFlite" company in Dallas/Fort Worth. The commander completed conversion to the Falcon 10 on 28 November 2006. He already completed successfully a transition course to the Falcon 10 in the year 1981 and a respective refresher course in the year 1982. No statement can be made about the possible strengths and weaknesses of a pilot candidate because the training and qualification sheets only include which exercises the candidate has flown and the fact that he is proficient in this regard.

After his conversion to the Falcon 10, the commander completed a proficiency check on 10 September 2007 and 18 September 2008. These two checks were assessed by the same examiner. The latter did not have a type rating on the F10/100. According to information from Austro Control GmbH (Civil Aviation Authority of Austria) the check took place with application of JAR-FCL 1.425 (a) (2). In the past, this examiner had already assessed the commander on other aircraft type checks.

The commander's licence does not include any entries on completed courses in relation to multi-crew cooperation (MCC) and crew resource management (CRM), as required according to JAR OPS for flying aircraft with a two-man crew. The Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT)

deemed that in view of the many ratings he possessed and so-called "grandfather rights", the commander did not have to complete an MCC course, especially as the commander possessed an Austrian licence, not a JAR licence. It also has to be mentioned that the BMVIT does not have the competence to issue licences directly; this is in the responsibility of Austro Control GmbH (ACG).

1.5.1.1 Flying experience

Total	17 269 hours
of which as commander	14 879 hours
on the accident type	739 hours
of which as commander	424 hours
during the last 90 days	57 hours
of which on the accident type	57 hours

1.5.1.2 Duty times

The commander was off duty on 11 February 2009. The flight from Vienna to Samedan on 12 February 2009 was the commander's first flight on that day.

1.5.1.3 Particular incidents in the course of his career

1.5.1.3.1 General

Previous accidents and incidents involving the commander involved in the accident are known; these are listed below. These incidents and accidents, if mentioned at all, are entered in the commander's logbook as normal flights.

1.5.1.3.2 Accident on 15 September 1992

The following information is based on various reports and interrogation records of persons involved.

On a test flight in a Falcon 20, an accompanying specialist was attempting to localise abnormal noises in the aircraft. The specialist was standing between the two pilots' seats in order to monitor the pressurisation system instruments. The commander initiated a steep descent to obtain maximum speed. This manoeuvre led to a significant loss of altitude below the altitude cleared by the ATCO. In response to the intervention by the ATCO, the commander corrected this by pulling abruptly on the controls and at the same time initiating a left turn, causing a positive g-loading far above the permitted limit.

During this flight manoeuvre, the accompanying specialist suffered fractures to both lower legs, leading to temporary invalidity. According to the statement of a second radio technician on board, he blacked out briefly.

According to the available research results, injuries comparable to those suffered by the accompanying specialist occur at an acceleration of about 5 g. Persons involved in the accident reported that they had perceived extraordinarily high acceleration during this accident.

There is no documentation as to whether this massively excessive g-loading led to a corresponding check being performed on the structure of the aircraft. Apart from an accident report to the SUVA accident insurance fund, there are no corresponding reports or notifications concerning the results of this test flight.

1.5.1.3.3 Accident on 24 September 1999

The following information originates from the investigation report of the Austrian Air Accident Investigation Bureau (GZ 84.473/5-FUS/02).

On the morning of 24 September 1999, during a landing on runway 08 of the Tulln/Langenlebarn (A) military aerodrome it was not possible for the aircraft Learjet 36A to brake in sufficient time on the runway. It overshot the end of the runway and crossed a rural road before coming to a standstill some 220 metres beyond the end of the runway.

All three landing gear struts were torn off. The underside of the fuselage and the gear suspension exhibited structural damage. The wings were deformed.

Among other things, the accident report contains the following concerning the history of the flight [translated from German]: *"Tulln Radar gave clearance for a visual approach on runway 26; at the same time a wind from 260 degrees, 10 knots was communicated. (...) The aircraft landed with a tailwind of approximately 8 kt on runway 08 without landing clearance. Runway 08 had not been mentioned beforehand either by air traffic control units or by the crew in radio communications."*

Regarding the pilot's licence, the accident report notes, among other things [translated from German]: *"Contrary to the provisions of the flight operations manual (FOM) point 3.4.2 and 3.4.6, the pilot had not completed any internal tests with the aviation company. Nor had emergency ground training been undertaken on the aircraft type involved in the accident (ICAO Annex 6, point 9.2)."*

In relation to assessment and conclusions, the following points, among others, are significant [translated from German]:

- *Both pilots demonstrated a lack of procedural awareness (operating limits, approach speeds, knowledge of AFM and FOM, radio communication procedures).*
- *Evidence could not be provided that the pilot had adequate knowledge of the route to be flown or the destination aerodrome.*
- *The principles of Cockpit Resource Management were not complied with.*
- *The copilot was wearing a headset, but the pilot was not (FOM 4.7.1).*
- *About 1 minute before landing, the pilot took control and turned his speaker to low volume.*
- *One NM before the threshold of runway 08, the aircraft was flying at a speed of approximately 200 KIAS [V_{Ref} 124 KIAS] and at a rate of descent of approximately 4300 feet per minute.*
- *Although the aircraft was not stabilised on final approach (excess approach speed), a go-around was not initiated (FOM 4.18.5).*

1.5.1.3.4 Incident on 2 August 2007

On 2 August 2007 aircraft VP-BAF landed on runway 21 in Samedan and veered off the runway. The incident is noted in the Samedan airport daily log as follows: *"10:48 UTC, VP-BAF escape runway to right side due to reverse problem. No damage no injuries."*

On the sketch showing the incident it is clear that the aircraft skidded past and close to the winch for glider take-offs and came to a stop a few metres in front of the tarmac, on which aircraft were parked.

In the Samedan airport occurrence report the incident was reported as follows, according to the pilot's information [translated from German]: *"Aircraft escaped RWY after landing to the right onto grass. REVERSE LH defective, nosewheel steering does not respond".*

This incident was not recorded in the aircraft flight log by the pilot responsible. However, according to the aircraft technical log the following work was carried out in Samedan by a licensed mechanic from a maintenance company in Paris:

- *Reverse locked with Grumman procedure (Grumman Manual Supplement 78-30-00)*
- *Check braking and steering system*

Neither the incident nor the work carried out was entered in the aircraft log book. The company responsible for maintenance was not informed of this incident. The next day, the aircraft was flown to Paris, where among other things the thrust reverser was reactivated after a check by a licensed maintenance company. The brakes were also checked; a leak was found in the left braking unit and the unit was therefore replaced.

1.5.1.3.5 Incident on 16 August 2007

On 16 August, aircraft VP-BAF again landed on runway 21 in Samedan and once again veered off the runway. The incident is noted in the daily log as follows: *"10:02 UTC, VP-BAF escape runway to right side due to technical reason, No damage no injuries."*

Among other things, this incident is noted in the Samedan airport duty report as follows [translated from German]: *"Aircraft veers off runway approximately 70 metres before the APRON intersection and comes to a standstill approximately 50 metres behind the intersection."*

A representative of the airport stated that the aircraft again skidded past a few metres away from the winch for glider take-offs before coming to a standstill. This was apparently the reason why the winch for glider take-offs was relocated further away from the edge of the runway, for safety reasons.

This incident was not recorded by the pilot responsible in the aircraft flight log. The company responsible for maintenance was not informed of this incident. According to a statement by the owner, problems arose with the anti-skid system.

The aircraft was flown to Paris the next day for a technical inspection. There, a licensed maintenance company carried out, among other things, trouble-shooting on the left braking system and in the process replaced the tacho generators #1 and #2. The anti-skid system was checked and found to be in order. This work was not recorded in the aircraft log book.

1.5.1.3.6 Incident on 24 August 2008

On landing in Samedan on runway 03 on 24 August 2008 at 16:40 local time, the aircraft touched down 7.5 metres before the actual start of the runway, on a 14 x 14 metre asphalted area. The corresponding tyre marks were photographed by the airport's management authority. When spoken to about this landing, the commander replied, according to an airport management report, that for him it had been a normal landing.

With regard to this incident, the company's third pilot commented among other things:

"After landing I had a discussion with Mr. [name of Commander] that I will call and initiate a "go around" if he would make another approach that low – yes sometimes he had a tendency of approaching low at Samedan to touch down as early as possible."

1.5.2 Copilot

Person	Austrian citizen, born 1968
Licence	Commercial pilot licence aeroplane – CPL(A) according to joint aviation requirements (JAR), first issued by Austro Control GmbH on 16 November 2000, valid till 10 September 2013
	Commercial pilot licence aeroplane – CPL, first issued by the United States of America on 16 July 2008
	Certificate of validation by Department of Civil Aviation Bermuda, 24 October 2008
Ratings	Type rating Falcon 10, listed in the American licence
	Type rating Citation C525, valid till 24 July 2009 MP only
	Touring motor glider (TMG) type rating, valid till 16 November 2008
	Single-engine piston (SEP) aircraft, valid till 16 November 2008
	Type rating Malibu PA 46, valid till 23 August 2009
	Radiotelephony rating English (level 4, valid till 25 February 2012) / German (level 6, no time limit).
	Theory ATPL(A) 2 November 2000
Instrument flying rating	Instrument flight aeroplane IR(A), CAT. 1 instrument approaches on C525, valid till 24 July 2009.
	FAA instrument airplane DA-10
Last proficiency check	Conclusion of conversion course (type rating) in the USA on the Falcon 10 on 25 March 2008.
Medical fitness certificate	Class 1, without restrictions Valid till 16 November 2009
Last medical examination	5 November 2008

Trainings and checks were completed at the "CAE SimuFlite" company in Dallas/Fort Worth. No statement can be made about the possible strengths and weaknesses of a pilot candidate because the training and qualification sheets only include which exercises the candidate has flown and the fact that he is proficient in this regard.

The copilot's licence does not feature any entries on completed MCC or CRM courses, as required according to JAR OPS for flying aircraft with a two-man crew. The "MP only" entry under aircraft type C525 has the following background according to the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT): The type C525 is essentially an aircraft which may be flown by only one pilot. However, since the operator of the type C525 for which the copilot flew wanted this aircraft flown exclusively by two pilots, the pilot received the entry "MP only".

According to a statement from the third company pilot, it was envisaged to have the copilot attend an MCC course on 16 February 2009.

1.5.2.1 Flying experience

Total	2591 hours
on the accident type	119 hours
during the last 90 days	45 hours
of which on the accident type	29 hours

Before the copilot began training on the Falcon 10 aircraft, he flew the Citation C525 aircraft type for another company. During his employment as copilot operating the Falcon 10 he continued to fly regularly on the Cessna Citation C525.

The last entry in the copilot's logbook was made on 20 January 2009. On the basis of documents found in the wreckage of the aircraft, it must be assumed that the pilot was still flying the Citation C525, registration OE-FLB, at least on 29 January 2009. Since no further flights are entered in the logbook from 20 January onwards, no conclusive statements can be made about the flying experience of the copilot.

1.5.2.2 Crew times

No information can be given about the copilot's crew times.

1.5.3 Passenger

Austrian citizen, born 1955, no pilot's licences.

1.5.4 Flight Information Service Officer

Person	German citizen, born 1969
Licence	No licence
Medical fitness certificate	Class 3, issued on 11 September 2007, valid till 11 September 2009

In a letter dated 20 September 2007, the FISO was informed by the FOCA that until the entry into force of the revised Ordinance on licences for air traffic control personnel (VAPF), he was authorised to work as FISO.

Art. 65 of the VAPF states that the Ordinance is applicable to FISO from 1 June 2009. From this time, FISOs must possess a valid licence, issued by the FOCA. In a letter dated 11 June 2009, the FOCA communicated, among other things [translated from German]: *"(…) However, it seems realistic to issue the licences by the end of July (…)"*.

On 1 October 2009, the FOCA provided the FISO with the safety related task licence for Samedan, valid from 1 June 2009.

1.5.4.1 Experience

When the FISO started his job in Samedan he already had a ten year experience as weather observer on airfields in Germany. On 15 December 2007 MeteoSwiss confirmed that he had successfully completed the basic training as observer. Furthermore it was confirmed that the FISO also attended the refresher-course in August 2007.

1.6 Aircraft information

1.6.1 General information

Registration	VP-BAF
Aircraft type	Dassault/Bréguet Falcon 10/100
Characteristics	Low-wing, two engine business jet aircraft
Manufacturer	Avions Marcel Dassault/Bréguet Aviation
Year of manufacture	1987
Serial number	210
Owner	Laret Aviation Limited, Clarendon House, 2, Church Street, Hamilton HM 11, Bermuda
Operator	Laret Aviation Limited, Clarendon House, 2, Church Street, Hamilton HM 11, Bermuda
Engine	Twin shaft turbine engine, manufactured by Honeywell International, type TFE731-2C-1C No. 1, left, serial number: P-73569 No. 2, right, serial number: P-73578
Operating hours, airframe	Total hours since manufacture: 6386:09 hours Since the last periodic check (A-inspection): 34:39 hours
Operating hours, engine	Total hours since manufacture: Engine No. 1: 6060:32 hours, 5919 cycles Engine No. 2: 5955:32 hours, 5833 cycles Since last periodic check: Both engines: 48:32 hours, 42 cycles

Max. permitted masses	Take-off mass: 19 300 lb (8755 kg) Landing mass: 17 640 lb (8002 kg)
Mass and centre of gravity	The mass of the aircraft at the time of the accident was 15 438 lb (7003 kg). Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM).
Maintenance	The last A-inspection (300 flying hours or six month, whichever comes first) took place on 5 December 2008, at 6351:30 h. The last scheduled basic inspection (monthly check) took place on 6 February 2009, at 6383:19 hours.
Fuel grade	JET A1 kerosene
Fuel remaining	According to calculations, the take-off fuel was 4500 lb (2041 kg). This included, among other things, trip fuel of 1157 lb (525 kg) and a final reserve of 473 lb (215 kg). The remaining 2870 lb (1301 kg) would have permitted a flight to the planned alternate airport, Zurich (LSZH) and a holding procedure of 1:37 hours duration.
Registration certificate	Issued by Bermuda Department of Civil Aviation on 29 December 2006, valid till revoked.
Airworthiness certificate	Issued by the Government of Bermuda, Ministry of Tourism and Transport, Department of Civil Aviation on 31 December 2008, valid till 30 December 2009.
Certification	In private use VFR by day / VFR by night / IFR Category I /RVSM

1.6.2 Calculation of landing distance

The information on calculation of the required runway length, under the conditions prevailing in Samedan, can be found in the FAA-approved AFM (airplane flight manual; DTM 722) and in the aircraft manufacturer's operational instructions manual (DTM 726)(cf. section 1.17.2.3).

From the graph in the AFM (page 6-59), a landing distance can be derived as follows:

"Demonstrated horizontal distance required to land and to come to a complete stop from a point at a height of 50 ft above the landing surface at the standard temperature.
Engine thrust corresponds to idle."

If this distance is multiplied by 1.67, the required landing field length is obtained.

The mass of the aircraft at the time of the accident was 15 438 lb. On a dry runway, this graph produces a landing distance of 2600 ft and a landing field length of 4340 ft respectively.

Since the condition of the runway at the time of landing was reported as follows: *"For your information we have light snow on the complete runway 03",* the data for "wet runway" must be taken into account for the landing distance calculation according to the AFM.

If the maximum correction of 500 ft published in the newsletter is used, the result is a landing distance of 3100 ft (2600 plus 500) and a landing field length of 5177 ft respectively. The available landing distance in Samedan was 5906 ft.

1.6.3 Cockpit equipment

Among other things, aircraft VP-BAF was equipped with an electronic flight instrument system (EFIS), type "COLLINS EFIS-85C". This displayed the primary flight and navigation data on screens in the cockpit. Among other things the height above ground (radio altitude - RA) measured by the radio altimeter was also displayed.

In the case of the EFIS-85C, the RA is displayed digitally in green on the primary flight display (PFD) in the bottom right corner. This display appears only when the RA system is in operation and the aircraft is at a height of less than 2500 ft above ground level.

By means of a knob on the display control panel (DCP), a decision height (DH) can be pre-selected by pilots on their PFD. For example, if one chooses a DH of 200 ft, this value is displayed directly below the RA in cyan, as follows: "DH200". When this DH is reached in a descent, the display "DH" appears in yellow in the top left central area of the PFD. This display flashes for five seconds and then becomes steady.

It is no longer possible to establish whether and at what value the DH had been pre-selected by the crew at the time of VP-BAF's approach to Samedan. According to the CVR, possible flashing of the DH display was not mentioned either by the commander or by the copilot.

1.6.4 Ground proximity warning system

Aircraft VP-BAF was equipped with an enhanced ground proximity warning system (EGPWS) of the Allied Signal MK VII type.

Among other things, this system was configured on aircraft VP-BAF as follows:

- *Terrain awareness display*
- *Altitude callouts ID 76*
- *"Smart" 500 ft callout*
- *Bank angle callout*

The terrain awareness display is an enhanced function of the EGPWS which among other things detects conflicts with the terrain in advance, on the basis of a worldwide database. On this topic, the manufacturer writes as follows, among other things:

"When a compatible Weather Radar, EFIS, or other display is available and enabled, the EGPWS Terrain and Alerting Display (TAD) feature provides an image of the surrounding terrain represented in various colours and intensities.

A terrain conflict intruding into the caution ribbon activates EGPWS caution lights and the aural message ***"CAUTION TERRAIN, CAUTION TERRAIN"*** *or* ***TERRAIN AHEAD, TERRAIN AHEAD"****. The caution alert is given typically 60 seconds ahead of the terrain/obstacle conflict and is repeated every seven seconds as long as the conflict remains within the caution area…"*

On the CVR recordings, the acoustic warning "caution terrain, caution terrain" is audible at 14:59:55 UTC. The GPS recordings indicate that at this time the aircraft was descending at a rate of approximately 1500 ft/min, at an altitude of 10 536 ft (Annex 2). Its speed was 264 knots.

The "ID 76" configuration of the EGPWS relating to altitude callouts means that on aircraft VP-BAF the following callouts were programmed (manufacturer's MKVII EGPWS interface control document, sheet 240):

MINIMUMS, 2500, 1000, 500, 400, 300, 200, 100, 50, 40, 30, 20, 10

The "MINIMUMS" callout sounds when the DH set by the pilot is reached (cf. section 1.6.3).

None of these callouts is audible on the CVR recordings.

The "bank angle" callout was also activated on aircraft VP-BAF. On this topic, the manufacturer writes as follows, 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…"

No acoustic warnings about "bank angle" are audible on the CVR recordings, even though the calculations relating to speed and turn radius show that in the 360° turns which were flown the aircraft must have had a bank angle of up to 50 degrees and on landing first scraped the runway with its right wingtip.

In section III of the emergency procedures the manufacturer mentions, among other things:

"Total system deactivation can be accomplished with the GPWS circuit breaker."

Consequently, if the EGPWS circuit breaker is in the 'pulled' state, all the above-mentioned callouts are suppressed and are therefore no longer audible. This circuit breaker was found to be in the 'pulled' position after the accident.

1.6.5 Collision avoidance system

Aircraft VP-BAF was equipped with a traffic collision avoidance system (TCAS), type Collins TCAS II (version 7.0).

Like a secondary radar, the system transmits signals and determines, on the basis of ATC transponder signals from other aircraft, their position and vectors and calculates a possible collision point (closest point of approach – CPA) on the basis of its own position and direction of motion. If another aircraft approaches, acoustic and visual traffic advisory (TA) is provided and in the event of continuing dangerous convergence an acoustic and visual resolution advisory (RA) is issued.

The acoustic traffic advisory "traffic, traffic" sounds when aircraft are approximately 40 seconds away from the CPA.

The call out "traffic, traffic" is audible on the CVR recordings at 15:10:29 UTC and 15:10:42 UTC. At this time the aircraft was on final approach, at a distance of six to seven kilometres from the threshold of runway 03, overhead St. Moritz-Bad (Annex 2). The air rescue helicopter flying in the same area was equipped with an ATC transponder.

1.7 Meteorological information

1.7.1 General

The information in sections 1.7.2 to 1.7.4 and 1.7.6 and 1.7.7 was provided by MeteoSwiss. The information in section 1.7.5 originates from the Samedan aerodrome recordings. The information in section 1.7.8 is based on eye-witness observations. The information in section 1.7.9 was available to the crew for preparing and making the flight.

1.7.2 General meteorological situation

[translated from German]: *"In the morning, in a moderate north-westerly airflow caused a secondary cold front to cross the north side of the Alps. The corresponding humid air masses accumulated on the north slopes of the Alps, particularly in the central and eastern foothills of the Alps. On the south side of the Alps, the northerly wind (Nordföhn) ensured dry conditions."*

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 location of the accident were as follows:

Cloud	*7/8 at 8600 ft AMSL*
Weather	*Light snowfall*
Visibility	*About 3 km*
Wind	*4 kt from the north*
Temperature/dewpoint	*-09 °C / -12 °C*
Atmospheric pressure	*QNH LSZS 1006, LSZH 1017 hPa, LSZA 1010 hPa*
Hazards	*Diffuse visibility conditions due to light snowfall*

On the MeteoSwiss camera images from Murtel one recognizes extensive, slightly broken clouds, which partially caused light snowfall (cf. Annex 1). Furthermore, the weather change is visible between 15:00 UTC and 15:10 UTC as it was mentioned by several eye-witnesses (cf. chapter 1.7.8).

1.7.4 Astronomical information

Position of the sun	*Azimuth: 234°, elevation: 12°*
Lighting conditions	Daylight

1.7.5 Aviation weather reports

In the period from 14:50 UTC up to the time of the accident, the following aviation weather reports (METAR) applied:

LSZS 121450Z 36006KT 320V020 3000 –SN OVC030 M09/M11 Q1006=
LSZS 121520Z NIL=
LSZS 121550Z 01003KT 270V050 4000 –SN BKN030 M09/M12 Q1007 884900//=

1.7.5.1 ATIS reports of Samedan aerodrome

LSZS 13:50 UTC, Information INDIA:

"Runway in use 03; wind calm; visibility 3500 meters; showers of snow in the vicinity, overcast 4000 feet, temperature minus 8, dewpoint minus 11; QNH 1005"

LSZS 14:20 UTC, Information JULIETT:

"Runway in use 03; wind 050 degrees, 5 knots; visibility 3000 meters; light snow; overcast 3000 feet; temperature minus 8, dewpoint minus 11; QNH 1005"

No ATIS was issued at 14:50 UTC; the next ATIS was issued at 15:20 UTC, after the accident:

Samedan aerodrome had published the following SNOWTAM:

SNOW:
A) LSZS
B) 0902120745
C) 03
F) NIL/NIL/NIL
J) 200/7LR
P) YES020
T) RWY NML COND

In clear text, this means:

The following runway conditions were measured at 07:45 UTC on 12 February 2009 at Samedan airport for runway 03:

- over the entire length of the runway the surface is CLEAR AND DRY (observed on each third of the runway)
- banks of snow 2 m high lie at a distance of 7 m to the left and right of the runway
- snowbanks of more than 60 cm height lie at a distance of 20 m along the taxiways
- the runway condition is normal

1.7.6 Forecasts

The following TAF was issued for Samedan aerodrome:

LSZS 121125 1212/1221 33005KT 9999 SCT040 PROB30 TEMPO 1212/1215 SHSN=

In clear text, this means:

On 12 February 2009 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 330 degrees at 5 knots
Meteorological visibility	10 km or more
Cloud	3-4 eighths at 4000 ft AAL
Change	Between 12:00 UTC and 15:00 UTC, snow showers may occur at times, with a probability of 30%.

1.7.7 Aviation weather forecast and warnings

For the 12 February 2009 the following aviation weather forecasts and warnings were issued, among others:

1.7.7.1 GAMET

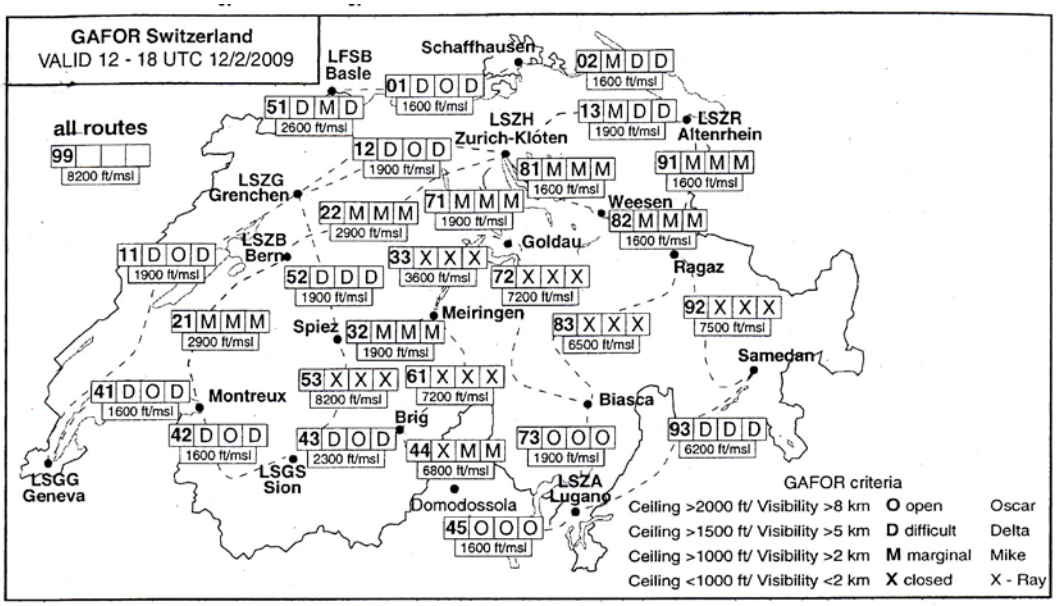
Gamet valid 12 – 18 UTC for the Region Eastern Alpine Switzerland:

ICE: LOC MOD BLW FL120
TURB: MOD
AIRMET APPLICABLE: 3
Wind/Temperature at 13'000 ft AMSL 010/35kt MS28
Wind/Temperature at 8'000 ft AMSL 360/30 kt MS16

1.7.7.2 GAFOR

The accident site is located on GAFOR routes 92 (Ragaz-Lenzerheide-Julierpass-Samedan) and 93 (Samedan-Malojapass-Menaggio-Lugano). The following forecasts were issued for these routes:

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



Interpretation of the weather categories:

O	open	no weather-related impediments to visual flight
D	difficult	pilots trained in visual navigation can still fly
M	marginal	pilots very well trained in visual navigation and with precise knowledge of local conditions can still fly
X	closed	visual flight impossible

1.7.7.3 AIRMET

The following Airmet was active at the time of the accident:

LSAS AIRMET 4 VALID 121400 / 121700 LSZH-
LSAS SWITZERLAND FIR MOD TURB FCST ALPS AND S OF ALPS BLW FL150 STNR NC=

In clear text, this means:

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

Name of the FIR	Flight information region (FIR) Switzerland
Weather phenomena	Moderate turbulence forecast
Region	In the Alps and south of the Alps below flight level 150
Movement	Stationary
Intensity	No change

1.7.7.4 SIGMET

No Sigmet was issued on the day of the accident.

1.7.7.5 Aviation weather forecast

Aviation weather forecast for Switzerland, valid from 12:00 to 18:00 UTC:

Under hazards, the following were stated [translated from German]:

Alpine crossings from the north mostly in cloud.

Moderate north wind turbulence over the Alps and on the south side of the Alps.

1.7.8 Weather according to eye-witness statements

1.7.8.1 Statements by a helicopter pilot

A helicopter pilot who has his home base in Samedan reported that he had been requested to undertake a rescue at 14:45 UTC. Among other things he stated [translated from German]: *"At this time visibility was approximately 1 km in snow showers due to the north wind. One could already see holes in the snow clouds. At 14:51 UTC I took off from Samedan, visibility was approximately 4 km. (...) At 15:00 UTC (St. Moritz Alp Giop 2200 m AMSL), I saw the jet flying a first left turn, high and relatively quickly, from the north-east along the Alpine ridge above Piz Julier and Julierpass. In the direction of Maloja I had approximately 8 km visibility. Heavy precipitation, snow clouds in the north and east. Everything was overcast in the south. (...) the jet was coming from Surlei, flying approximately 800 ft lower and on the other side of the valley, in the direction of the airport. However, it was still very high. I again saw a snow cloud moving in from the north."*

The helicopter pilot took off at 15:20 UTC from the Clinic "Gut" in St. Moritz for the return flight to Samedan airport. Concerning the weather situation, he stated the following, among other things [translated from German]: *"When I took off from the hospital, I had approximately 2 km visibility until Celerina. The situation in Celerina was the same. The light was very diffuse; visibility was about 1.5 km. I had contact with the aerodrome in the vicinity of the road named "Shell-strasse". We saw the jet involved in the accident on the runway, having visual contact at about 1 km. The light was very diffuse (whiteout). I can't confirm that I saw the centreline."*

1.7.8.2 Statements by a private pilot

The eye witness is himself a private pilot and holds an instrument flight rating. According to his statement, he flies to Samedan around twenty times every year. At the time of the accident [approximately 15:10 – 15:20 UTC] he was on the road from St. Moritz to Pontresina. Regarding the weather, the eye witness stated the following, among other things [translated from German]:

"(…) From San Gian church one couldn't see Muottas Muragl, so I also came to the conclusion that visibility was below 1 km. The road was covered with snow; there was massive snowfall, like a dark curtain, not just a light snowfall. (…) A dark, very thick shower curtain became visible [on the final approach to runway 03]*. So not just rather poor visibility."*

On the map of Samedan aerodrome, the eye witness sketched his observations as follows:

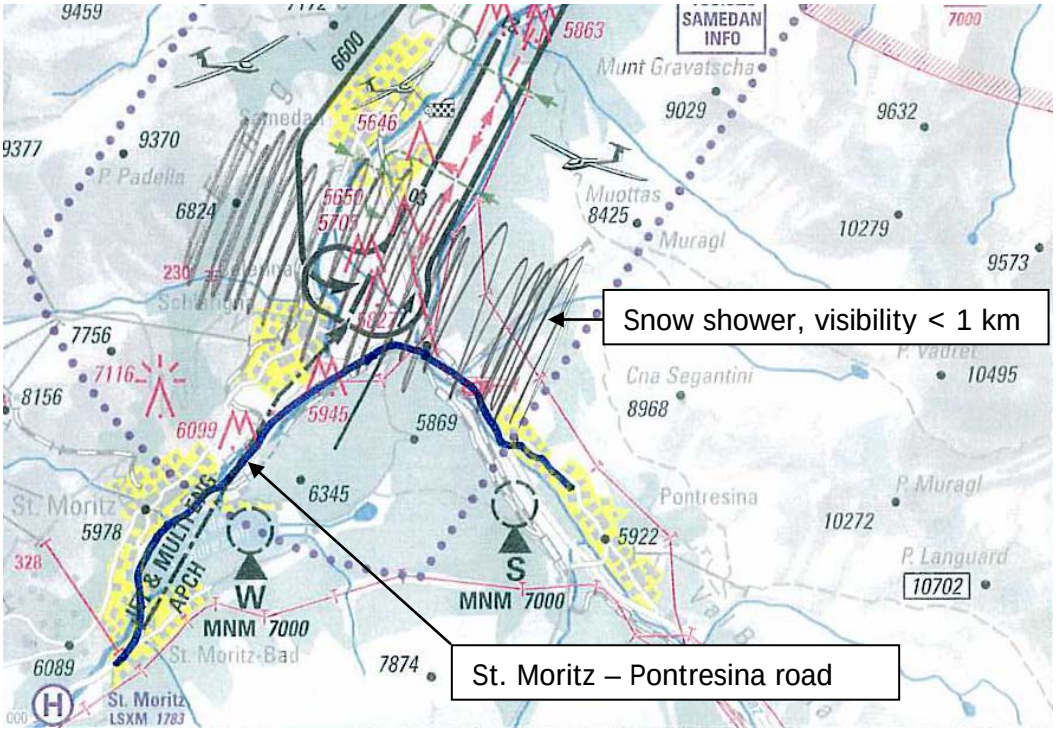


Figure 1: observations sketched by an eye witness

1.7.8.3 Statements by eye witnesses at Samedan airport

A first eye witness assessed the weather as follows [translated from German]: *"It's hard for me to say what the visibility distance was. A curtain of snow hung down towards St. Moritz. Visibility was better towards Zernez. It was already snowing slightly at the time of the accident."*

A second eye witness who made his way to the cockpit to provide first aid immediately after the accident assessed the weather as follows [translated from German]: *"I can't say any more how the weather was shortly before the accident. I only know that it was snowing slightly when I got to the cockpit."*

A third eye witness who at the time of the accident was at the end of runway 03, or rather at the threshold of runway 21, stated, among other things [translated from German]: *"It was snowing lightly and it was misty. I couldn't see or make out hangar 3."* From his location hangar 3 was at a distance of 1.4 km.

1.7.9 Meteorological information available to the crew

The meteorological data from Austro Control that were delivered to the crew by the company commissioned with the task contained among other things the following weather forecast for Samedan:

SALSZS 121220Z 03005KT 9999 BKN050 M07/M14 Q1005=
FCLSZS 121125Z 1212/1221 33005KT 9999 SCT040 PROB30 TEMPO 1212/1215 SHSN=

In addition the crew was in possession of the SNOWTAM from 07:45 UTC, which was published by Samedan (chapter 1.7.5.1). Alike the *fixed time prognostic chart ICAO area euro SIGWX, FL 100 – 450* and a wind chart *wind/temperature FL340 – 250 HPA* were available to the crew.

1.8 Aids to navigation

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

1.9 Communications

Radio communication between the crew and the air traffic services involved took place without difficulties up to the time of the accident.

1.10 Aerodrome information

1.10.1 General

Samedan airport is located 5 km north-east of St. Moritz. The reference elevation is 1707 m, corresponding to 5600 ft AMSL and 17.8 °C is derived as the reference temperature[3]. It is the highest airport in Europe. The airport reference point (ARP) has the coordinates 46° 32' 04" N/ 009° 53' 02" E.

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

Samedan airport is a none-controlled airport and may be used only under visual flight rules. Since the AIP does not stipulate special minima for visual flights, among others things, the following rules for airspace class G – none-controlled airspace apply *(VFR-Guide vom 13. März 2008, RAC 1-1, Luftraum-Einteilung, Kapitel 1.7)*:

VMC Minima

Unterhalb FL 100 und bis 3000 ft AMSL	*Auf oder unterhalb 3000 ft AMSL oder 1000 ft AGL (je nachdem welches die grössere Höhe gibt):*
Sicht 5 km *Distanz zu den Wolken:* *Horizontal 1500 m* *Vertikal 1000 ft*	*Sicht 5 km** *Ausserhalb Wolken mit Bodensicht*

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

**Regelung in der Schweiz:*

- *Die Klasse G beinhaltet den Luftraum von GND bis 2000 ft/600 m AGL, ausserhalb der TMA/CTR (Ausnahme siehe RAC 1-1, Seite 33);*
- *Sicht 5 km; sofern die Fluggeschwindigkeit jederzeit eine Umkehrkurve innert Sichtweite gestattet und andere Luftfahrzeuge oder Hindernisse rechtzeitig erkannt werden können darf die Flugsicht bis 1,5 km betragen;*
- *...*

As a comparison the meteorological minima for military operation by day are according SAM 2, dated 23 October 2008, for aircraft with a mass less than 3 t, a cloud base of 1300 ft AGL and a visibility of 2000 m respectively for a mass above 3 t a cloud base of 1300 ft AGL and a visibility of 5000 m.

The airport is open daily from 08:00 LT to sunset or to 19:00 LT 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 companies 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 History

Samedan airport came into service on 27 January 1938.

In 1950 the Swiss Confederation took over the installation and at the same time guaranteed joint use by civil aviation.

On 1 January 2004, Samedan airport passed into the ownership of the Grisons canton. Since the Grisons canton did not wish to operate the airport itself, on 5 July 2004 the cantonal government concluded an agreement on operation with the newly founded Engadin Airport AG. Engadin Airport AG assumed control of operations on 6 December 2004. Operating regulations approved by the FOCA are in existence.

The airport employs 45 people, handles approximately 20 000 flights per year and processes some 35 000 passengers.

In 2007 the governing body was restructured and among other things the position of CEO was created. In March 2007, the definitive organisational form with the individual office-holders and their responsibilities was laid down in the Air Traffic Management Manual (ATMM) (cf. chapter 1.17.3).

There was an architectural competition in 2007 to re-design the airport. The "Sungate" project won this competition. The airport is to be further expanded on the basis of this project. For this purpose the governing body also planned to purchase the land on which the airport is sited and which is owned by the Grisons canton (as of May 2009).

1.10.3 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	5600/5574 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 cannot be used for civil purposes, as they are neither tested nor approved by the FOCA.

According to the statement of the FISO, he had switched on the approach lights at full intensity. According to the transcript of the radio conversations and the CVR, this was never communicated to the crew; nor are there any indications that the crew were consciously aware of this approach lighting.

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

Runway 03 was in service at the time of the accident.

1.10.4 Rescue and fire-fighting services

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

1.10.5 Aerodrome 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 information service, Samedan airport employs flight information service officers (FISO), who require a licence to perform their duties. Unlike an air traffic control officer (ATCO), the FISO is entitled only to transmit information to crews, but not to give them instructions. Their duties are laid down in the ATMM (cf. chapter 1.17.3.3).

1.10.6 Winter service

1.10.6.1 General

According to the ATMM, the chief ground services (CGS) is responsible for the winter service. The corresponding regulations are laid down in his functional specification (cf. chapter 1.17.3.2).

1.10.6.2 Snow clearance

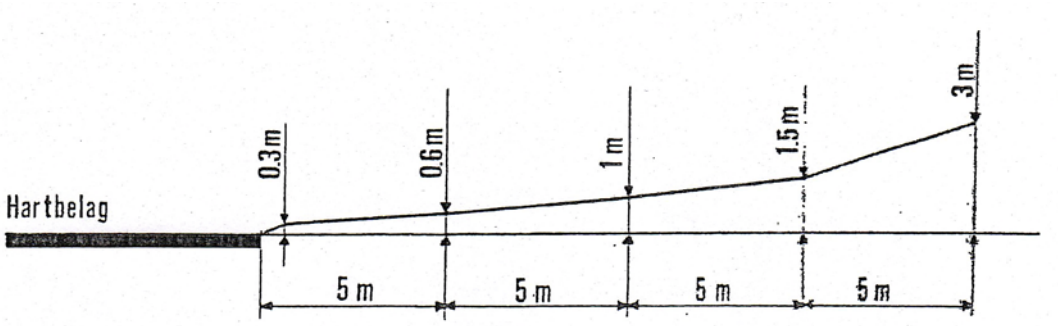
The internally published procedures for Samedan airport include an undated *"Weisung betreffend Schneeräumung"* [Instruction concerning snow clearance] which specifies which clearance vehicles must perform their work in which sequence. The following is stated in this instruction in bold text:

"Wenn immer möglich halten wir uns bei der Schneeräumung an die technische Mitteilung vom BAZL." [Wherever possible, with regard to snow clearance we adhere to the technical notification from the FOCA.]

This refers to the Technical Notification entitled *"Schneeräumung"* [snow clearance] by the FOCA, "Sektion Flugplätze", dated 1 January 1986, which states, among other things:

„(...) Die vielen Schadenmeldungen der vergangenen Winter veranlassen uns, Sie mit folgender ICAO-Richtlinie bekannt zu machen.
[The many damage reports of previous winters prompt us to acquaint you with the following ICAO regulations.]

Zulässige Schneehöhe entlang der Pisten, Rollwege und Abstellflächen
[Permissible snow height along runways, taxiways and parking areas]



Vielleicht finden Sie diese allgemeine Richtlinie für Ihre Verhältnisse übertrieben. Wir möchten es in diesem Fall Ihnen überlassen, die für Ihre Gegebenheiten zweckmässige Schneeverteilung festzulegen. (...)"
[You may find this general guideline excessive for your conditions. In this case we would like to leave it to you to specify appropriate distribution of snow for your circumstances.]

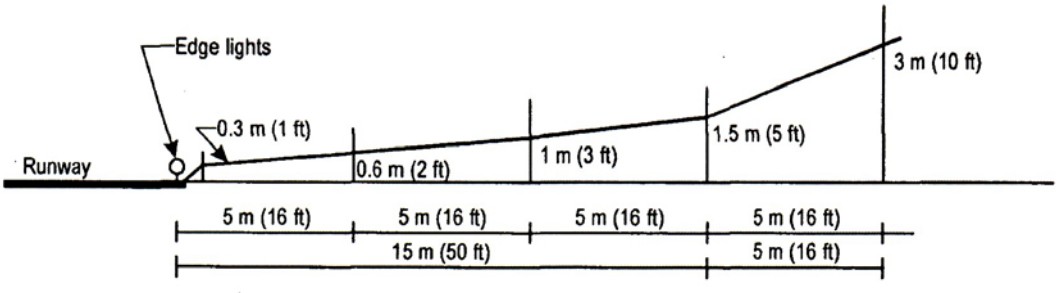
On the day of the accident, according to the driver of the snow clearance vehicle, there was continual light snow, so he repeatedly had to clear snow. According to his statement, it had also snowed slightly during snow clearing just before the accident. He stated that he had known that an aircraft was in a holding area and that he was therefore clearing the centreline. He did this by clearing two tracks left and right of the centreline. One track, or rather track width, is 4.6 metres, so the centreline was clear over a total width of approximately 16 metres. The driver stated that he estimated that there was around 5 mm of snow on the rest of the runway and that the cleared area left and right of the centreline was not black, because it was snowing slightly, but was darker than the rest of the runway.

1.10.6.3 ICAO guidelines concerning snow clearance

The corresponding guidelines and recommendations are contained in the ICAO airport services manual (ASM), Part 2. This ASM is based on or rather is an amendment of Annex 14, Volume 1 of the ICAO. Section 7.3, "Snow plan proce-

dure", states the following, among other things, under "Permissible snowbank height" in paragraph 7.3.5:

"The height of a snowbank on an area adjacent to a runway, taxiway or apron should be reduced so far as is practicable so as to provide wing overhang clearance and preclude operational problems caused by ingestion of ice into turbine engines. Figure 7-1 shows the maximum snow height profile allowable during initial snow-clearing operations on such area. This is the desired profile that should be obtained after snow has ceased to fall and after time and conditions permit clearance equipment to be diverted from higher priority work. When conditions permit, the profile shown in Figure 7-1 should be reduced in height in order to facilitate future snow removal operations and to reduce the possibility of snow ingestion into jet engines. Complete removal down to ground level should be the aim in areas where snow removal equipment can work, such as on shoulders.



B. Runways used by other than very large aircraft

Figure 7-1. *Maximum height of snow profile"*

1.10.6.4 Publication of braking coefficient and braking action

Samedan airport renounces to measure and publish a braking coefficient or a braking action. In this context, the manager of Samedan airport stated:

"So lange wir nicht ice covered Piste haben, ist die Piste offen. Braking action geben wir keine mehr durch. Früher war das so, dass der Chef mit seinem Auto auf die Piste fuhr und eine entsprechende Aussage machte. Seit ca. eineinhalb Jahren nicht mehr."

[The runway is open as long as we don't have an ice-covered runway. We no longer announce a braking action. Previously, the manager used to drive his car onto the runway and make an appropriate statement. We haven't done that for about a year and a half.]

1.10.6.5 ICAO guidelines for measuring braking action

Moreover, already in the foreword to the ASM it is pointed out how important it is to measure braking coefficient or braking action, in order to have reliable information about the condition of the runway surface.

For example, in section 1.3 "Need for assessment of runway surface condition", sub-section 1.3.1 states the following, among other things:

"Runway surface friction/speed characteristics need to be determined under the following circumstances:

d) ...

e) the snow-, slush-, or ice-covered runway on which there is a requirement for current and adequate assessment of the friction conditions of the runway surface; and

f) the presence and extent along the runway of a significant depth of slush or wet snow (and even dry snow), in which case the need to allow for contaminant drag must be recognized.

Note: Assessment of surface conditions may be needed if snowbanks near the runway or taxiway are of such height as to be a hazard to the aeroplanes the airport is intended to serve. Runways should also be evaluated when first constructed or after resurfacing to determine the wet runway surface friction characteristics."

In Appendix 6 to the ASM *"Methods of measuring or assessing braking action when no friction test devices are available",* two methods are described which enable a conclusion to be drawn concerning the braking action. The two methods are the following:

- *Measuring of braking action by braking a truck or car to a full stop*
- *Meteorological observations (related to runways covered by snow or ice)*

1.11 Flight recorders

1.11.1 Flight data recorder

Not prescribed and not installed.

1.11.2 Cockpit voice recorder

Type	Fairchild A100A
Manufacturer	Fairchild
Year of manufacture	10-89
Serial number	S/N 55842 / Part No. 93-A100-83
Recording medium	Magnetic tape
Duration of recording	30 minutes

Some of the conversations and noises recorded on the CVR could not be interpreted in their entirety, as the noise level inside the cockpit was relatively high and consequently the quality of the recordings was not entirely satisfactory. All communication with the corresponding air traffic control units took place in English. The conversations between the two pilots took place in German, the mother tongue of both pilots.

1.11.3 Mobile GPS device

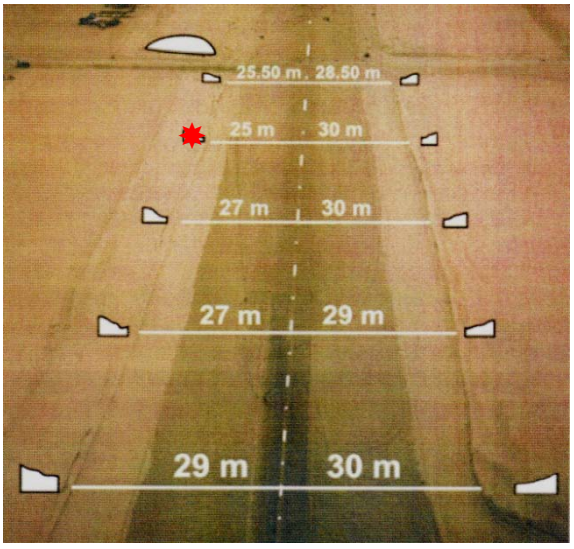
A Garmin type 496 mobile GPS device was found in the wreckage of the aircraft. It was possible to interpret the stored data and reconstruct the flight path of VP-BAF in relation to measured altitude above sea level, groundspeed, track and respective current position (WGS[4] 84) (see Annex 2 and 3).

[4] WGS: World Geodetic System. This system is a geodetic reference system for positioning on the Earth. It is the basis of the Global Positioning System (GPS), which enables surveying of the earth and orientation using NAVSTAR satellites. WGS 84 is a uniform system for the entire Earth. The WGS 84 standard was adopted in 1989 by Eurocontrol for aviation.

1.12 Wreckage and impact information

1.12.1 Site of the accident

After the accident runway 03 was photographed in the direction of landing and the snowbanks running along the runway were measured. The entire surface of the runway was covered with a layer of snow which along the runway centreline was only a few millimetres thick at a width of seven to eight meters and which therefore appeared somewhat darker. From the runway threshold to the final position of the wreck, a maximum of 30 metres and a minimum of 25 metres were measured between the runway centreline and the snowbanks on the left and right of the runway. The cross-section of the snowbanks, measured at a width of 4 metres, was between 90 and 150 centimetres high on the runway side and between 2.5 and 4 metres on the outside.



Point of contact of the left wingtip with the snowbank.

Figure 2: Diagrammatic representation of the snowbanks along runway 03

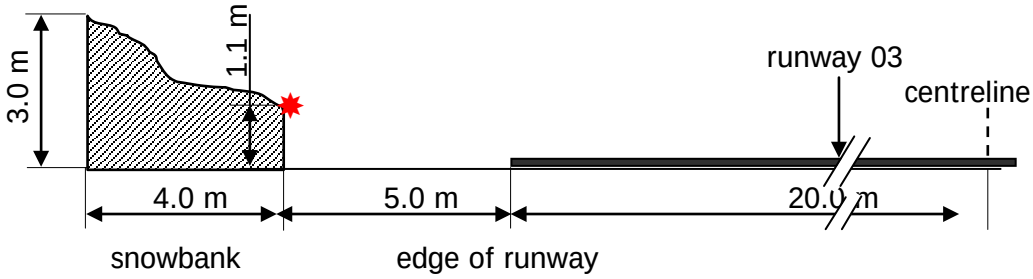


Figure 3: Cross-section of the snowbank at the point of contact with the left wingtip

1.12.2 Impact

It was possible to reconstruct the landing sequence and impact on the basis of the marks on the snow-covered runway and the eye-witness statements.

After the aircraft began to turn slightly counter-clockwise as a result of the contact of the left wingtip with the snowbank along runway 03, the right side of the fuselage hit the corner of a frozen snowbank about four metres high north of the taxiway linking the apron with the runway. The mobile GPS device indicated a speed on impact of 107 kt (198 km/h).

The fuselage slid a further 135 metres and came to a standstill on the left edge of runway 03. The front section with the cockpit came to a standstill after 158 metres, lying on its right side, at the right edge of runway 03.

1.12.3 Wreckage

The aircraft broke into two pieces as a result of the force of the impact. The fracture occurred behind the aircraft's entry door. On the aircraft fuselage the right landing gear was buckled and at the cockpit the nosewheel had sheared off. The fuselage, at the left edge of the runway, was rotated 90° clockwise in relation to the runway centreline and the cockpit, at the right edge of the runway, was rotated about 180 degrees. The thrust reversers on the engines were retracted.

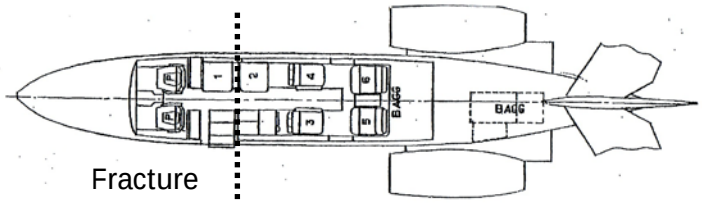


Figure 4: Seat arrangement in the aircraft and the fracture position

Figure 5 and 6: Aircraft fuselage at the left edge of the runway and the cockpit at the right side of the runway in their final position on runway 03.

1.12.4 Findings in the cockpit after the accident

The instruments in the cockpit were inspected visually after the accident. It showed that on the commander's side the altimeter was set to the standard pressure of 1013 hPa. On the copilot's side, a pressure of 1006 hPa was set on the altimeter, corresponding to the QNH value which had been reported to the crew by the Samedan airport FISO.

The speed bug on the commander's airspeed indicator was set to 119, and the one on the copilot's airspeed indicator was set to 114.

The altitude on the altitude alert indicator was set to 11 000 ft.

The used fuel indicator showed 1848 lb (838.25 kg).

The power levers were in the idle position. Thrust reverse was not selected.

The enhanced ground proximity warning system circuit breaker was in the pulled position.

On the copilot's side the laminated booklet "Laret Checklist Falcon 10/100" was jammed between the instrument panel and the inner cockpit bulkhead. It was open so that the procedures for approach and landing were visible.

Three different checklists were onboard; one was the one mentioned above, plus one by the CAE SimuFlite company and one by the Flight Safety International company. Regarding descent, approach and landing, the latter is not identical to the other two checklists or with the manufacturer's checklist. The aircraft manufacturer's operational instructions manual was also found on board. The aircraft manufacturer's airplane flight manual (AFM) and the aircraft flight log could not be found.

1.13 Medical and pathological information

An autopsy was performed on the pilots' bodies. It established that the commander suffered internal bleeding immediately after the collision due to the severe internal injuries caused by the deceleration forces. The copilot suffered traumatic brain injury with destruction of major regulatory centres. These injuries also caused death immediately after the impact.

The pathological findings established during the commander's autopsy had no influence on the accident.

In the case of the copilot, no changes to organs were found which would indicate pre-existing illnesses.

The toxicological analyses on both pilots found no evidence of alcohol, narcotics or medicines.

1.14 Fire

Fire did not break out.

1.15 Survival aspects

1.15.1 General

The accident was survivable only by chance, given the great forces which occurred. The surviving passenger was sitting in seat 1 (cf. figure 4) with his back to the right side of the fuselage, at 90 degrees to the direction of flight.

1.15.2 Emergency transmitter

The aircraft was equipped with an emergency location beacon aircraft (ELBA), model ADT 406 AF/AP. The unit was installed, but did not respond during the accident, because the lateral impact did not trigger the emergency beacon's acceleration sensor. An inspection after the accident indicated that the unit was fully functional.

1.15.3 Action by the rescue and fire-fighting services

The four air traffic employees of the Samedan airport 'fire & rescue' team that were at the accident site first, were busy at the time of the accident with the following tasks: Two of them were busy de-icing aircraft on the apron. According to their statements, they saw the aircraft involved in the accident on the runway just before the taxiway. They noticed a cloud of snow, heard a bang and saw aircraft parts thrown into the air.

They instantly left their location, rushed to the fire service vehicle which was parked next to Hall 2 and drove it to the wreck. They saw one person standing next to the cockpit, whom they assisted until the rescue services arrived.

After this person had informed the attendants that he was the only passenger and that the two pilots were still in the cockpit, one of the two attendants tried to get into the cockpit from the rear, through the open fuselage. Since access was blocked by equipment and cables, he tried to smash the cockpit windscreen with a pickaxe. He wanted to get to the pilots as quickly as possible. Since he was unable to smash the front screen and the triangular window, he then tried to smash the side window, which he managed to do. He determined that the pilots had no pulse and began with other helpers to remove the cockpit bulkhead from the rear.

At the time of the accident, the third member of the fire and rescue team, with the fourth member as co-driver, was in the snow clearance vehicle at the end of runway 03, or rather at the threshold of runway 21. According to his statement, he heard the *"crash, crash, crash"* callout on the radio and then drove the snow clearance vehicle immediately to the location of the accident. He then let his colleague out, drove the snow clearance vehicle in front of the hangar and also made his way to the wreck.

1.16 Tests and research

Since the aircraft was not equipped with a flight data recorder, recordings of the behaviour of the engines, among other things, was unavailable. However, these were equipped with a recent-generation engine control system. The N1 replacement digital electronic engine control (DEEC) has a non-volatile memory (NVM) which records a limited quantity of engine data. In addition, the DEEC categorises the seriousness of the violations of the N1, N2 and ITT limit values and splits these into two types[5].

The NVMs were read by Honeywell, the engine manufacturer, and the data was analysed. Among other things, the manufacturer summarises this in its report dated 18 March 2009, as follows:

"Analysis and conclusions

The download of the maintenance and incident data from both left and right engine DEECs was successfully completed. There were no faults or type I or II exceedances in either engine DEEC. Analysis of the data indicated that both engines were rotating, operating, and responsive to changes in power lever angle. Both the left and the right engines were operating at an N1 (Low pressure spool)) rpm between 30-40%, with an N2 (High pressure spool) rpm between 60-70% at the time the aircraft landed (i.e. weight on wheels). Both controllers were in auto mode during the landing. Electrical power was lost to both DEECs approximately 2-3 seconds after landing."

[5] Definitions according to engine manufacturer Honeywell (72-00-00, Adjustments/Test limits):

Type I *exceedance requires download of ECTM (engine condition trend monitoring) data and logging of exceedance type, peak and duration in the Engine Log Book.*

Type II *exceedance requires appropriate Engine Light Maintenance Manual or heavy Maintenance Manual maintenance actions, a download of ECTM data and logging of exceedance type, peak and duration in the Engine Log Book.*

The two graphs below, from the manufacturer's report, show the progression of the two speeds N1 and N2 as a function of the position of the respective power lever angle (PLA).

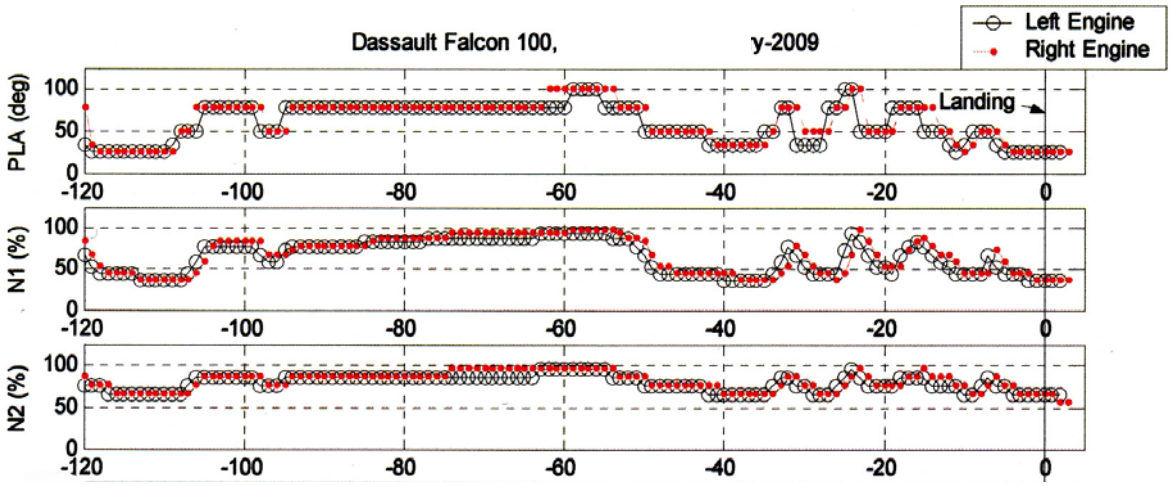


Figure 7: Power lever angle (PLA), N1 and N2 during the last 120 seconds

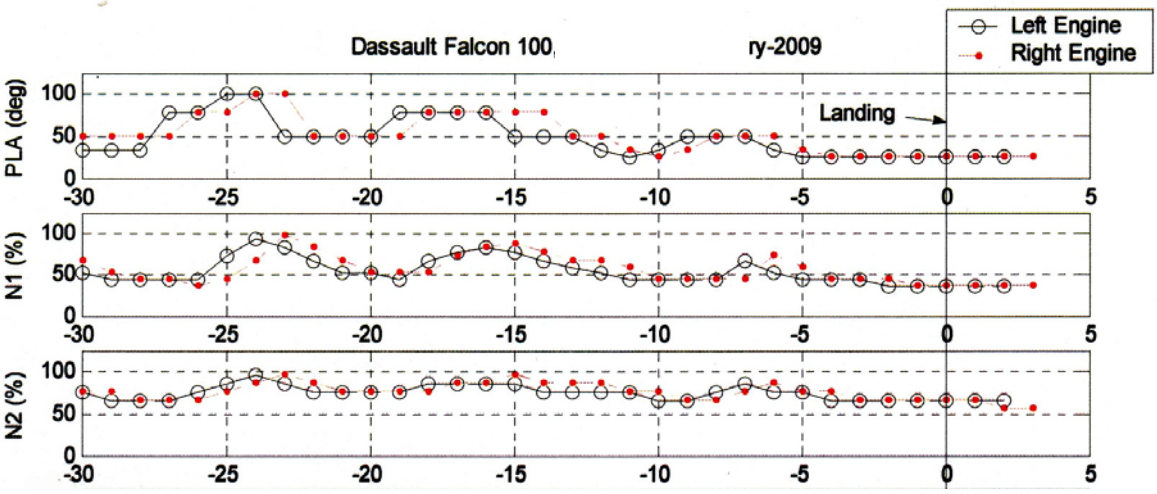


Figure 8: Power lever angle (PLA), N1 and N2 during the last 30 seconds

1.17 Organisational and management information

1.17.1 Aircraft operator

1.17.1.1 General

Laret Aviation Ltd. Bermuda was the owner and operator of aircraft VP-BAF. The company does not own any other aircraft. Laret Aviation Ltd. Bermuda is a subsidiary of Laret Aviation AG, Basel; the latter is owned in its entirety by the passenger who was on board the flight involved in the accident.

Laret Aviation AG, Basel, was constituted from the company New Fast AG and according to the "Schweizerisches Handelsamtsblatt" has the following commercial purpose (SHAB 198/2006, 12 October 2006):

"Halten und Zurverfügungstellung von Flugzeugen an einen geschlossenen Kreis von Personen zu Selbstkosten. Die Gesellschaft kann sich an anderen Unternehmen beteiligen, solche gründen, übernehmen und mit ihnen fusionieren. Sie kann Liegenschaften und Immaterialgüterrechte erwerben, belasten und veräussern."

1.17.1.2 Conditions of employment of the pilots

The two pilots involved in the accident were employed full-time by Laret Aviation Ltd. Bermuda. According to the statement by its representatives, the company had employed the copilot involved in the accident in 2008. This was in consideration of replacement of the commander involved in the accident on the grounds of age which was envisaged in the course of 2009. The representative of Laret Aviation Ltd. Bermuda was not aware whether the two pilots involved in the accident were active for other aviation companies.

Since the company was founded in 2006, a third pilot had been employed at the same time as the commander involved in the accident.

1.17.1.3 Responsibility for flight operations

According to the statement of the representative of Laret Aviation Ltd. Bermuda, neither company – Laret Aviation AG Basel or Laret Aviation Ltd. Bermuda – had engaged in any operational activities. They were contractual partners of companies which provided the services required for flights to be undertaken.

For example, among other things, a Swiss flight operations and services company was responsible for maintenance of the aircraft. After two incidents in August 2007 (cf. chapter 1.5.1.3), according to statements by the owner and representatives of this company, differences in opinion arose and as a result the service agreement was cancelled by mutual agreement in September 2007. According to his statement, the responsible representative of Laret Aviation Ltd. Bermuda had no knowledge of these two incidents in August 2007. A French company was subsequently commissioned to carry out the maintenance work on aircraft VP-BAF.

In the opinion of Laret Aviation Ltd. Bermuda the commander involved in the accident was responsible for all relevant aspects of the operation of aircraft VP-BAF.

Thus he was in particular responsible for the training of pilots and for the organisation of the prescribed refreshers and checks. He was also responsible for monitoring the operational readiness of the aircraft.

1.17.1.4 Operating procedures

According to information obtained from the company's third pilot, aircraft VP-BAF was in principle operated according to the manufacturer's and CAE SimuFlite's procedures and checklists. With one exception the company itself had not published any of its own procedures. This exception concerns the laminated "Laret Checklist Falcon 10/100" for normal operation. The checklist is an extract from the "CAE SimuFlite" checklist and its content is identical to the latter.

It should be noted that the procedures in this checklist regarding descent, approach and landing, among other things, do not coincide in all respects with the aircraft manufacturer's AFM (cf. Annex 5).

For example, the operator's checklist does not address the approach speed (V_{REF}) and setting the radio altimeter, whereas setting the pressure (QNH) for the altimeter is already mentioned in the descent check and not, as by the manufacturer, only in the approach check.

1.17.2 The aircraft manufacturer

1.17.2.1 General

The "Dassault Aviation" company is a French aircraft manufacturer which constructs military and civil aircraft. The company was founded in 1930 by Marcel Bloch as the "Société des Avions Marcel Bloch". After World War Two, Marcel Bloch changed his name to Marcel Dassault and the company's name was changed in December 1947 to "Avions Marcel Dassault".

In 1971, Dassault acquired the "Breguet Aviation" company and renamed the company as "Avions Marcel Dassault/Bréguet Aviation" (AMD-BA)". In 1990 the company was again renamed and acquired its current name "Dassault Aviation".

The Falcon 10 aircraft was constructed in 1971 as a shorter version of the Falcon 20. The Falcon 10 was modified from production number 194 onwards. It acquired an EFIS (electronic flight instrument system) in the cockpit, an additional window on the right side of the cabin and an extra rear baggage compartment. Production numbers 195 and 196 were still the old version and from production number 197 onwards only the modified version was produced; for commercial reasons it was given the designation Falcon 100. After production number 228, in 1989, manufacture of this model ceased.

1.17.2.2 Limitations

The aircraft manufacturer's airplane flight manual (AFM; DTM 722), Section I, Limitations, publishes the following limitations, among others:

MAXIMUM LANDING GEAR OPERATING SPEED

VLO = 190 kt

VLO is the maximum speed at which it is safe to extend or retract the landing gear

MAXIMUM LANDING GEAR EXTENDED SPEED

VLE = 220 kt

VLE is the maximum speed at which the aircraft can be safely flown with the landing gear extended and locked.

MAXIMUM SPEEDS, HIGH LIFT DEVICES EXTENDED

Configuration	*VFE*
Slats extended	*200 kt*
Slats + Flaps 15°	*190 kt*
Slats + Flaps 30°	*165 kt*
Slats + Flaps 52°	*165 kt*

1.17.2.3 Operating procedures

The aircraft manufacturer's operational instructions manual (DTM 726) describes in chapter "S1 Normal", among other things, how the aircraft should be operated with two pilots. The division of tasks between the two pilots is described in section 2 "Distribution of duties". Also, in section 7 "Descent – Approach – Landing", the individual points as listed in the checklist are described in detail.

For example, the following is stated concerning approach speed under point 4 of the descent checklist:

"4. Approach speed VREF ..... COMPUTED

- *It is the speed to be normally used in final approach with flaps extended at 52°. To fix this speed refer to Flight Manual (section 6).*
  Place the index of airspeed indicator on the VREF value determined."

Furthermore, with reference to landing, the following is stated regarding speed, among other things:

"The final approach speed to maintain throughout the flare up to wheel touchdown is VREF provided no abnormal conditions imply an increase of this speed."

These abnormal conditions list points which were not relevant in the case of the landing of aircraft VP-BAF.

Point 8 of the approach checklist also contains the following information concerning the radioaltimeter:

"8. Radio altimeter decision height ..... SET"

Section 11 "Operating in cold weather conditions ..." includes the following, under point "2. Landing":

"For landing, comply with the same maximum precipitation heights as for take off (see page 2-060 (1): equivalent water depth).

According to the runway condition, landing distances can be largely increased."

Among other things, the section entitled "S2 Performances", in "temporary revision No. 883" under sub-section 2-070 "Landing on contaminated runways", contains the following:

"The level of safety is decreased when operating on contaminated runways and therefore every effort should be made to ensure that the runway surface is cleared of any significant precipitation."

Just three minutes before landing, the crew of VP-BAF received the following information, among other things, from the Samedan FISO: *"For your information we have light snow on the complete runway 03."*

Furthermore, the following, among other things, is also stated under "performance" regarding landing:

"DEFINITIONS
Landing field length:
The calculated landing distance on contaminated runway multiplied by a factor of 1.15 to be applied in accordance with the relevant operating regulations.

RUNWAY CONDITIONS
Runways contaminated by standing water, slush or loose snow:
A runway is considered to be contaminated when more than 25% of the runway surface area within the required length and width being used, is covered by surface water more than 3 mm (0.12 in.) deep, or by slush or loose snow, equivalent to more than 3 mm (0.12 in.) of water."

From the "equivalent water depth" graph (page 2-060 (1)) it can be seen that the equivalent water depth for the conditions prevailing in Samedan was less than 3 mm.

"USE OF CHARTS
Landing:
Actual landing distance on contaminated runways is calculated by applying the adjustment factors shown in the following table to the dry runway actual landing distance obtained from AFM chart 6-59."

According to this table, it is recommended to use the information corresponding to a "wet runway" for a snow-covered runway with an equivalent water depth of less than 3 mm (0.12 in.). It should be noted that nowhere in the entire section entitled "Performance" is there any explicit information published about "wet runway" conditions. The manufacturer answered a corresponding enquiry to the effect that this would not be necessary, as in the JAR or FAR regulations it is specified that it would be necessary for this purpose to multiply the required runway length by a factor of 1.15.

A single note in this regard is to be found in "Service newsletter No. 9" dated December 1976. Among other things, this newsletter states the following:

"Wet runways reduce braking efficiency but this reduction is minimized by a good antiskid system. The antiskid system adapts the braking force according to runway adherence conditions. In that case, increase in landing distance will not exceed 500 feet."

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 office holders and their responsibilities 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 is 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.”

The functions relevant to the accident and their obligations are given below.

1.17.3.2 Responsibilities of the Chief Ground Services

Section 12.3 "Organisation" of the ATMM states that the chief ground services (CGS) is responsible for the operational services. Snow clearance is also listed under these operational services in section 12.6.1 "Job Description". Regarding responsibilities and qualification requirements, reference is made to the "Pflichtenheft Chief Apron und Betriebe", along with the job description. In this specification, entitled "Pflichtenheft Chief Ground Service", dated 22 March 2007, snow clearance is no longer mentioned explicitly.

1.17.3.3 Duties of the FISO

The duties of the FISO are described in detail in section 2 "Responsibilities and Administration" of the ATMM. Among other things, section 2.4 "Responsibility of FISO" states 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 "General Administration" of the ATMM lists the various administrative tasks which the FISO must carry out. Among other things, these also include runway condition checks and the production of weather reports.

In relation to runway condition checks, section 6.2 "Aerodrome Surface Inspections" of the ATMM contains the following:

"The FISO is responsible that at least one regular surface inspection is performed each day. This inspection should be made before flying commences."

The following is also mentioned in section 6.2.2 "Abnormal Conditions":

"The FISO shall issue a warning when pilots may not be aware of conditions known to the FISO which may lead to a braking efficiency reduction.

A deterioration of wheel braking action may occur as a result of thawing snow, slush or ice, or due to heavy rainfall beyond the capacity of the drainage system, or obstruction of the system."

Under 6.2.4 "Snow and Ice", the following is also stated, among other things:

"In addition a check should be made when snow and ice are present to ensure that:

a) Badly rutted or frozen ground is adequately marked

b) Runways and taxiways are delineated if covered with snow or ice and a note taken of the extent of sweeping or sanding carried out.

The presence of snow and ice on the paved runway or the apron is to be reported on the RTF using the following description (as for Snowtam): (...)"

With regard to the production of weather reports, section 10 "Meteorological Services" of the ATMM contains 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 provides the airport with weather data and weather forecasts via the internet, for the attention of the FISO. Section 10.2 "Source of Weather Data" of the ATMM also contains 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" states that Samedan airport operates an automatic terminal information service (ATIS). The FISO is responsible for this operation.

1.17.3.4 FISO training

At the time of the accident FISO training was based on a two month basic course and a one month continuing education course, which both have finished at the *"entry point nord"* school in Malmö. This school calls itself as *"northern european air traffic services (ATS) academy"* that offers training to all air navigation service providers. The training by this school was acknowledged by the Federal Office of Civil Aviation (FOCA) in Switzerland.

After this three month of training a local based further training took place. The future FISO worked under operational conditions in Samedan and under supervision.

This effort could last several months. If the supervising instructor considered the future FISO to be ready for an independent mission, the airport management asked the FOCA for the final test to get the respective license.

According statement by the FOCA this final check included a written test with specific questions regarding the operation in Samedan and in addition the FISO's work was assessed during a whole day in Samedan by the FOCA inspector, together with the instructor.

The FISO were additionally trained as weather observer. This training was done by MeteoSwiss and included a one week training followed by a one day refresher every two years. The training partially took also place in Samedan, whereby additionally once a year an observer person in charge was on-site.

1.18 Additional information

None.

1.19 Useful or effective investigation techniques

None.

2 Analysis

2.1 Technical aspects

There are no indications of any pre-existing technical defects which may have caused or contributed to the accident.

2.2 Human and operational aspects

2.2.1 Aircraft manufacturer

The information in the aircraft manufacturer's operational instructions manual (DTM 726) is complemented by so-called "temporary revisions". These revisions date back as far as 1991 and thus do not correspond in any way to temporary information. The fact that such revisions were not incorporated into the normal procedures long ago must be considered not particularly user-friendly.

Section "S2 Performances" in the same manual contains information on how the landing distance (cf. section 1.17.2.3) should be calculated in the event of contaminated runway conditions. Reference is made to "Temporary Revision No. 883" dated 6 June 2003. The comment that the information should be used by analogy with a wet runway, which was, among other things, published without providing any information at all on criteria concerning a wet runway in the entire section, represents a deficit.

2.2.2 Aircraft operator

The business model as applied by Laret Aviation is widespread. In the present case, all competencies regarding flight operations were entrusted to a single person, namely the commander.

As a result, important operational control mechanisms were invalidated. When quality assurance as a whole is in the hands of a single individual, that person monitors it himself and there has to be some doubt as to whether weaknesses are detected and corrected by taking the necessary measures.

2.2.3 Flight crew

2.2.3.1 Cooperation

Cooperation within a multi-person crew demands that the tasks of individual crew members are defined and coordinated. Closely associated with this is an awareness of what the individual crew member must contribute to the team's performance and what is to be expected in the way of support from the other team members.

As a result of the experience of numerous accidents in which deficient cooperation between individual crew members was a causal factor, crew resource management (CRM) was developed at the beginning of the 1980s as training for flight crews and subsequently taken up as a component of the training and continuing training of commercial pilots. Crew resource management shall sharpen the awareness that beside technical knowledge on board of an aircraft human relations are a decisive factor for safe conduction of flight.

There is no trace of such cooperation between the pilots of VP-BAF according to the CVR recordings. Neither the planning of the approach nor the flight manoeuvres carried out were discussed among the crew. Furthermore, the call outs from

the EGPWS "caution terrain" and from the TCAS "traffic, traffic" were not addressed by the crew.

The pulling of the circuit breaker to deactivate the EGPWS call out was not mentioned by either pilot. No instructions from the pilot flying to carry out the approach check and the final check are discernible on the CVR. The actions to be taken for these checks were neither clearly addressed nor were the corresponding actions acknowledged or confirmed. The fact that the commander had not set the speed bug to the approach speed and that the altimeter remained set at the standard pressure of 1013 hPa until landing, indicates that certain essential settings for the approach were omitted.

According to the documentation available, the two pilots had not completed a CRM course. With reference to the incidents and accidents mentioned, in which the commander was involved, there is some doubt as to whether a CRM course would have had the necessary effect.

On the other hand it is conceivable that CRM training would have enabled the copilot to intervene in certain critical flight phases, in so far as he would have recognised them as such.

2.2.3.2 Operating procedures

The "Laret Checklist Falcon 10/100" found between the instrument panel and the inner bulkhead of the cockpit lay open so that the procedures for approach and landing were visible. It can therefore be assumed that the copilot was using this checklist. In terms of normal operation, it is identical to the “CAE SimuFlite” checklist, but not to that of the aircraft manufacturer.

Thus, for example, in the checklist used by the crew the "altimeter" point is addressed as early as the descent check. This is not very appropriate as the points in the descent check are normally executed when cruising, shortly before the descent starts, i.e. at a time when the local QNH cannot yet be set. There is therefore the risk that setting of the local QNH will subsequently be forgotten. This might explain why the standard pressure of 1013 hPa was found set on the commander’s altimeter after the accident. The manufacturer does not require setting of the local QNH until the approach check, which is more appropriate in terms of the flight sequence.

In contrast to the aircraft manufacturer’s checklist, the checklist used does not address the radio altimeter respectively the setting of a DH. This is not comprehensible as it is compelling that the setting or not setting of the DH is addressed by the two pilots.

Similarly, the point "approach speed" is not addressed explicitly in the checklist used by the crew. Under this point in the descent check, the manufacturer refers to the fact that the approach speed must be determined and the speed bug must be set to this value on the airspeed indicator. The correct approach speed is an elementary requirement for a successful landing. It is therefore incomprehensible why this point is not explicitly mentioned in the crew's checklist. This probably also explains why the speed bug (index) on the commander’s airspeed indicator was set to an incorrect value.

It is also worth mentioning that neither the aircraft manufacturer’s airplane flight manual (AFM) nor an aircraft flight log were onboard the aircraft. Consequently, elementary documents essential to conducting a flight were not on board. Only the aircraft manufacturer’s operational instructions manual was found on board.

The missing documents were made available by the aircraft operator after the accident.

The AFM was not updated to reflect the current technical condition of the aircraft. The system descriptions corresponded to those of the Falcon 10 aircraft. The system changes regarding the modifications of the aircraft to the Falcon 100 and additional modifications could not be found in the AFM.

2.2.3.3 Flight preparation

The documents such as the flight plan, weather and wind information, which the crew had received before the flight, allowed complete flight planning to be carried out.

Since neither pilots had luggage on board, it can be assumed that they planned to return to Vienna the same evening.

On the operational flight plan (OFP) which was used for the flight to Samedan, the crew had entered neither the actual amount of fuel nor the current take-off mass of the aircraft. Also, no corresponding information could be found among the other papers on board. It is therefore safe to assume that only an estimation of the take-off mass, if any at all, was made for the flight to Samedan. The weight sheet onboard the aircraft which was available for calculation of the take-off mass was not adjusted to reflect the latest weighing, which took place on 6 February 2009 after the aircraft was repainted.

2.2.3.4 History of the flight

The 14:20 UTC ATIS report, which announced a visibility of 3000 metres, overcast at 3000 ft and light snowfall, elicited no reaction from the crew, according to the CVR. This is surprising as the ATIS report indicated substantial worsening of the conditions compared with the weather forecasts before the flight.

After contact was made with the FISO in Samedan, the latter informed the crew as follows: *"Victor Papa Bravo Alfa Foxtrot at the moment we have overcast three thousand feet with snow but in the region Maloja it makes open so you can expect high visibility until Maloja, then reduce up to three thousand meters before threshold zero three. We have runway zero three in use and the QNH is one zero zero six for landing, report ten miles for straight in zero three next."* Neither this report, nor the information given one minute later that the crew would have to expect a ten-minute delay due to snow clearing, elicited any reaction in the cockpit. A possible approach strategy and the runway condition to be expected (a contaminated runway) were not discussed.

The weather conditions would have allowed the crew to fly holding circuits above the cloud ceiling. It is possible that the crew were expecting the weather to worsen and wanted to make use of the good visibility conditions in the Maloja area reported by the FISO to get below the cloud ceiling and thus make it possible to approach Samedan.

The aircraft was descending north-east of the Piz Nair when the "caution terrain" call out sounded in the cockpit. Although the crew then initiated a gentle climb, no comment was made about this warning sounding. The position and condition of the "EGPWS" circuit breaker on the circuit breaker panel after the accident permit the conclusion that this circuit breaker, identified by a white collar, was not ejected as a result of the accident. From this it can be concluded that the crew pulled out the corresponding circuit breaker in response to the "caution ter-

rain" warning. This meant that following this manipulation, other acoustic warnings and messages, such as call outs for altitudes and "bank angle" in the event of excessive bank angles, were no longer audible to the crew.

According to recordings on the CVR, the checklist for the approach was not addressed. At 15:00:20 UTC the commander ordered the slats and flaps to be extended. The slats and flaps, and half a minute later the landing gear, were extended at a speed which was up to 30 knots above the maximum permitted speed (Annex 3). This transgression of the limits specified by the manufacturer was not addressed by the copilot.

At 15:01:24 UTC the crew received the information that they would have to wait a further 10 minutes. In the meantime, another aircraft was taking off from runway 03 and gave the following report after take-off: *"Oh, by the way. For Zernez just departing threshold runway 21 is clear weather, nice... no showers, beautiful weather."*

This report of good weather to the north of the airport elicited no reaction from either the crew or the FISO. A possible approach from the north, where according to this statement better conditions prevailed, was not mentioned.

Based on altitude and airspeed changes during the 360° turns flown by the crew of VP-BAF, rough handling of controls can be concluded. In addition, the high bank angle of up to 50 degrees during the 360° turns indicates that the crew had manoeuvred themselves into a situation with little margin for action.

When the pilot of a rescue helicopter in the same area asked the crew of VP-BAF for their altitude at 15:08:33 UTC, the latter responded with 9300 ft. However, the aircraft was actually at an altitude of 9000 ft. It is likely that the commander gave this information because his altimeter was still set to 1013 hPa and not to the effective QNH of 1006 hPa. This setting indicated to the commander an altitude about 200 ft higher than the actual flying altitude. Such a pressure setting may give the crew a false sense of security.

The discussions in the cockpit indicate that the crew had intermittent visual contact with the runway. However, they also show that it was recognised how the clouds were moving about and the visibility conditions were changing rapidly.

When the crew lined up on the extended runway centreline after the fourth 360° turn, the copilot asked the commander whether he should extend the flaps to the full down position. The latter answered in the affirmative and full flaps were set at a speed which was again above the maximum permitted speed. The speed reduction actually required to match the approach speed of 114 kt only took place slowly. Even shortly before the landing, the aircraft's speed was still some 10 kt too high. The speed bug set incorrectly by the commander may have reinforced this trend.

A rescue helicopter pilot acquainted with local conditions asked for the position of VP-BAF at 15:10:23 UTC. The crew replied: *"two miles"*. The aircraft was actually just short of four miles from the runway threshold. Shortly afterwards, the TCAS call out "traffic, traffic" sounded twice in the cockpit. This call out was triggered by the presence of the rescue helicopter. It was not addressed by the crew and it must remain open whether they even perceived it. Nor is any reaction audible in response to the information from the helicopter pilot that visibility was very poor *("very low visibility")*. This behaviour permits the conclusion that the crew were focused exclusively on the impending landing.

As the CVR recordings show, the crew had the runway in sight only about ten seconds before landing. At this time the aircraft was approximately 700 metres from the threshold of runway 03 and 50 m to the right of the runway axis. It is not understandable that from this initial position the approach was continued and a landing was forced. In particular, the situation was aggravated by the prevailing diffuse light and a snow-covered runway, which was difficult to make out in the snow-covered landscape.

From the prevailing weather conditions and in view of the incorrect altimeter setting, it can be concluded that the commander was unable to assess height above ground reliably. Since the EGPWS had previously been deactivated, the crew had no acoustic information about the aircraft's height above ground or bank angle at their disposal. It is highly probable that the crew were no longer able to assess reliably their actual attitude, their spatial position and their height above ground. Since the aircraft was to the right of the runway centreline when the crew were able to recognize the runway, the commander tried to line up with the extended runway centreline by means of a course correction to the left. As a result the aircraft crossed the runway centreline and a counter-correction to the right became necessary. During this right turn the right wingtip of the aircraft scraped the runway and the aircraft touched down to the left of the runway centreline, with a direction of motion which took it towards the left edge of the runway. This resulted in the collision with the snow bank.

2.2.4 Airport operator

2.2.4.1 Information service

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 misleadingly perceived by crews as an air traffic controller. This perception may seduce them so that crews were not aware enough that this information were only a basis for their own decisions. This is of particular importance in the case of weather information transmitted by the FISO after the transition from instrument flight rules to visual flight rules until landing.

According to the ATMM, the FISO is among other things also responsible for runway condition checks.

Under weather conditions such as those prevailing on the day of the accident, this task can be very time-consuming and the FISO is dependent on information from the snow clearing team. The same applies to the information which the FISO must be in possession of in order to draw up a SNOWTAM, for which he is also responsible according to the ATMM.

It is also questionable how the FISO can perform the task of communicating a "braking efficiency reduction" when neither a braking coefficient nor a braking action is measured.

In addition, it cannot be excluded that the FISO, as an airport employee, is subject to a certain degree of economic pressure.

2.2.4.2 Winter service

Snow clearance is not described in the duty-specification for the "chief ground services", who is responsible for this task. Snow clearance is only mentioned briefly in the job description. The question is posed as to whether this topic is assigned the necessary importance by the airport management.

The instruction "Weisung betreffend Schneeräumung" points out that, whenever possible, one should comply with the corresponding FOCA technical notice. This technical notice, however, leaves it up to the airport operator to define an appropriate distribution of snow, even if this means that the ICAO guidelines are not complied with. The airport operator obviously made use of this freedom, as the banks of snow present on the day of the accident did not comply with the ICAO guidelines in terms of their dimensions.

The airport had published a SNOWTAM which did not correspond to reality. According to this SNOWTAM, among other things snow banks two metres high were to be found at a distance of seven metres to the left and right of the runway. The snow banks measured after the accident, however, were up to four metres high and at the point at which the left wing of the aircraft contacted the snow bank, the bank was only five metres from the edge of the runway.

Samedan airport renounces to measure and publish a braking coefficient or a braking action. Such information is an essential factor for a pilot's situational assessment before a landing on a wet or contaminated runway. This is also the reason why the ICAO stresses the importance of such information and at the same time describes two methods of taking a corresponding measurement.

2.2.5 Crew training and qualification

According to joint aviation requirements (JAR), a CRM or MCC course is required to fly an aircraft as a two-man crew. There are no entries concerning completed MCC or CRM courses in the commander's licence. According to the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT), the commander did not have to complete any such courses in view of the many ratings which he possessed and because of so-called "grandfather rights". In addition, the BMVIT mentions that the commander possessed an Austrian licence, not a JAR licence. It should also be noted that this JAR-OPS provision applies only to commercial operation of aircraft and not to private operation.

It does not make sense that in the MCC/CRM context a distinction is made between commercial and private operation. MCC or CRM courses serve to optimise the operation of an aircraft by a two-man crew and to enable the early detection and elimination of potential hazards in two-man operation. In this context it is fully irrelevant whether an aircraft is being operated commercially or privately. It also makes no sense to speak of grandfather rights as a reason for avoiding taking such courses in this context. It is precisely older pilots, who have not experienced the CRM culture, who should be confronted with this issue.

The pilots completed refreshers and checks at recognised firms such as "CAE SimuFlite" and "Flight Safety". With regard to the checks and courses completed, no specific information about any detected strengths and weaknesses of the candidates was available to the investigation authority.

2.3 Meteorological aspects

On the day of the accident, humid polar air from the north north-west was flowing towards Switzerland and accumulating on the northern slope of the Alps. Given this accumulation from the north, the sky above Nordbünden and Mittelbünden was covered and it occasionally snowed. In such weather conditions, the Engadine, as a high valley in the Alps, constitutes a transitional zone to the southern side of the Alps, which has little cloud due to the influence of the Nordföhn. In the lee side of the mountain chain located to the north-west of Samedan, gaps occured in the cloud cover. To the south of Samedan, on the windward side of the Bernina massif, the rising air again favoures cloud formation. In the village of Poschiavo located south of the Bernina massif, 6/8 cloud cover was still being observed at 9500 ft AMSL at 15:00 UTC.

In the region of Samedan airport, the weather conditions were changeable. The main cloud base was at approximately 3000 ft AAL, corresponding to 8600 ft AMSL. Occasionally, this stratum would lift a little. Below this cloud base, snow showers and shreds of stratus moved over the valley.

This also explains the statements of various eye witnesses (cf. chapter 1.7.8). Thus, for example, one minute before the accident a helicopter pilot reported very poor visibility in the St. Moritz region. Another eye witness, who is a private pilot, observed in the area of the final approach on runway 03 at the time of the accident, a *"dark, very dense shower curtain*" (cf. also the two camera images from Murtel at 15:10 and 15:20 UTC, Annex 1).

A whitish sky, a freshly snow-covered landscape and snow showers driving across the valley led to very diffuse visibility conditions, which made visual flight navigation very difficult and at times impossible.

The weather conditions at the time of the accident were approaching the marginal for a visual approach to Samedan and a landing was not possible at all times.

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, in accordance with the AFM, at the time of the accident.
- The investigation produced no indications of any pre-existing technical defects which might have caused or influenced the accident.
- The last scheduled maintenance (basic inspection, monthly check) took place on 6 February 2009, at 6383:19 hours.
- The last airworthiness certification was issued on 31 December 2008, valid till 30 December 2009, by the "Government of Bermuda, Department of Civil Aviation".

3.1.2 Crew

- The pilots were in possession of the necessary licences for the flight.
- The two pilots suffered fatal injuries on the impact. The passenger was seriously injured.
- The toxicological analyses on both pilots found no evidence of alcohol, narcotics or medicines.
- The two pilots concluded their conversion to the Falcon 10 with the CAE SimuFlite company in Dallas.
- Training and qualification sheets made available to the investigation by CAE SimuFlite contained no information on possible strengths and weaknesses of the candidates.
- The commander's two proficiency checks after conversion to the Falcon 10 were assessed by the same examiner. The latter had no type rating for this aircraft type.
- The checklists used by the crew did not correspond to the one of the manufacturer.
- The two pilots were regularly and frequently in Samedan. For example, the commander had flown to Samedan thirty times in 2008 and the copilot six times.
- Incidents occurred during landings at Samedan with the commander on 2 August 2007, 16 August 2007 and on 24 August 2008.
- Two earlier accidents in which the commander had significant involvement are known.
- Neither pilot had completed an MCC course or a CRM course.

3.1.3 History of the flight

- A coordinated working method in terms of crew resource management (CRM) between the commander and the copilot was not discernible.
- The crew were informed of the weather by the flight information service officer (FISO) at 14:54:02 UTC, to the effect that at that time the cloud base was at 3000 ft, with snowfall and visibility of 3000 m but that good visibility could be expected above the Maloja pass.
- At 14:55:33 UTC, the crew were informed by the FISO that they would have to wait for approximately 10 minutes because of snow clearing on the runway.
- The crew were discussing the snow clearing at 14:59:55 UTC when the call out *"caution terrain!"* sounded twice in the cockpit. The descent was interrupted at an altitude of 10 500 ft and a gentle climb to just under 11 000 ft was initiated.
- As a result of the deactivation of the EGPWS, the crew no longer had any acoustic information about the aircraft's height above ground or bank angle at their disposal.
- The maximum speed for extending the slats and flaps was exceeded by 15 knots.
- The maximum speed for extending the landing gear was exceeded by 30 knots.
- At 15:06:39 UTC, the passenger asked the commander whether they could exit, as this circling was apparently very unpleasant.
- At 15:08:14 UTC, the FISO informed the crew of VP-BAF that they could now approach and that they should expect *"blowing snow on the runway"*.
- At 15:09:21 UTC, just under three minutes before landing, the crew of VP-BAF received the following information, among other things, from the Samedan FISO: *"For your information we have light snow on the complete runway zero three."*
- The calculations based on airspeed and turn radius indicate that in its last 360° turn before landing, the aircraft must have had a bank angle of about 50 degrees.
- At 15:10:29 UTC and at 15:10:42 UTC, the TCAS message *"traffic, traffic!"* sounded twice in the cockpit of VP-BAF.
- The question in the cockpit of VP-BAF at 15:11:49 UTC as to whether the runway was in sight was answered in the negative and five seconds later came the call out: *"There on the left".*
- One second later, the commander confirmed: *"I have it"* and just under ten seconds later the aircraft touched down 135 m after the runway threshold, on the left half of runway 03.
- It initially scraped the ground with its right wingtip, then the right followed by the left main landing gear touched down.
- The aircraft drifted slightly to the left and 258 m after the runway threshold its left wingtip made contact with the bank of snow running along runway 03.

- The aircraft then slightly rotated counter-clockwise about its vertical axis and the right side of the fuselage hit the corner of a frozen bank of snow up to four metres high which was located after the taxiway which links the tarmac with the runway.
- The aircraft broke into two pieces as a result of the force of the impact. Fire did not break out.

3.1.4 Wreckage information

- The speed bug on the airspeed indicator on the commander's side was set at 119 kt, and that on the copilot's airspeed indicator at 114 kt.
- On the commander's side, the altimeter was set to the standard pressure of 1013 hPa. On the copilot's side, the effective QNH of 1006 hPa was set.
- The altitude on the altitude alert indicator was set to 11 000 ft.
- The circuit breaker of the enhanced ground proximity warning system (EGWPS) was in the pulled position.

3.1.5 General conditions

- The weather conditions at the time of the accident were approaching the marginal for a visual approach to Samedan and a landing was not possible at all times.
- The dimensions of the snowbank heaped up along runway 03 did not comply with ICAO guidelines.
- The FOCA "Technische Mitteilung" of 1 January 1986 allowed deviations from these guidelines.
- The airport Samedan renounces of measuring and publishing any braking action or braking coefficient.
- The distance between the edge of the runway and the snowbank heaped up along runway 03 did not conform to the information in the SNOWTAM.

3.2 Causes

The accident is attributable to the fact that the crew wanted to make a landing with inadequate visual references from an unfavourable initial position and as a result, after touchdown the aircraft collided with a snowbank running along the runway.

The following factors contributed to the accident:

- The rapidly changing weather conditions on the mountain aerodrome of Samedan were misjudged by the crew.
- A coordinated crew working method in terms of crew resource management was missing.
- The deactivation of the EGPWS, which meant that acoustic messages concerning the aircraft's height above ground and bank angle were no longer available in the final phase of the approach up to the first contact with the runway.
- A snowbank up to four metres high ran along the edge of the runway.

4 Safety recommendations and measures taken after the accident

4.1 Safety recommandations

None.

On account of several accidents and serious incidents at Samedan airport, the Swiss AAIB has elaborated a safety record to the FOCA with various suggestions.

4.2 Measures taken after the accident

Three days after the accident inspectors from the Federal Office for Civil Aviation (FOCA) examined Samedan airport. After that the FOCA ordered without suspensive effect the closing of Samedan airport (letter dated 16 Februar 2009, Aktenzeichen 62-04.002). The FOCA based this order on statements in the "ICAO airport service manual part 2" and on "ICAO Annex 14 band I chapter 3ff".

Closing the airport by the FOCA was connected with the following instruction:

„Zur Herstellung des vorschriftskonformen Zustandes hat die Engadin Airport AG die folgenden Massnahmen umzusetzen:

a) die seitlichen Schneewälle der Piste sind gemäss den ICAO Vorgaben (Airport Services Manual Part 2, Point 7.3.5) abzutragen. Das Vorgehen ist in folgender Prioritätenordnung zu wählen:

   1. Bereich Schwellen 03 und 21;
   2. RWY – TWY - Kreuzungen;
   3. Übrige Bereiche

b) Die Engadin Airport AG hat dem BAZL ein Standplatzkonzept für den Snowpark bezüglich des Einhaltens der Mindestabstände, der Höhen sowie der Operationen der verschiedenen Flugzeugtypen in diesem Bereich einzureichen.

(...) Der Betrieb darf nur nach der ausdrücklichen und schriftlichen Zustimmung des BAZL wieder aufgenommen werden."

In a letter, dated 17 February 2009, the FOCA specified their order, based on a respective inquiry, among others, as follows:

„Generell sind auf dem Engadin Airport Helikopteroperationen nach wie vor erlaubt."

After a repeated inspection, the FOCA released the runway of Samedan airport again for operation on 20 February 2009 with the following notification:

„Bern, 20.02.2009 – Das Bundesamt für Zivilluftfahrt (BAZL) hat die Anfang Woche gesperrte Piste des Flugplatzes Samedan wieder für den Betrieb freigegeben, nachdem die zu hohen Schneemauern ordnungsgemäss weggeräumt worden sind."

Samedan airport resumed operation again on 20 February 2009 at 14:00 UTC.

According to the FOCA it was announced on a "Flugplatzleitermeeting" held on 16 September 2009 that with immediate effect the "Flugplatzleiterhandbuch" including the Technical Notification entitled *"Schneeräumung"* [snow clearance], dated 1 January 1986, is no longer valid.

On 2 December 2009, Samedan airport published a new snow cleaning concept that was approved by the FOCA.

Within this snow cleaning concept, in chapter 2 "Zielsetzungen", the following is stated, among other things:

1. *Einhaltung der Normen und Empfehlungen der ICAO Annex 14 Volume I und ICAO Airport Service manual Part 2 – Pavement Surface Conditions*
2. *...*
3. *...*
4. *Einhaltung des Bundesverwaltungsgerichtsentscheids vom 02.10.2009, "Demnach erkennt das Bundesverwaltungsgericht: "Ziff. 3: "Der Flugbetrieb auf der Start- und Landepiste ist einzustellen, wenn Reibungseigenschaften und Rollwiderstand nicht den Anforderungen von Ziff. 10.2.8 des ICAO Anhangs 14/I und den entsprechenden technischen Ausführungsbestimmungen entsprechen oder wenn die Piste nicht über die ganze Breite als homogene schwarze und seitlich klar begrenzte Fläche erkennbar ist."*

Remark by the Aircraft Accident Investigation Bureau (AAIB): Several points of the snow clearing concept refer in detail to the snow profile as laid down in the ICAO guidelines (cf. chapter 1.10.6.3). The question may be asked, why in the whole snow clearing concept measuring and publishing of braking coefficient or braking action is not mentioned with a single word (cf. chapter 1.10.6.5, respectively "ICAO annex 14/1 Ziff 10.2.8, attachment A, section 6" and "ICAO airport service manual part 2", on which the snow clearing concept is referred to several times explicitly).

According to the FOCA an examination of the conversion and a possible specification of the guidelines put in force in Switzerland on 15 March 2008 according art. 15 of the "Flugplatzleiterverordnung" regarding friction measuring is initiated. Measuring and publishing of braking coefficient and expected braking action are part of that examination.

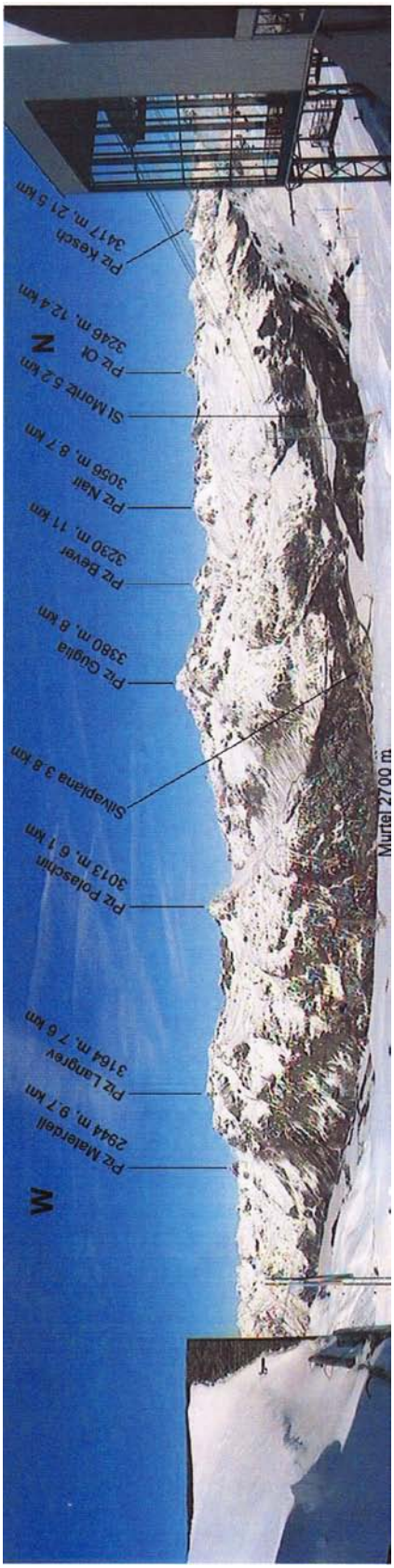
On 19 August 2009 Engadin Airport AG made an application to the FOCA in order to change the airspace classification "Golf" into "Echo" within the FIZ Samedan. They explained it among other things by the fact that by doing so, higher minima regarding visibility and cloud ceiling had to be applied and therefore safety would change for the better as well.

In a letter, dated 8 October 2009, the FOCA refused that request in regard to the "Verordnung über die Infrastruktur der Luftfahrt " (VIL, SR 748.131.1). But at the same time the FOCA stated that the director of a licensed airport has at any time the competence to release restrictions of any kind. Until completing this investigation no change has been made to the minima published at the time of the accident.

Payerne, 10 June 2010 Aircraft Accident Investigation Bureau

Annexes

Annex 1: Camera images



General view from Corvatsch mid-station "Murtèl", 2700 m/M (8859 ft AMSL)

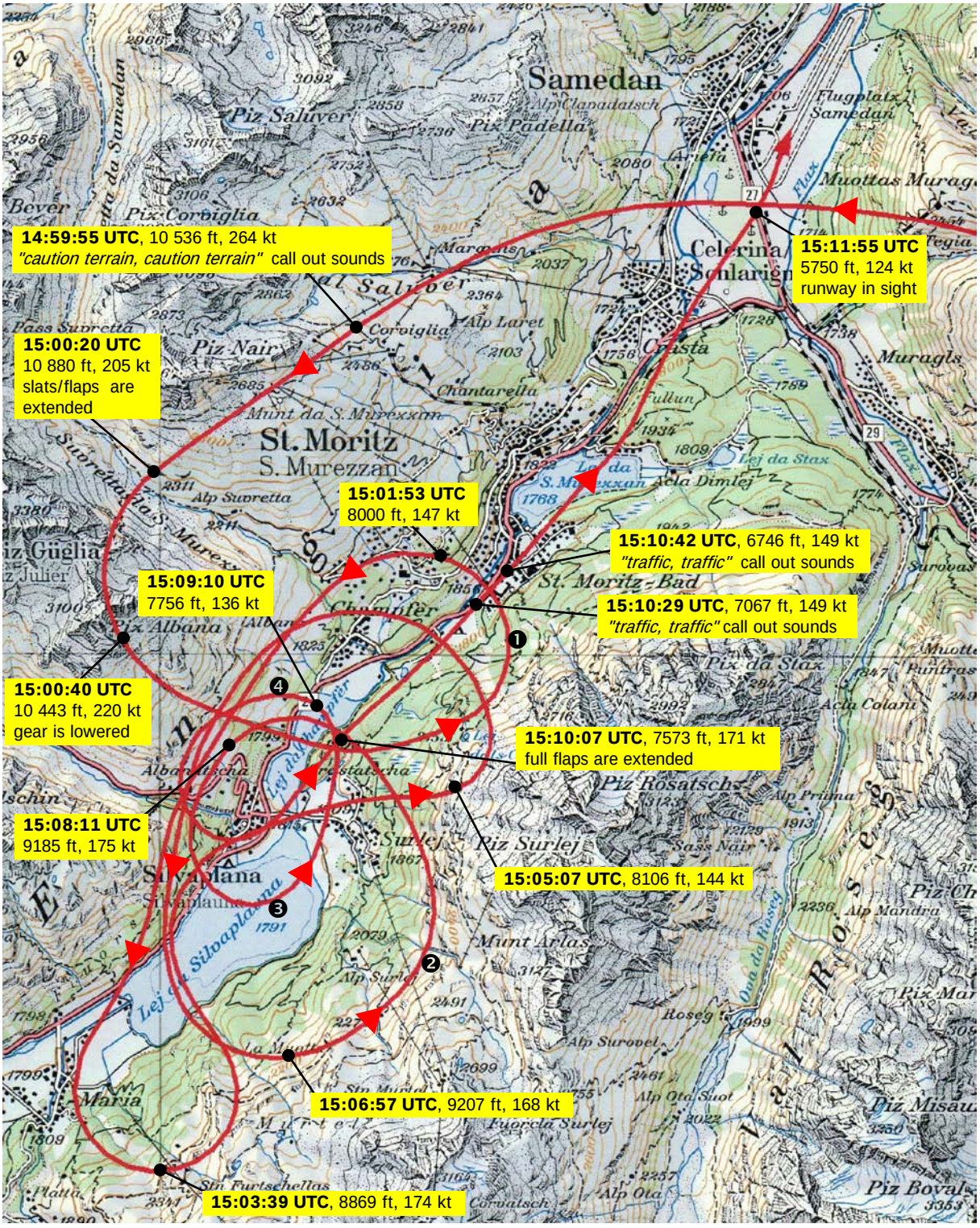
Visibility at 15:00 UTC. At this time the aircraft VP-BAF was east of Piz Güglia, between Silvaplana and St. Moritz, on an altitude of about 11 000 ft AMSL. Afterwards the crew flew a first 360° to the left, a 180° turn to the north and to the south each and three further 360° to the left (cf. Annex 2 and 3).

15:00 UTC: twelve minutes before the accident. At this time the aircraft VP-BAF was between Silvaplana and St. Moritz on an altitude of about 11 000 ft AMSL.

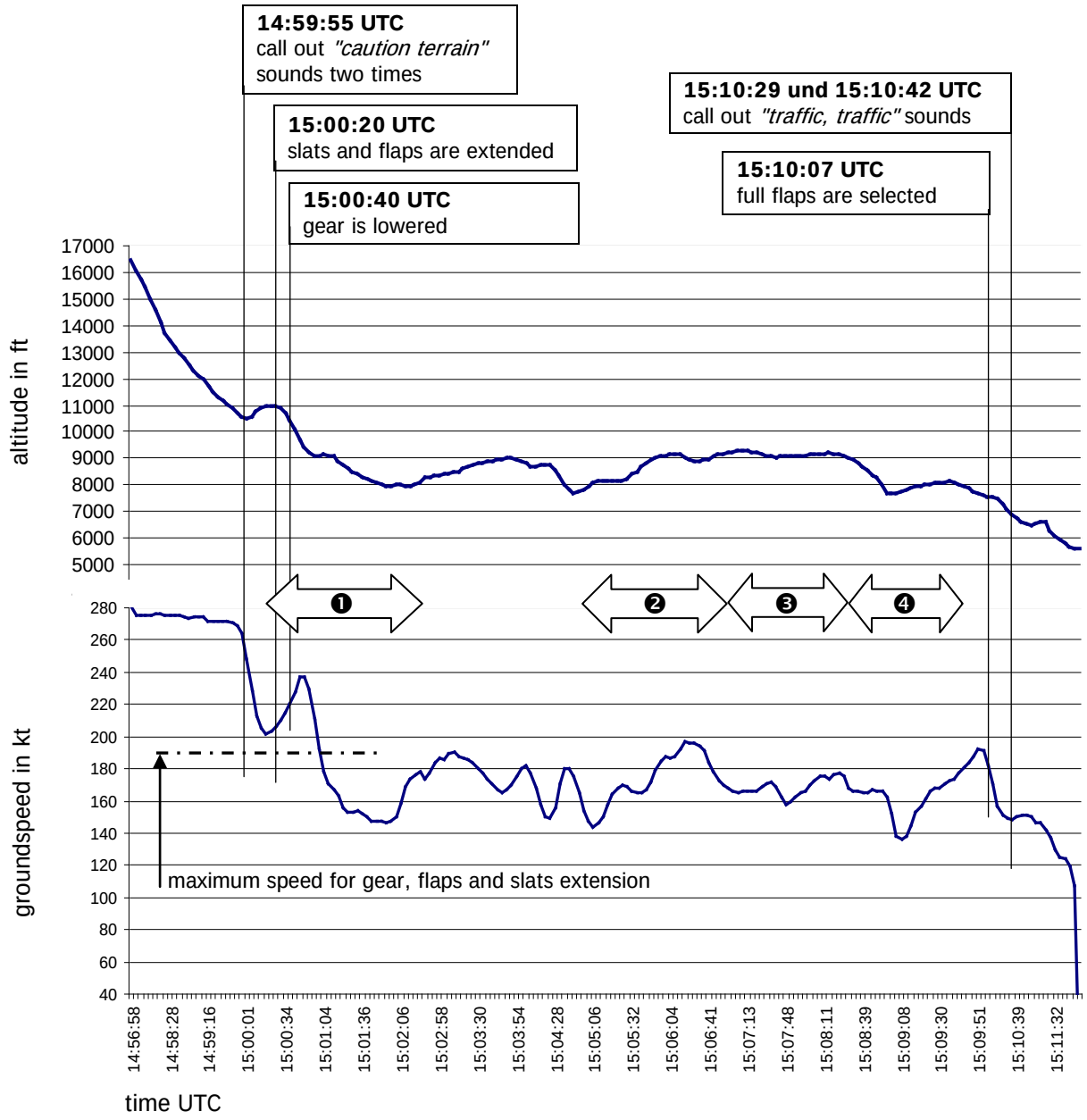
15:10 UTC: two minutes before the accident. At this time the aircraft VP-BAF was between Silvaplana and St.Moritz and on the final approach to runway 03 in Samedan.

Annex 2: History of the flight of aircraft VP-BAF

The speed information corresponds to ground speed. Given the prevailing wind, it can be concluded that the speed indication in the cockpit (indicated air speed – IAS) deviated from this by a maximum of 4 kt. The altitude information corresponds to the calculated altitudes according to the mobile GPS device.



Annex 3: History of the flight regarding altitude and speed



Legend:

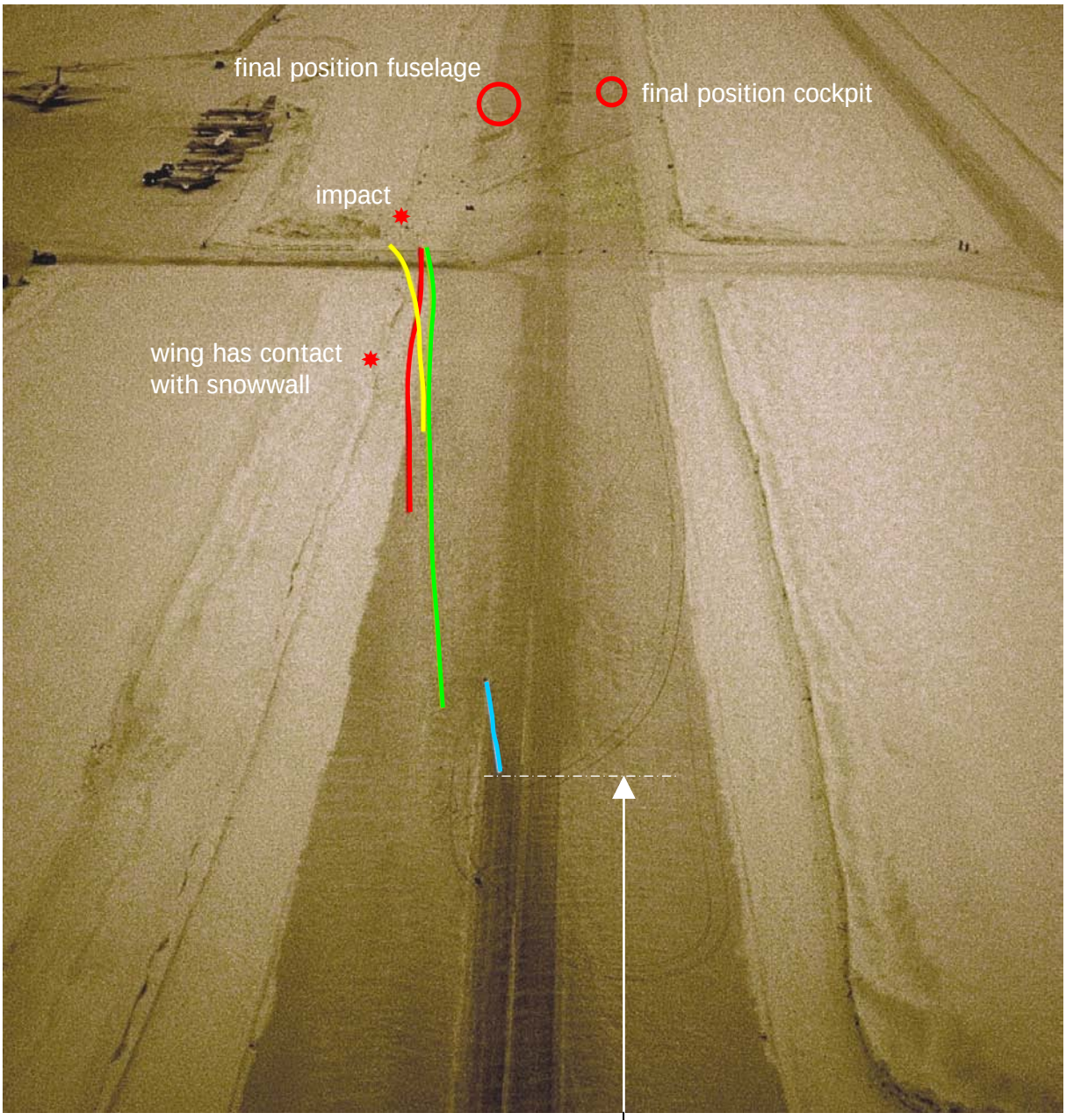
❶ first 360° to the left

❷ second 360° to the left

❸ third 360° to the left (maximum bank angle 45 degrees)

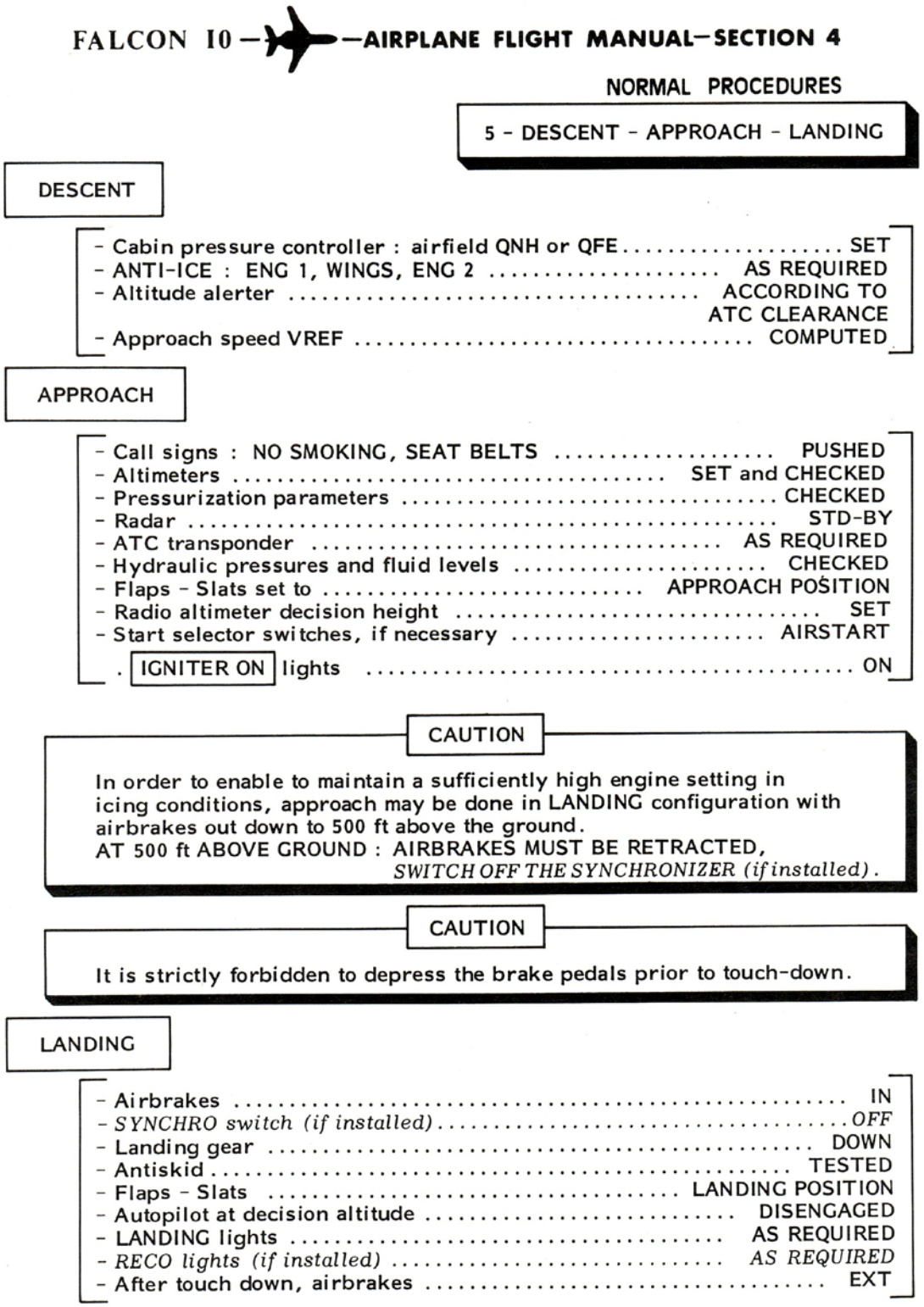
❹ fourth 360° to the left (maximum bank angle 50 degrees)

Annex 4: Landing and accident sequence on the runway



Annex 5: Checklists

Extract from the Airplane Flight Manual (AFM; DTM 722):



FALCON 10 — AIRPLANE FLIGHT MANUAL — SECTION 4

NORMAL PROCEDURES

5 - DESCENT - APPROACH - LANDING

DESCENT

- Cabin pressure controller : airfield QNH or QFE ..... SET
- ANTI-ICE : ENG 1, WINGS, ENG 2 ..... AS REQUIRED
- Altitude alerter ..... ACCORDING TO ATC CLEARANCE
- Approach speed VREF ..... COMPUTED

APPROACH

- Call signs : NO SMOKING, SEAT BELTS ..... PUSHED
- Altimeters ..... SET and CHECKED
- Pressurization parameters ..... CHECKED
- Radar ..... STD-BY
- ATC transponder ..... AS REQUIRED
- Hydraulic pressures and fluid levels ..... CHECKED
- Flaps - Slats set to ..... APPROACH POSITION
- Radio altimeter decision height ..... SET
- Start selector switches, if necessary ..... AIRSTART
- . IGNITER ON lights ..... ON

CAUTION

In order to enable to maintain a sufficiently high engine setting in icing conditions, approach may be done in LANDING configuration with airbrakes out down to 500 ft above the ground.
AT 500 ft ABOVE GROUND : AIRBRAKES MUST BE RETRACTED, *SWITCH OFF THE SYNCHRONIZER (if installed).*

CAUTION

It is strictly forbidden to depress the brake pedals prior to touch-down.

LANDING

- Airbrakes ..... IN
- *SYNCHRO switch (if installed)* ..... *OFF*
- Landing gear ..... DOWN
- Antiskid ..... TESTED
- Flaps - Slats ..... LANDING POSITION
- Autopilot at decision altitude ..... DISENGAGED
- LANDING lights ..... AS REQUIRED
- *RECO lights (if installed)* ..... *AS REQUIRED*
- After touch down, airbrakes ..... EXT

Procedures according to "Laret Checklist Falcon 10/100" and "CAE SimuFlite" respectively.

DESCENT

Pressurization	SET
Fuel Quantity/Panel	CHECKED
Anti-Ice Panel	SET
T.O.L.D. Card	COMPUTED
Crew Briefing	COMPLETED
Altimeter (At Transition Level)	SET
Recognition Lights	ON

APPROACH

Slats/Flaps	SET
Standby Pump	ON
Anti-Ice Panel	SET
Avionics	SET
Cabin Signs	ON

BEFORE LANDING

Landing Gear	DOWN/3 GREEN/NO RED
Hyd. Press/Quantity	CHECK
Anti-Skid	TESTED
Start Selectors	AIRSTART
Slats/Flaps	SET FOR LANDING
Landing Lights	SET