Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Büro für Flugunfalluntersuchungen BFU
Bureau d'enquête sur les accidents d'aviation BEAA
Ufficio d'inchiesta sugli infortuni aeronautici UIIA
Uffizi d'inquisiziun per accidents d'aviatica UIAA
Aircraft Accident Investigation Bureau AAIB

Final Report No. 2084 by the Aircraft Accident Investigation Bureau

concerning the accident involving

the Bombardier BD-700-1A10 aircraft, registration N906JW

on 6 February 2009

Samedan Airport, municipality Samedan/GR

Aéropôle 1, Route de Morens, CH-1530 Payerne

Ursachen

Der Unfall ist darauf zurückzuführen, dass das Flugzeug nach einem unstabilisierten Anflug zu spät und zu schnell auf der Piste 03 aufsetzte und in der verbleibenden Distanz auf der schneebedeckten und teilweise vereisten Piste nicht zum Stillstand gebracht werden konnte.

Folgende Faktoren haben zum Unfall beigetragen:

- Unzureichende Flugvorbereitung
- Anflug auf einen Gebirgsflugplatz bei kritischen meteorologischen Bedingungen

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	Bank of Utah, 711 South State St, Salt Lake City, UT 84111, USA
Operator	JW Asset Management Ltd. c/o Bank of Utah
Manufacturer	Bombardier Inc., Montreal, Canada
Aircraft type	BD-700-1A10
Country of registration	United States of America
Registration	N906JW
Location	Samedan Airport (LSZS), Samedan/GR municipality
Date and time	6 February, 16:48 UTC

Investigation

The accident occurred at 16:48 UTC. The notification was received by the Swiss Aircraft Accident Investigation Bureau (AAIB) at 17:30 UTC. The investigation was opened in the early morning of 7 February 2009 in cooperation with the Grisons cantonal police. The AAIB informed the following states concerning the accident: Canada and the United States of America. These two states each nominated an accredited representative, who assisted with the investigation.

The present investigation report is published by the AAIB.

Summary

During a private flight to Samedan (LSZS), aircraft BD-700-1A10, registration N906JW, took off from Warsaw (EPWA) at 14:57 UTC on 6 February 2009. The cockpit crew and two passengers were on board. This was this crew's first flight to Samedan.

The flight initially was carried out under instrument flight rules. Once the crew were able to make visual contact with the Samedan runway, at 16:39 UTC the approach to Samedan started with the flight now under visual flight rules.

It had snowed in Samedan until shortly before the arrival of N906JW. The runway was partly covered with snow and most of its surface was icy. Snow clearance was interrupted because of the aircraft arriving from Warsaw. After N906JW had to discontinue the approach to runway 03, it again flew a circuit at low altitude to commence a second approach.

The aircraft touched down at 16:47 UTC approximately 450 m after the threshold of runway 03. The aircraft could not be decelerated sufficiently, such that the aircraft skidded over the end of the runway into a bank of snow and after rotating 80° clockwise around its vertical axis came to a standstill some 30 m beyond the runway. The rescue services arrived at the aircraft immediately after it came to a standstill.

The occupants were not injured. The aircraft was damaged. There was no other damage.

Causes

The accident is attributable to the fact that after an unstabilised approach the aircraft touched down on runway 03 too late and too fast and could not be brought to a standstill within the remaining distance on the snow-covered and partly iced runway.

The following factors contributed to the accident:

- Inadequate flight preparation
- An approach on a aerodrome in mountainous area under critical weather conditions

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 flight recorders, radiotelephony traffic, radar data and the statements of the crew members and respondents were used. For the flight the commander was pilot flying (PF) and the copilot was pilot not flying (PNF). The conversations inside the cockpit were conducted in Polish and translated into English for the report.

Up to waypoint GUGSA the flight was conducted according to instrument flight rules (IFR). The approach to Samedan (LSZS) was carried out under visual flight rules (VFR/Y flight plan). On that day, Samedan airport ceased operations at 17:13 UTC.

The flight was a private flight.

1.1.2 Pre-history

The Bombardier BD-700-1A10 aircraft, registration N906JW, was deployed for the private use of the manager of a group based in Poland and the United States of America.

On 6 February 2009 the aircraft was prepared in Warsaw (EPWA) for a flight to Samedan. The mission was to fly the manager of the group and his companion to Samedan. N906JW was subsequently to fly from Samedan to Basel (LFSB), where the aircraft was planned for scheduled maintenance.

Since this was the first flight to Samedan for both pilots, according to their statements, they informed themselves about the conditions at Samedan airport with the help of documentation from the internet and reports of other pilots' experiences. On the morning of the departure date, the commander had several telephone conversations with different agencies at Samedan airport in order to obtain more detailed information about the prevailing weather situation and the runway conditions. According to the statement of the commander it was also mentioned that the runway would be cleared from the snow upon their arrival.

The flight planning was carried out by a specialised company in Warsaw and included the creation of an operational flight plan (OFP), preparing the ATC flight plan, calculating of the required fuel and obtaining the other flight documentation. Zurich was selected as the alternate airport, where a limousine had been reserved in case it became necessary to transport the two passengers to St. Moritz. The crew planned to have sufficient fuel on board to be able to hold over Samedan long enough for the weather conditions to allow a final approach according to visual flight rules.

The fuel calculation on the OFP resulted in a minimum block fuel of 8513 lb. In order to be able to fly any necessary holding patterns over Samedan on the one hand and, on the other hand, to be able to fly on immediately to Basel after disembarking the passengers, an actual block fuel of 15 000 lb was planned for the departure from Warsaw.

The aircraft was refuelled with 8900 lb of kerosene, so prior to the departure the desired amount of kerosene was in the tanks of N906JW.

1.1.3 History of the flight

On 6 February 2009 the Bombardier BD-700-1A10 aircraft, registration N906JW, left the stand at 14:45 UTC and took off from Warsaw at 14:57 UTC. The crew and two passengers were on board.

The flight took place without any noteworthy incidents. Whilst cruising at FL 360 the advisory message FLIGHT SPOILERS FAULT was displayed to the crew. After the crew had consulted the quick reference handbook (QRH), the copilot wondered whether the runway in Samedan was long enough to be able to land with the spoiler problem. In this regard, the commander pointed out at 15:19:26 UTC: "*Tam jest* [copilot's name]*, ten... prawie 6000. To nie bedzie nawet problemu..."* – [[copilot's name], there is... almost 6000, should not be a problem...]

The commander then estimated the expected landing mass to be 62 000 lb and consulted the necessary tables to determine the landing distance. He came to the following conclusion: "*Nam jest potrzebne 2900 a jak bys zdubeltowal to 4000.* [copilot's name]*, slyszysz? 2990 stop bez zadnych ...(***).."* – [We need 2900, and if you double it, 4000. [copilot's name], do you hear? 2990 feet without any...(***)[1]]

The discussion was interrupted by instructions from air traffic control. There was subsequently no further discussion about the spoiler fault. The crew then discussed whether Zurich or Basel should be chosen as the alternate airport. Interrupted by the air traffic control officer (ATCO) of Prague radar, who wanted to know whether the crew of N906JW could accept FL 380, the crew again applied themselves to the continuing progress of the flight.

N906JW then climbed to FL 380. After a brief discussion concerning the fuel consumption caused by the stronger headwind, at 15:26:37 UTC the commander noticed that time might be tight and that they would probably not arrive in Samedan until 17:00 UTC. While the crew looked for the reason for the 13 to 17 minute delay, one of the pilots interrupted the discussion and informed his colleague about another aircraft in the vicinity.

The discussion about the expected time of arrival then continued. In addition the pilots tried to ascertain the time from which the airport would be closed. At 15:28:26 UTC the crew began briefly to get to grips with a possible approach procedure in Samedan. Suddenly the commander interrupted the discussion, stating that he had made a calculation error concerning the arrival in Samedan and that they would now arrive 30 minutes before the airport closure. However, the crew ascertained that the time after landing would no longer be sufficient to fly N906JW on to Basel that same evening.

At 15:32:36 UTC the commander instructed the copilot to look for the approach charts for Zurich in the flight manual, so that they would be prepared if they had to divert to Zurich. In the meantime, at 15:33:30 UTC, shortly before N906JW passed waypoint MIKKO, the copilot made contact with Vienna air traffic control.

The crew then again busied themselves with the approach charts for Samedan and Zurich. As they did so, the crew were interrupted by instructions from Vienna air traffic control. These included a clearance to climb to FL 400, the allocation of transponder code 7316 and a clearance to fly direct to waypoint ABRUK. The

[1] (***) This last part was difficult to understand. In the translator's opinion: "*without any additional penalty distance, or without any factors"*

crew were then requested at 15:44:53 UTC to call the next sector of Vienna on 133.965 MHz.

At 15:45:41 UTC, the pilots discussed the snowfall prevailing in Samedan, the fact that they would then be able to fly the aircraft only visually and that they did not have the option of an instrument approach. At this point they received the instruction to contact Vienna Radar on 126.280 MHz. The landing preparation then continued, with a discussion of pre-selection of the autobrake system. The crew agreed on choosing the medium setting.

The JULIETT ATIS information was then monitored; it contained the following information: "*Samedan information JULIETT, runway in use by ATS, METAR for Samedan one five two zero, wind calm, visibility four thousand metres, light snow, cloud overcast at three thousand feet, temperature minus one, dew point minus two, QNH niner niner three runway is snow covered, snow remove in progress, Samedan information JULIETT".*

There followed a discussion in which the crew believed themselves to be fortunate that visibility had improved from 2000 to 4000 m in the last 20 minutes. There was no discussion about the runway condition. The commander then stated that it would definitely not be possible to fly on to Basel that day. There followed an instruction to the copilot to use the satellite telephone to call the appropriate handling agencies in Samedan and to inform them that they would be landing in approximately 30 minutes.

At 16:00:06 UTC the crew were instructed to contact Padua air traffic control on 133.705 MHz. At 16:00:38 UTC, the crew reported that they were ready for descent. The ATCO replied that he would coordinate this. Just two minutes later, the crew received clearance to descend to FL 350. During the continuing descent, the following remarks were made by the crew:

16:13:45 UTC, commander:	"*Dobra, idz do dolu. Nie wywalaj spoilerow."* – [Good. Start down. Do not deploy the spoilers]
16:13:59 UTC, copilot:	*"Ida normalnie* [spoilers]*. To tylko tamte sa zamkniete"* – [[Spoilers] operating normally. Only the others are stowed.]
16:15:38 UTC, commander:	"*Trzymaj 280 na, na tym, ze bylo jak najmniej predkosci. Dobra?"* – [Keep 280 on, on the.. So keep minimum speed, OK?]

The pilots now tried to establish adequate ground reference in order to change from instrument flight rules to visual flight rules. In the process, the speed was reduced. At this time N906JW was approximately 65 km south-west of the town of Bozen/IT.

N906JW was approaching waypoint RESIA when at 16:18:39 UTC the crew made contact with the terminal centre Zurich, sector south on the 128.050 MHz frequency. The aircraft was at FL 170 and received the allocated transponder code 7512 from the ATCO. The ATCO also asked the crew to advice when they were ready to continue flying under visual flight rules. The crew then enquired whether they could descend to a lower flight level. The ATCO informed the pilots that FL 170 was the lowest IFR flight level.

At 16:21:26 UTC the crew subsequently requested to fly holding patterns over waypoint GUGSA at FL 170 until the weather situation improved over the destination airport. This was approved by the ATCO. The pilots agreed to call Samedan

on the second radio to obtain further information about the current weather situation.

At 16:23:13 UTC the commander made contact with the Samedan AFIS unit on the 133.325 MHz frequency. "*Good afternoon Samedan Tower, Samedan Tower, N906JW".* The Flight Information Service Officer (FISO) answered as follows: "*N906JW, Samedan Information, go ahead."* After the commander had enquired about the current weather, the FISO gave him the following information: "*November juliett whiskey, for your information, the QNH niner niner three, and just for a few minutes ago, there was a big blue hole overhead the field, I suggest, you to proceed overhead the field and to try to come into the valley*."

The pilots then tried to make visual contact with the airport or rather the valley. At 16:24:31 UTC, the commander said to the copilot "*Czekaj, czekaj, moze bede widzial cos. Polecimy jeszcze piec mil w ta strone I to bedzie ta alejka, tutaj*." – [Wait, wait maybe I will be able to see something. We will proceed another five miles in this direction and it will be this valley here.], followed by the copilot's remark: "*Czekaj, czekaj, czekaj, czekaj, czekaj, czekaj, czekaj, może będę widział coś."* – [Wait, wait, wait, wait, wait, wait, wait, maybe I will see something.]

At this time, N906JW was between the villages of S-Chanf and Brail at FL 170 and was flying on a heading of 073°. Approximately 30 seconds later the crew were still trying to make visual contact with the airport; the commander asked the FISO on the radio: *"Hello sir, well we're crossing overhead right now we've a few breaks, ah, do you have any winds down there, which way should we expect the clouds to move?"* The FISO replied at 16:30:22 UTC: *"November juliett whiskey, the, just the blue hole was overhead the field, then just to the west, was the last time I saw it. Just now wait a minute, I tell you".*

The intention to fly direct onto runway 21 was not further pursued shortly afterwards, because the crew were unable to recognise the runway clearly as a result of the cloud. N906JW then turned again at 16:30:35 UTC in a gentle right turn in the direction of waypoint GUGSA. In this phase the commander was communicating with the FISO about the extent to which the cloud was clearing over the airport and whether there was a sufficiently large hole in the cloud to enable the VFR approach to be initiated.

At 16:35:40 UTC, the autopilot was switched off. The aircraft was practically over the airport at FL 170. The heading was 105° and the speed was about 186 KIAS. In a further left turn, the aircraft turned in the direction of La Punt. When it did so, the altitude varied by ± 500 ft. The subsequent radio contact between the FISO and the commander ensued:

16:37:19 UTC: *"Juliett whiskey, are you able to come into the valley then?"*

16:37:23 UTC: *"I think we are. But, ah, ah, we're making another circle here, just to make sure that this is the one."*

16:37:30 UTC: *"November juliett whiskey, I have all the lights turned on, they are just for the landing lights, because we don't have centerlights available."*

16:37:41 UTC: *"Roger that, we're looking for the lights right now. Hopefully we can do it. If not, we're gonna go to Zurich."*

16:38:23 UTC: *"OK, sir, it looks like I have the runway in sight. We're right overhead, we'll try to make an approach."*

16:38:29 UTC: *"November juliett whiskey, what runway do you prefer? Runway zero three or runway two one?"*

16:38:34 UTC: *"Two one"*

16:38:35 UTC: *"Ok, runway two one, for your information the runway is covered with wet snow, only the centerline of the runway is completely free."*

16:38:46 UTC: *"Ok, we'll do that, sir. Thank you very much."*

16:38:57 UTC: *"November juliett whiskey, Samedan?"*

16:39:00 UTC: *"Yes, sir?"*

16:39:02 UTC: *"Just come, ah, report when you are on the approach for runway two one to tell to the sweeper that should vacate runway."*

In the meantime the copilot reported at 16:38:41 UTC to the sector south ATCO that they had the airport in sight and would start their approach. This was confirmed by the ATCO at 16:38:55 UTC as follows: *"Juliett whiskey roger, IFR cancel time one six three niner you may leave the frequency and descend, good bye."*

At this time, the aircraft was still above the village of Bever at FL 161. Its heading was 210° and its speed was 166 KIAS. The commander then reported to the FISO at 16:39:11 UTC: "*Ok, ah, I have the valley now, and ok, looks like we're going..., oh, I lost the valley."*

There followed a left turn onto heading 030°, during which a descent was initiated. At 16:40:12 UTC, the landing gear was extended. When this was done, N906JW was in a left turn with bank angles up to 43°. Shortly afterwards, the commander reported that they now wanted to approach runway 03. The FISO then asked for their current position. This was confirmed by the commander at 16:42:04 UTC as follows: "*Right now we are slightly southeast of the field, going ????? zero three from what I see."* With it the aircraft was north-west of the airport at FL 105 (DFDR).

N906JW was flying straight towards St. Moritz and was descending at an average rate of descent of 1500 ft/min. At 16:42:10 UTC, the FISO reported to the crew: "*November juliett whiskey just for your information the marshaller just informed me, that the runway is with wet snow and a little bit icy",* and this was acknowledged by the commander with "*Ah roger that"*. In a subsequent left turn, the aircraft flew around the town of Celerina in the direction of the threshold of runway 03. In this turn, the rate of descent varied between 2000 and 2300 ft/min.

In the final phase of this approach on runway 03 the following warnings were generated by the enhanced ground proximity warning system (EGPWS):

16:43:32 UTC: *"Sink rate... sink rate"*

16:43:43 UTC: *"Sink rate"*

16:43:45 UTC: *"Pull up"*

16:43:55 UTC: *"Five hundred"*

16:44:03 UTC: *"Approaching zero three, five thousand nine hundred available"*

Eye witnesses on the ground observed how N906JW was approaching to the north of the runway centre line in the direction of the hangar. The crew decided to discontinue the approach and reported at 16:44:08 UTC: "*Looks like a slight*

missed approach. We'll have to do a little circle". At 16:44:12 UTC the EGPWS message "*Caution terrain... caution terrain" was generated.* Without gaining any substantial height, N906JW continued to fly in the direction of the runway.

The FISO informed the crew that they have been approaching runway 03, which they confirmed. The crew also reported that they would now turn onto the downwind leg of the approach to runway 03. The FISO instructed the pilots to report on final approach to runway 03.

At 16:44:30 UTC the copilot warned the commander with the callout: *"Speed, speed, speed, speed",* which the commander confirmed with the statement: "*Już widzę go, widzę go ... bo autothrust mi wiesz.. wysiadły"* – [I see it, I see it... because the autothrust, you know... disengaged]. The speed of N906JW at this time was 122 KIAS. Shortly afterwards, the FISO again advised the crew: *"November juliett whiskey, I report you again that the runway is ..ah covered with..ah..snow and icy",* which was confirmed with *"Ahh... roger roger".*

The aircraft passed the village of Bever in a tight left turn just 1000 ft above ground level. The commander then instructed the copilot that the bank angle was excessive. At the same time, at 16:45:12 UTC the EGPWS message *"bank angle... bank angle"* sounded. On the downwind leg of the approach to runway 03, the commander requested the copilot several times not to neglect the height above ground. In this phase, the radioaltimeter indicated values between 680 and 850 ft. At 16:45:35 UTC, the EGPWS message "*Caution terrain...caution terrain"* again sounded. The aircraft was almost directly over Celerina. The commander instructed the copilot to fly straight over the houses[2] in front of them. At 16:46:08 UTC, the EGPWS generated the message "*five hundred"*, indicating a height of 500 ft above the ground. Immediately afterwards, the commander reported that N906JW was turning onto the 03 final approach. The FISO confirmed this message at 16:46:13 UTC with: "*November juliett whiskey, wind calm runway zero three, land at your own discretion, runway covered with snow and icy".*

Over the next 70 seconds, the CVR (*cockpit voice recorder*) recorded the following:

16:46:24 UTC, commander:	*"Yes you have to go down, we go down – only do not cross controls there"*
16:46:35 UTC, commander:	*"Seven hundred RA"*
16:46:51 UTC, commander:	*"Max autobrake?"*
16:46:53 UTC, EGPWS:	*"Sink rate, sink rate"*
16:46:56 UTC, commander:	*"One thousand five hundred sink rate"*
16:46:58 UTC, copilot:	*"Speed is good"*
16:47:04 UTC, EGPWS:	*"Sink rate sink rate"*
16:47:07 UTC, commander:	*"OK...you got it?"*
16:47:09 UTC, EGPWS:	*"Bank angle, bank angle"*
16:47:11 UTC, copilot:	"*OK, we are reducing..."*
16:47:12 UTC, EGPWS:	*"Bank angle, bank angle"*

[2] According to the DFDR recordings, these must have been houses of the Celerina village.

16:47:15 UTC, EGPWS:	"*Fifty"*
16:47:16 UTC, EGPWS:	*"Forty*"
16:47:17 UTC, commander:	"[copilot's name], *go down"*
16:47:17 UTC, copilot:	"*OK, go down"*
16:47:17 UTC, EGPWS:	*"Thirty*"
16:47:18 UTC, EGPWS:	*"Bank angle, bank angle"*
16:47:22 UTC, copilot:	*"Robię reversers od razu max"* – [I am making reversers max immediately]
16:47:23 UTC, commander:	*"Nie..."* – [do not..]
16:47:24 UTC, copilot:	*"Max reverse"*
16:47:27 UTC, commander:	*"Trzymaj go tylko na centralnej, na centralnej..."* – [hold it only on the center line, center line]

At 16:47:29 UTC, N906JW touched down approximately 450 m after the threshold of runway 03 at a speed of 120 KIAS, corresponding to a relative speed of 128 kt over ground. The crew then tried to activate reverse thrust for 16 seconds. However, this only worked for the left engine thrust reverser system. The right engine reverse thrust system could not be activated.

At 16:47:40 UTC the EGPWS generated the message *"two thousand remaining*"*,* indicating the remaining runway length in feet. At that time the aircraft was still travelling at a speed of 72 kt. Shortly before this, the AUTOBRAKE FAIL caution message was registered. At 16:47:40 UTC, the EGPWS warning *"one thousand remaining"* sounded, followed by *"five hundred"* at 16:47:46 UTC.

At 16:47:59 UTC, N906JW overran the end of the runway at a speed of 17 kt, skidded into a snow bank and came to a standstill some 30 m beyond the runway after rotating 80° clockwise around its vertical axis.

The airport fire brigade, which was standing ready at the runway on taxiway C, followed N906JW after the landing and was at the accident site after the aircraft came to a standstill. When it was clear that the aircraft was no longer able to move under its own power, the crew were instructed to shut down the engines. Once a path had been cleared to the aircraft's doors, the passengers left the aircraft using the stairs integrated into the doors. The aircraft's occupants were uninjured.

1.1.4 Accident site

Accident site	Samedan Airport (LSZS)
Date and time	6 February 2009, 16:48 UTC
Lighting conditions	Evening twilight
Coordinates	788 004 / 157 428 (Swiss grid 1903) N 46° 32' 30.15'' / E 009° 53' 23.97'' (WGS 84)
Elevation	1699 m AMSL 5574 ft AMSL

Final position	Approximately 30 m from the threshold of runway 21 of Samedan airport, on the extended runway centreline (see Annex 3)
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	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	2	2	4	Not applicable
Total	2	2	4	0

1.2.2 Nationality of the occupants of the aircraft

The crew consisted of one citizen of the United States of America and one Polish citizen.

Two Polish citizens were onboard as passengers.

1.3 Damage to aircraft

According to an extract from the report of the maintenance company responsible for the repairs, the aircraft suffered the following damage:

- Left-hand onboard flap damaged
- Left-hand inboard flap outboard carriage damaged
- Left-hand inboard flap aft canoe fairing attachment fitting damaged
- Left-hand middle flap damaged
- Left-hand middle flap outboard carriage damaged
- Left-hand outboard flap damaged
- Outboard flap carriage damaged
- Both nose landing gear doors damaged
- Nose landing harness damaged
- Nose landing gear supports broken

This damage was temporarily repaired in Samedan so that N906JW could leave for Basel on 27 February 2009.

During the repair work in Basel, other damage was discovered in the area of the extension/retraction cylinder on the left main landing gear; this was most probably caused during recovery of the aircraft.

1.4 Other damage

There was no other damage.

1.5 Personnel information

1.5.1 Commander

Person	US citizen, born 1967
Licence	Airline transport pilot certificate (ATP), issued by the Federal Aviation Administration (FAA) on 18 April 2008.
Ratings	Type rating BD700 as pilot in command, valid until 15 April 2009. Class rating for airplane multi-engine land.
Instrument flying rating	Instrument flight aircraft IR(A) Category I instrument approaches with BD700.
Last proficiency check	Type rating check on 18 April 2008 for type approval on BD700.
Medical fitness certificate	Class 1 (first class), no restrictions, valid until 15 October 2008 Class 2 (second class), no restrictions, valid until 15 April 2009
Last medical examination	16 April 2008
Commencement of pilot training	1990

1.5.1.1 Flying experience

Total[3]	9329.7 hours
on the accident type	287.0 hours
during the last 90 days	73.4 hours
of which on the accident type	73.4 hours
during the last 24 hours	2.1 hours
of which on the accident type	2.1 hours
As commander	6801.7 hours
Total no. of landings	8269
Landings during the last 90 days	16
Landings, total, on the accident type	60
Landings during the last 90 days on the accident type	16

[3] The flying times in the commander's logbook were recorded using decimal points, as is customary in the USA.

1.5.2 Copilot

Person	Polish citizen, born 1954
Licence	Private pilot certificate (PP), issued by the Federal Aviation Administration (FAA) on 12 November 2008. This licence is valid only together with the air transport pilot licence aeroplane - ATPL(A) according to joint aviation requirements (JAR), first issued by the Polish Civil Aviation Office CAO (Urzad Lotnictwa Cywilnego – ULC) on 15 July 2008.
Ratings	Type rating BD700
Instrument flying rating	Instrument flight aircraft IR(A) Instrument flights with BD700 first issued on 30 June 2008, valid until 30 June 2009
Last proficiency check	Type rating check on 30 June 2008 for type approval on BD700
Medical fitness certificate	Class 1, restrictions: Must wear spectacles and carry a spare pair of spectacles (VDL) Valid from 4 February 2009 until 6 August 2009
Last medical examination	4 February 2009
Commencement of pilot training	1974

1.5.2.1 Flying experience

Total	8038:06 hours
on the accident type	69:14 hours
during the last 90 days	25:48 hours
of which on the accident type	25:48 hours
during the last 24 hours	2:03 hours
of which on the accident type	2:03 hours
As commander	6306:24 hours

Total no. of landings	10 792
Landings during the last 90 days	9
Landings, total, on the accident type	35
Landings during the last 90 days on the accident type	9

1.5.3 Flight Information Service Officer

Person	Spanish citizen, born 1982
Licence	At the time of the accident, a licence for the FISO at Samedan airport was not yet required.

On 9 December 2008, under the supervision of the FOCA, the FISO completed the so called “FISO examination LSZS*”,* which he passed. This examination was invigilated by another Samedan airport 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 issued the FISO with the "safety related task licence" for Samedan, valid from 1 June 2009.

1.6 Aircraft information

1.6.1 General information

Registration	N906JW
Aircraft type	BD-700-1A10
Characteristics	Twin-jet executive aircraft, constructed as a cantilever low-wing aircraft of full metal construction with retractable landing gear in nosewheel configuration.
Manufacturer	Bombardier Inc., Montreal, Canada
Year of manufacture	2001
Serial number	9110
Owner	Bank of Utah, 711 South State St, Salt Lake City, UT 84111, USA
Operator	JW Asset Management Ltd. c/o Bank of Utah
Equipment	Among other things, the aircraft is equipped with the following systems: • Electronic flight information system – EFIS (2) • Radioaltimeter (2) • Air data computer – ADC (3) • Autopilot system (2) • Flight management system – FMS (2) • Terrain collision avoidance system – TCAS II (1) • Enhanced ground proximity warning system – EGPWS (1)

	• VHF radio (3) • HF radio (2) • Transponder (2) • Weather radar (1) • Inertial reference system – IRS (3) • Global positioning system – GPS • Distance measuring equipment – DME
Operating hours	Airframe 1779.2 hours (TSN[4])
Number of landings	540
Max. permitted masses	Max. permitted take-off mass 96 000 lb (43 545 kg) Max. permitted landing mass 78 600 lb (35 653 kg)
Mass and centre of gravity	The mass of the aircraft at the time of departure was 66 932 lb (30 359 kg). The mass of the aircraft at the time of the accident was 60 082 lb (27 253 kg). Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM).
Technical limitations	None listed
Permitted fuel grade	JET A1 kerosene
Fuel	According to the flight plan, take-off fuel was 15 300 lb (6940 kg). Among other things, this included trip fuel of 5874 lb (2664 kg). The remaining 9426 lb (4276 kg) would have been sufficient for the flight to the alternate airport (LSZH) and for flying a holding pattern for 3:19 hours, without having to use the final reserve of 1085 lb (493 kg).
Registration certificate	Issued by the Federal Aviation Administration (FAA) of the United States of America on 10 September 2007.
Airworthiness certificate	Issued by the Federal Aviation Administration (FAA) of the United States of America on 27 March 2002, valid until revoked.
Certification	Transport category
Category	IFR Category II

[4] TSN: time since new

1.6.2 Maintenance

The maintenance of N906JW was carried out at maintenance companies in accordance with the manufacturer's maintenance program.

Before every flight, a maintenance company in Warsaw carried out the pre-flight checks, which if necessary could also be carried out by the crews. Mechanics from this company would be flown in for repair work. According to the crew's statement, this had never been necessary until the accident.

When scheduled maintenance work fell due, the flights were arranged so that after the mission the aircraft could if necessary be flown on to the nearest airport where this work could be performed.

The last major maintenance work took place during an "A check" at TAG Aviation Berlin (EDDB) from 12 to 17 November 2007. At that time the aircraft's operating hours were 1504.1 hours and 434 cycles.

An alteration to the airframe was concluded on 20 March 2008 at a Bombardier branch location in Bradley/USA (KBDL). At that time the aircraft had flown 1615.2 hours and 468 cycles.

1.6.3 Flight spoiler system

Flight spoilers are movable panels on the upper side of aircraft wings. They are used to assist control of flight in turns. After touchdown, these spoilers are fully deployed to dump the wing lift and at the same time to increase drag.

On the BD-700 twelve spoilers are located on the upper side of the wings; they are hydraulically actuated and electrically controlled. Eight spoilers act as multi-function spoilers (MFS) and four function on the ground as ground spoilers (GS).

The MFS are extended individually for roll assistance and symmetrically for proportional lift dump. After landing, the MFS are fully extended and assist the GS for ground lift dumping. As a result, the wheels have better downforce on the ground, so the wheel brakes are able to decelerate the aircraft more effectively.

Among other things, the two flight control units (FCU) also monitor and command the entire spoiler system and prevent undesirable asymmetric operation of the system, by de-activating the spoilers in pairs, followed by a corresponding fault message in the cockpit.

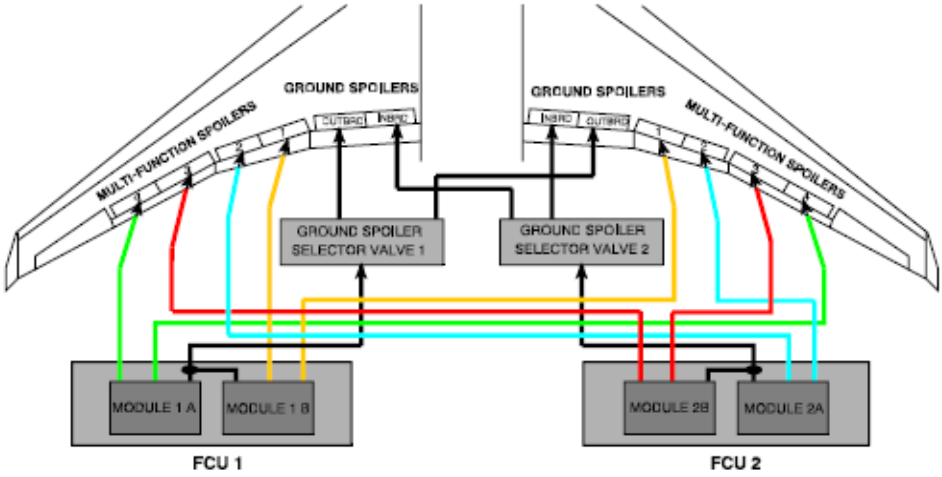


Fig. 1: Control and monitoring of the spoiler system

1.6.4 Engines

1.6.4.1 General

Aircraft N906JW was equipped with two axial flow, dual shaft turbofan engines, type Rolls Royce BR 700-710A2-20, with a rated thrust of 14 750 lb:

Engine 1	Serial number 12331 Year of manufacture 2001
Operating hours	1779.2 hours (TSN) 540 cycles
Thrust reverser	Hurel-Dubois Meuron SA, France Serial number 231 LH This system had been incorporated in the aircraft since new.
Engine 2	Serial number 12330 Year of manufacture 2001
Operating hours	1779.2 hours (TSN) 540 cycles
Thrust reverser	Hurel-Dubois Meuron SA, France Serial number 228 RH This system had been incorporated in the aircraft since new.

1.6.4.2 Engine control

1.6.4.2.1 General

Thrust management on the Rolls Royce BR 700-710A2-20 is controlled throughout all phases of operation by the full authority digital electronic control (FADEC). An electronic engine controller (EEC) is the major part of the FADEC, interfacing between the airplane and the engine.

The EEC controlling the FADEC works on two channels. Each of these channels is able to maintain correct control of the engines. Since these channels work independently of each other, a desirable system redundancy is achieved.

1.6.4.2.2 Regulation of engine power

Engine power is regulated primarily via the throttles. A set angle of the throttles on the quadrant is converted into a signal which is converted by the engine electronics into a corresponding engine power output.

Among other things, the throttle quadrant covers the following various thrust levels such as:

- Maximum take-off (MTO)
- Maximum climb (CLB)
- Flexible climb (Flex CL)
- Maximum continuous (MCT)
- Flexible take-off (Flex TO)
- Reverse (REV)

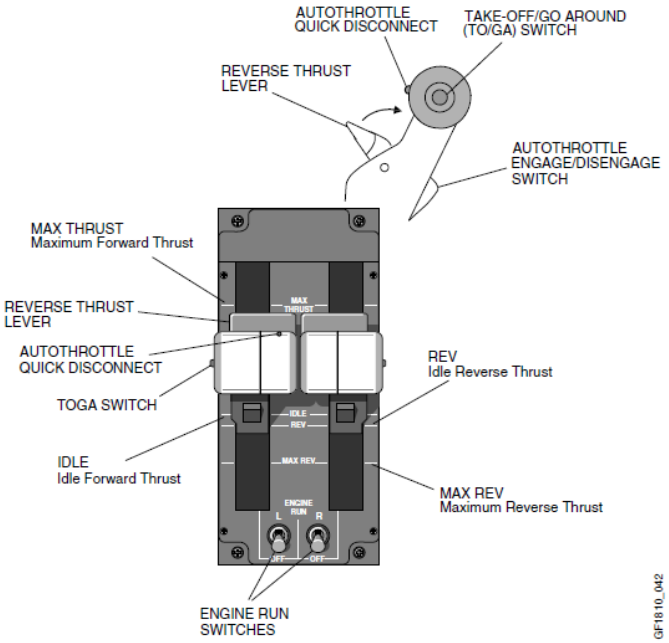


Fig. 2: Throttle quadrant from above

1.6.4.2.3 Control of thrust reverser system

The thrust reversers provide additional deceleration to assist during landings and rejected take-offs. When deployed, the upper and lower doors pivot to redirect exhaust gases through the top and bottom of the nacelle, eliminating forward thrust and providing a braking effect.

Reverse thrust is activated by lifting two additional levers (reverse thrust levers) which are located at the front of the throttles. Among other things, the following conditions must be met for this to happen:

- Throttle at idle position.
- Corresponding landing gear sensors activated[5].

Only then the levers can be raised and the throttles moved into the reverse thrust control range. As soon as the hydraulically powered buckets are fully extended, maximum reverse thrust power can be set.

[5] Either the weight on wheel (WOW) sensor or the wheel spin up sensor is activated; this corresponds to the status when the aircraft is on the ground. These sensors prevent inadvertent deployment of the thrust reverser system in flight.

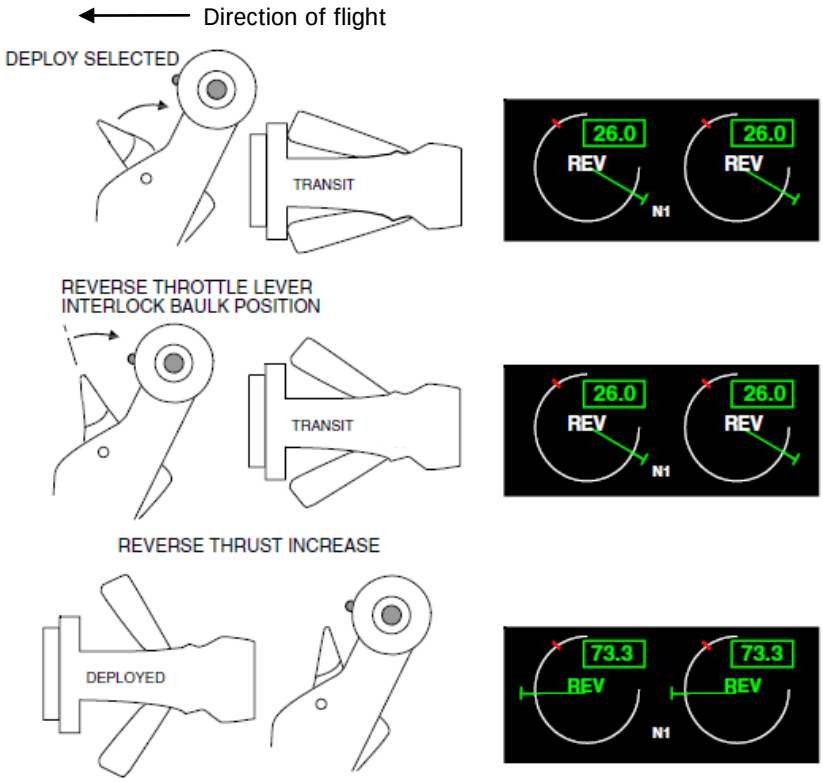


Fig. 3: Procedures and cockpit display during operation of the thrust reverser system

Experience shows that the sequence for activation of the reverse thrust system must be initiated step by step; otherwise there is a risk of causing a malfunction, which may lead to asymmetric operation of the system.

The system can be de-activated mechanically using bolts. The thrust reverser system has no effect on calculation of the aircraft's required landing performance.

1.6.5 Throttle quadrant

In aircraft N906JW a throttle quadrant manufactured by WMPC Products Corporation was installed.

Part number	3F1205C
Serial number	C0066
Operating hours	2379. 7 hours and 854 cycles since manufacture

This quadrant was installed in N906JW on 3 April 2003.

An investigation of the pre-history of this quadrant produced the following results:

"*11/05/1999 with RMA: 02KXS*

Reason for Return:

L/H THROTTLE LEVER WILL NOT PASS THROUGH THE STOP INTO MAX REVERSED POSITION WITH ENGINES RUNNING

WMPC Finding: No Fault Found

2/20/2002 with RMA: 03200

Reason for Return: R/H TR WILL NOT DEPLOY INTERMITTENTLY.

WMPC Finding: No Fault Found
6/21/2002 with RMA: 034X0
Reason for Return: RECEIVED FROM STOCK
DAMAGED/ KNOBS ON HANDLES RECEIVED DAMAGED.
WMPC Finding: Replace Damaged Knob"

After the accident the throttle quadrant was removed from the aircraft and inspected. The results are given in section 1.16.2.

1.6.6 Braking system

1.6.6.1 General

The main landing gear consists of two twin main landing gears. Each wheel is braked hydraulically using a carbon disk brake. The braking systems of both main landing gears are each controlled by a brake control unit (BCU). All four wheel brakes have an anti-skid system which is regulated via the BCU.

The brakes of the outer and inner wheels are supplied with pressure by two independent hydraulic systems.

A parking brake actuates the brakes by means of a cable system to prevent accidental rolling on the ground. In an emergency and when taxiing, the brakes can be operated via the same system; in this case the function of the anti-skid system is no longer available.

1.6.6.2 Operation of the wheel brakes

The four main landing gear brakes are operated via the brake pedals in the cockpit. An electronic signal is transmitted to the BCU, which regulates the hydraulic pressure to the brakes to generate the corresponding braking effect. The rotary speed of all four wheels is constantly monitored and compared by sensors. The signals from these sensors are also used, among other things, to regulate the anti-skid system's control valves.

In addition, the autobrake function is controlled via an interface between the BCU and the anti-skid system.

The BCU also has built-in test equipment (BITE)[6] and is also responsible for the following functions:

- Gear retract braking (stops wheel rotation, after take off).
- Inhibiting normal gear braking in flight.

When the aircraft is in the air, this is detected by the BCU by means of a corresponding signal from the WOW sensor. Brake pressure is then discharged to prevent touching down on the runway with locked wheels during a landing.

After touchdown, a pre-defined rotation of the main wheels (wheel spin-up) must be reached or the corresponding signal from the WOW sensor must be present before the BCU allows brake pressure to be established. The BCU modulates braking pressure according to the pedal inputs from the cockpit or according to the pre-selected mode of the autobrake system. In the process the hydraulic

[6] The abbreviation BITE (built in test equipment) refers to hardware and software in a computer system which makes it easier to check and monitor the correct operation of the system, and if necessary it allows an automated reaction to any problems that occur.

pressure to each wheel brake is reduced as soon as an abnormal rate of deceleration is measured, e.g. when the wheels lock.

1.6.6.3 Autobrake system

The autobrake system is activated automatically on touchdown and supports the crew during braking after landing. The system provides three levels (low – LO), (medium – MED) and (high – HI). The highest level does not correspond to the maximum possible braking effect. This can be achieved only by fully depressing the brake pedals.

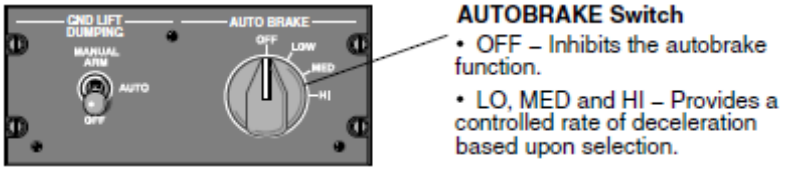


Fig. 4: Autobrake console

If a difference between the actual and set value of the predefined deceleration rates is detected, the system switches off automatically and the rotary switch defaults to the OFF position.

All of the following conditions must be met to “arm” the autobrake and hold the switch in the selected position:

- Switch selected to either LO, MED or HI.
- Airplane in the flight mode of operation (example: WOW indicating air).
- No deploy command for the ground spoilers.
- Brake pedal application less than 20% travel.
- Wheel speed at zero velocity.
- No autobrake or brake control faults.

The autobrake system will apply when all of the following conditions are met:

- Autobrake switch selected to either LO, MED or HI.
- Wheel spin-up is active.
- Ground spoilers commanded to deploy.

The autobrake will “disarm” if the autobrake switch is selected to “OFF” at any time or under any of the following conditions (release the deceleration control and command the autobrake switch to rotate to the “OFF” position):

- Brake pedal application of greater than 20% travel.
- Any autobrake or brake control fault during autobrake operation.
- Wheel speed signal invalid.
- Ground spoilers stowed after having been deployed.

1.6.7 Navigation Management System

Among other things, the navigation management system (NMS) onboard the N906JW supports the crew with the following functions:

- Position determination using various sensors (GPS, DME/DME, VOR/DME).
- Generation of a route on the basis of manually entered waypoints and with the assistance of the navigation database (NDB).
- Retrieving a standard instrument departure route (SID) or a standard arrival route (STAR).

- Support with flight and fuel monitoring.
- Outputting navigation data for the graphic display on the corresponding screens.
- Determining current and planned flight parameters for take-off and landing.

The NMS is continuously monitored by a system and system faults are displayed to the crew.

1.6.8 Ground proximity warning system

The enhanced ground proximity warning system (EGPWS) generates visual and aural warnings when the aircraft approaches the ground in a dangerous manner. The EGPWS also generates acoustic altitude information in order to inform pilots that they are approaching the runway during landing. In addition it warns of wind shear and generates enhanced information about the terrain surrounding the current position of the aircraft, among other things by means of a database.

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

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

For each category there are defined aural (synthetic voice) and visual warnings. If multiple acoustic warnings are triggered at the same time, they have different degrees of urgency.

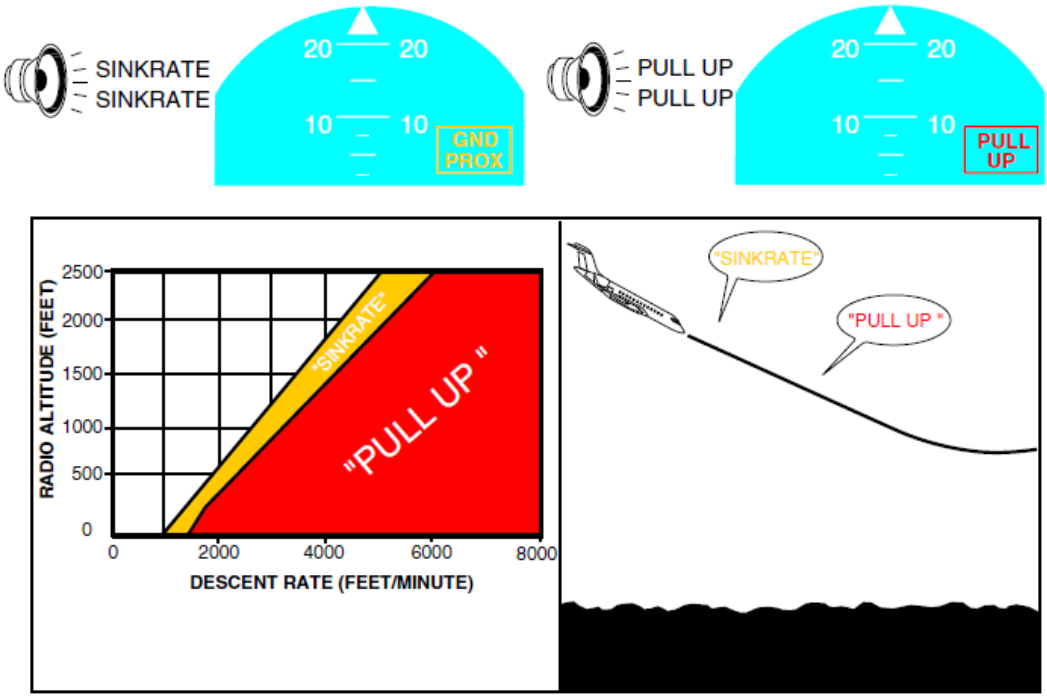
In the present case, the following warnings were generated on both approaches to Samedan:

Mode 1 – Excessive Descent rate

Mode 1 provides aural and visual alerts and warnings in the event that the EGPWC determines that the rate of descent is excessive with respect to airplane altitude. The mode is active when the airplane is less than 2500 ft AGL. Mode 1 requires radio altitude and rate of descent data.

The annunciation envelope consists of two areas: alert and warning.

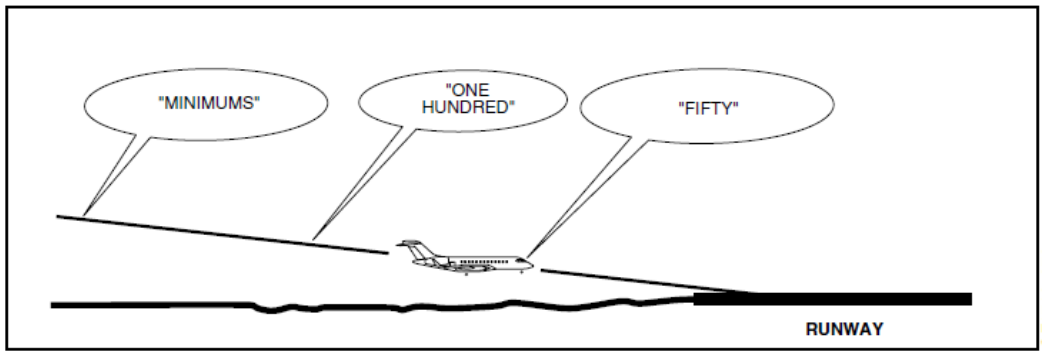
- Penetration of the alert area will annunciate a GND PROX alert on the PFD and generate an aural “SINKRATE, SINKRATE”. The aural alert will be annunciated once and will be repeated only if condition degrades by more than 20% based on computed time to impact. The visual alert will remain until the condition is rectified.
- Penetration of the warning area will annunciate a PULL UP alert on the PFD and generate an aural “PULL UP” warning. The aural warning is annunciated continuously until the condition is rectified.



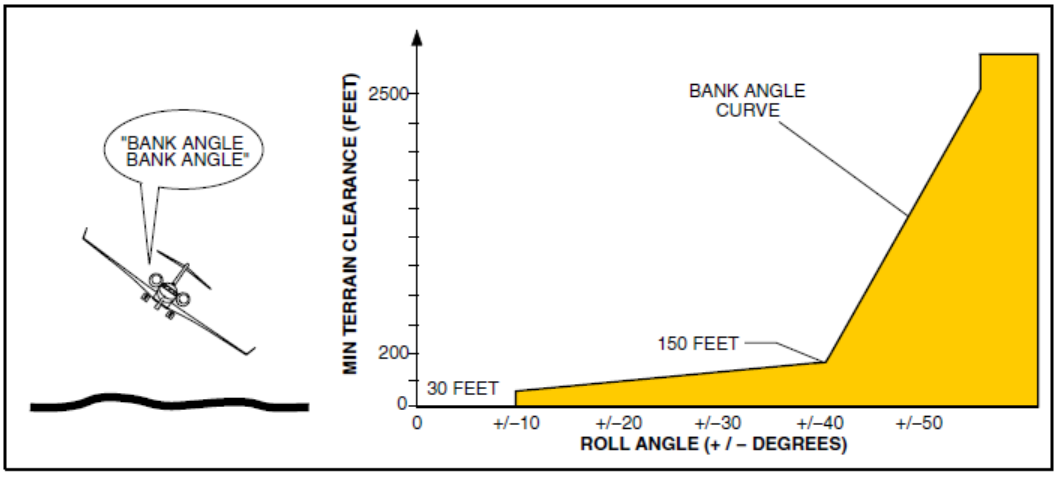
Mode 6 – Callouts

Mode 6 provides the following advisory alerts: transition through approach minimums, altitude callouts on approach and excessive bank angles.

- Transition through the preset approach minimums, (APPROACHING DECISION HEIGHT or APPROACHING MINIMUMS), generates an aural “MINIMUMS, MINIMUMS” warning. The warning function is enabled between 1000 feet and 10 feet radio altitude for DH minimums and when the corrected altitude exceeds the MDA value by 200 feet. The landing gear must be down for activation of the warning.
- An altitude callout function generates annunciation for descent below pre–programmed altitudes. Typical installations include aural callouts at “FIVE HUNDRED”, “FIFTY”, “THIRTY” and “TEN” feet as the aircraft transitions these altitudes. Other altitude callouts are programming selectable depending on individual operator’s requirements. The last annunciated or transition altitude is memorized. This will prevent the repeat annunciation of a callout, should the airplane transition through said altitudes again. The memory is cleared and reset, once the airplane climbs to an altitude greater than 1000 feet, or in the event a transition occurs from approach mode to take-off mode. A “smart altitude callout” provides an aural “FIVE HUNDRED” at 500 feet radio altitude during a non-precision approach. The callout is generated during a precision approach if the airplane flight path deviates greater than ±2 dots of either the glideslope or localizer. The callout is also generated during a backcourse approach.



- The excessive bank angle alert is a function of the roll angle with respect to altitude above ground level. The alert envelope varies linearly from a 10° bank at 30 feet AGL and to 40° of bank at 150 feet AGL, to 55° of bank at 2450 feet AGL. This will generate an aural “BANK ANGLE, BANK ANGLE”. The alert is annunciated once and will repeat if the bank angle increases by 20%. The alert will be annunciated continuously if the bank angle is increased to 55°. The alert will be annunciated until the bank angle is decreased below said value.

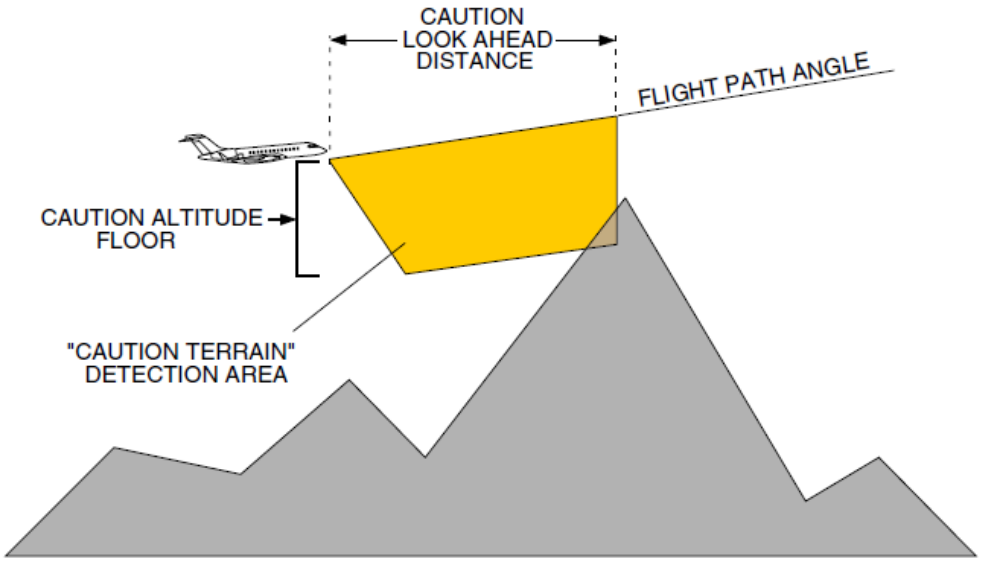


Terrain Awareness Alerting

The terrain alerting function computes minimum terrain clearance envelopes for areas along the flightpath of the airplane. The function uses airspeed and flight-path angle data in conjunction with a database containing worldwide topographical relief information in grid format. The database does not account for man-made obstructions except for all known man-made obstacles in Canada and the United States.

The terrain display is available by pressing “TERR” button on the MFD control panel. Terrain within 2000 feet of the airplane altitude is displayed. Terrain will automatically pop up, in MAP mode, on the MFD at a 10NM range, if there is a terrain threat caution at 60 seconds from impact.

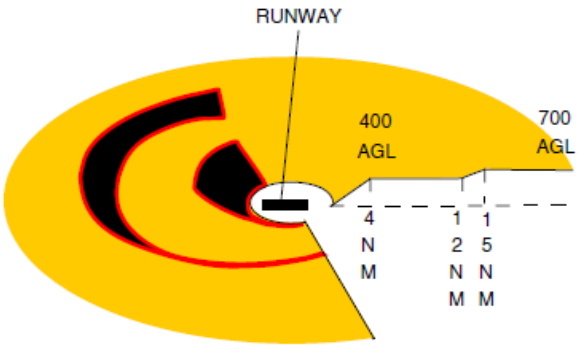
When a terrain threat is detected, a “CAUTION TERRAIN, CAUTION TERRAIN” aural is generated and GND PROX is annunciated on the PFD. When an obstacle threat is detected, a “CAUTION OBSTACLE, CAUTION OBSTACLE” aural is generated and GND PROX is annunciated on the PFD. When alerts are activated, areas which meet the terrain threat alert criteria are depicted yellow.



Terrain Clearance Floor (TCF)

The TCF function supplements the GPWS function by providing an additional terrain clearance alert envelope around airports. The TCF criteria is used to determine alert and warning envelopes.

TCF creates an increasing terrain clearance envelope around the intended airport runway directly related to the distance from the runway. TCF alerts are based on current airplane location, nearest runway center point position and radio altitude, along with an internal database that includes all worldwide, hard-surfaced runways greater than 3500 feet in length. Penetration of the alert envelope will generate an aural “TOO LOW TERRAIN” and a GND PROX message is displayed on the PFD. The aural alert is repeated twice and again thereafter if the radio altitude value decreases by more than 20% from the altitude at which the initial warning was issued. The GND PROX message remains displayed until the airplane exits the alert envelope.



1.7 Meteorological information

1.7.1 General

The information in chapter 1.7.2 to 1.7.7 was provided by MeteoSwiss and is translated from German.

1.7.2 General meteorological situation

Switzerland was ahead of an extensive low pressure system ranging from Scandinavia over the British Isles to Spain. Moderate to strong upper-level winds carried abundant moisture from the western Mediterranean to the southern part of the Alps.

1.7.3 Weather at the time and location of the accident

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

Cloud	8/8 at around 7400 ft AMSL
Weather	Light snowfall
Visibility	Around 3000 m
Wind	Variable at 2-3 kt
Temperature/Dewpoint	-1 °C / -2 °C
Atmospheric pressure	QNH LSZS 993 hPa QNH SLZH 990 hPa QNH LSZA 995 hPa
Hazards	Diffuse light conditions due to low cloud base and light snowfall

1.7.4 Astronomical information

Position of the sun	Sun below the horizon
Lighting conditions	Evening twilight

1.7.5 Aerodrome routine meteorological reports

In the period from 16:20 UTC up to the time of the accident, the following aerodrome routine meteorological reports (METAR) applied:

LSZS 061620Z VRB01KT 5000 –SN OVC030 M01/M02 0993 88//9999

In clear text, this means:

On 6 February 2009, shortly before the 16:20 UTC issue time of the aerodrome weather report, the following weather conditions were observed at airport LSZS:

Wind	Variable at 1 kt
Meteorological visibility	5000 m
Precipitation	Light snowfall
Cloud	8/8 with cloud base at 3000 ft AAL

Temperature	-1 °C
Dewpoint	-2 °C
Atmospheric pressure	993 hPa, pressure reduced to sea level according to the ICAO standard atmosphere
Runway condition report	On all runways either the nature, extension and thickness of the contamination are not reported, or cleaning of the runways is being carried out. No reliable information on braking action can be provided.

1.7.6 Forecasts

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

LSZS 061125Z 0612/0621 02008KT 0500 –SN FG OVC005

In clear text, this means: On 6 February 2009, the following weather conditions were forecast for Samedan airport between 12:00 UTC and 21:00 UTC:

Wind	From 020 degrees at 8 kt
Meteorological visibility	500 m
Weather	Light snowfall, fog
Cloud	8/8 with cloud base at 500 ft AAL

1.7.7 Warnings

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

LSAS AIRMET 5 VALID 061400/061700 LSZH-
LSAS SWITZERLAND FIR MOD ICE FCST S AND W PART OF SWITZERLAND 4500FT/AMSL/FL150 STNR NC AND SWITZERLAND FIR MOD TURB FCST ALPS BLW FL150 STNR NC=

1.7.8 ATIS reports from Samedan Airport

LSZS 15:20 UTC, information JULIETT:

"Runway in use by ATS, METAR for Samedan 1520, wind calm, visibility 4000 meters, light snow, cloud overcast 3000 feet, temperature minus 1, dewpoint minus 2, QNH 993, runway snow covered, snow remove in progress."

LSZS 16:20 UTC, Information KILO:

"Runway in use by ATS, METAR for Samedan 1620, wind calm, visibility 5000 meters, light snow, cloud overcast 3000 feet, temperature minus 1, dewpoint minus 2; QNH 993, runway snow covered, snow remove in progress."

1.7.9 Snowtam report

Samedan aerodrome had published the following SNOWTAM:

SWLS0043 LSZS 02060655
(SNOWTAM 0043
A) LSZS
B) 02060655
C) 03 F) 4/4/4 G) 200/200/200 H) 9/9/9 J) 190/6LR L) TOTAL P) YES020
T) RWY CONTAMINATION 100 PERCENT)

In clear text, this means:

The following runway condition was measured on 6 February 2009 at Samedan airport for runway 03 at 06:55 UTC:

- All three thirds of the runway surface are covered with dry snow.
- The average depth of the layer of snow is 200 mm on all three thirds.
- Braking action unreliable.
- Snow banks 190 cm high run along both sides of the entire runway at a distance of 6 m.
- Along the taxiways there are snow banks higher than 60 cm at a distance of 20 m.
- The runway is 100% contaminated.

This SNOWTAM report was not present in the crew's flight planning documentation.

1.7.10 Weather according to eye witness reports

Various persons on the airport made the following weather observations at the time of the accident:

"Wind was calm and visibility 5 km, probably more. Broken at 3000 ft and at the moment of the landing [N906JW] *it was snowing very very light."*

The following reports are translated from German:

"Above the aerodrome a blue sky and the moon could be seen. Visibility as far as St. Moritz and Zuoz."

"There had been a brief brightening; the moon could be seen above the Muottas Muragl and a bit of blue sky. Diffuse light."

"It was cloudy and dark. Height about the edge of the wood, Muottas Muragl (clouds)."

"Light snowfall, visibility not optimal, evening twilight."

"Weather: it was not snowing, there was a foehn wind."

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

1.9.1 Air traffic control unit involved

Samedan AFIS Frequency 135.325 MHz

1.9.2 Recording of conversations

In the control tower the following data is continuously recorded and stored:

- Radio conversations
- Telephone conversations
- METAR

Radio communication between the crew of N906JW and Samedan AFIS was recorded. Comprehensibility was good. A transcript of the radio conversations was available for the investigation.

No failures or defects in communications systems are listed in the "*daily log of ATS unit"* in the control tower.

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[7]. 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 [Below FL 100 and up to 3000 ft AMSL]	*Auf oder unterhalb 3000 ft AMSL oder 1000 ft AGL (je nachdem welches die grössere Höhe gibt):* [At or below 3000 ft AMSL or 1000 ft AGL (whichever is the greater)]:
Sicht 5 km *Distanz zu den Wolken:* *Horizontal 1500 m* *Vertikal 1000 ft* [Visibility 5 km Distance to cloud: horizontal 1500 m vertical 1000 ft]	*Sicht 5 km** *Ausserhalb Wolken mit Bodensicht* [Visibility 5 km* Outside cloud with sight of ground]

[7] 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;

- ...

[*Regulation in Switzerland:
- Class G includes airspace from GND to 2000 ft/600 m AGL, outside TMA/CTR (for exception see RAC 1-1, page 33);
- Visibility 5 km; if at any time airspeed allows a 180° turn within visibility distance and other aircraft or obstacles can be detected in good time, flight visibility may come to 1.5 km;
- ...]

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 to civil twilight time or to 19:00 at the latest.

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

In addition, various helicopter 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 1.17.2).

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 power and informed the crew. Receipt of this information was confirmed by the crew. According to the CVR recordings there are no indications that the crew consciously perceived these approach lights during the two approaches.

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

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 controller (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. section 1.17.3.1).

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. section 1.17.3.1).

1.10.6.2 Snow clearance

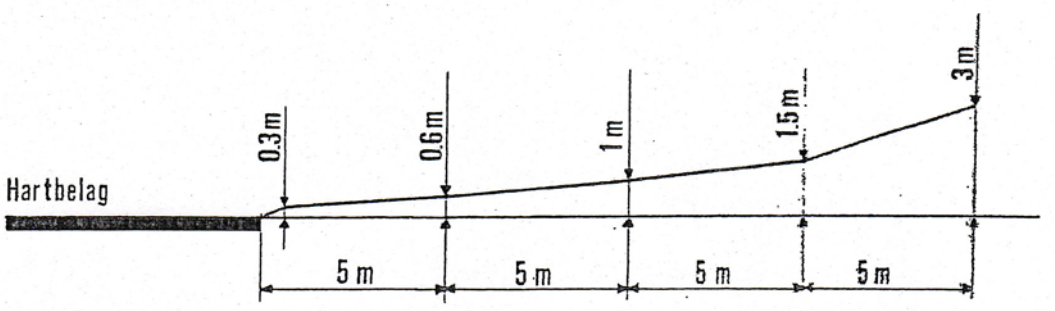
The internally published procedures for Samedan airport include an undated *"Weisung betreffend Schneeräumung"* [Instruction concerning snow clearance] which specifies which clearance vehicles must perform their work in which sequence. The following is stated in this instruction in bold text:

"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]

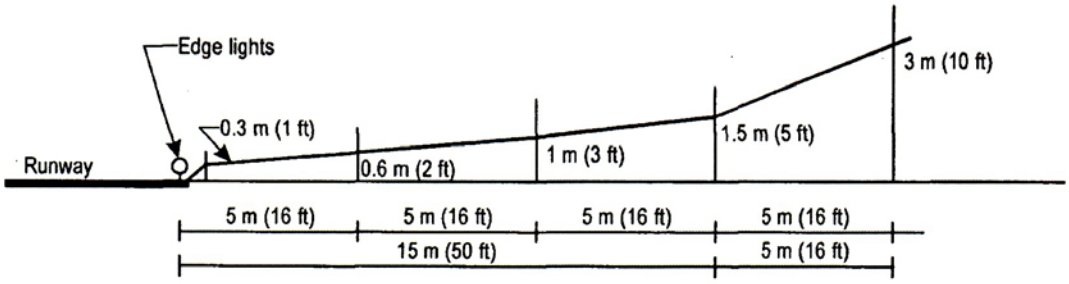


Vielleicht finden Sie diese allgemeine Richtlinie für Ihre Verhältnisse übertrieben. Wir möchten es in diesem Fall Ihnen überlassen, die für Ihre Gegebenheiten zweckmässige Schneeverteilung festzulegen. (...)"
[You may find this general guideline excessive for your conditions. In this case we would like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

1.10.6.3 ICAO regulations 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 procedure", 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 regulations 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

Type	980-4700-027
Manufacturer	Honeywell
Serial number	SSFDR 08235
Recording medium	Solid state memory
Duration of recording	50 hours

It was possible to analyse the data recorded by the digital flight data recorder (DFDR) in full.

Whilst cruising, the crew addressed a fault with the spoiler system. This related to the multifunction spoiler (MFS) 1L and 1R. The DFDR recorded an invalid signal for both these spoilers throughout the flight involved in the accident.

1.11.2 Cockpit voice recorder

Type	980-6022-001
Manufacturer	Honeywell
Serial number	CVR120-04194
Recording medium	Solid state memory
Duration of recording	120 minutes

A transcript of the cockpit conversations was produced. Since the crew conversed in Polish, the transcript was translated from Polish into English at the relevant points.

1.12 Wreckage and impact information

1.12.1 Site of the accident

See Annex 3

1.12.2 Touchdown point

The aircraft touched down approximately 450 m after the threshold of runway 03. As deceleration on the remaining 1350 m of the partly icy runway was not sufficient, the aircraft overran the end of the runway and, after rotating approximately 80° clockwise around its vertical axis in the 0.80 m to 1.70 m high snow, came to a standstill a good 30 m before the threshold of runway 21.

1.12.3 Information on the aircraft after the accident

The following morning the aircraft was towed onto the apron with the aid of recovery vehicles.

The following individual findings were made on the wreckage:

- The flaps were fully extended.
- The left flap was damaged at three points and at the corresponding casings of the spindle drives.
- Damage to the nosewheel doors, nosewheel taxilight and the left landing gear door.

According to the pilot's statement, the thrust reverser system for the right engine could not be activated, so the thrust reverser system could not be fully used because of the resulting asymmetric effect.

The brakes worked normally, according to the pilot's statement.

1.13 Medical and pathological information

The alcohol test was negative for both pilots.

1.14 Fire

Fire did not break out.

1.15 Survival aspects

1.15.1 General

As N906JW overran the runway at low speed and was decelerated by the soft snow, there was no immediate danger to the occupants.

1.15.2 Emergency transmitter

The aircraft was equipped with an emergency transmitter (emergency location beacon aircraft – ELBA). The device was built-in. The emergency transmitter was not triggered because of the low deceleration forces during the accident.

1.15.3 Evacuation

The occupants were able to vacate the aircraft normally via the steps integrated into the main entry door.

1.16 Tests and research

1.16.1 Thrust reverser

Two days after the accident, the thrust reverser system was visually inspected. No defects could be found. The subsequent function check with engines running also showed no anomalies.

1.16.2 Throttle quadrant

The recordings from the DFDR show that the right thrust reverser was not activated. The throttle quadrant was subsequently inspected for a malfunction.

Tests with different operating forces applied to the throttle levers and in particular to the reverse thrust levers resulted normal manipulation processes.

1.17 Organisational and management information

1.17.1 Aircraft operator

1.17.1.1 General

Flight operations using N906JW, involved transporting the manager of a group based in Poland and the United States of America. The aircraft's home base was Warsaw and operation started in spring 2008. It was conducted in accordance with the flying rules of the American Federal Aviation Authority (FAA) according to FAR[8] 91, the regulations for private aviation.

N906JW was operated in accordance with the manufacturer's standard operating procedures.

1.17.1.2 Crew

The crew consisted of the two pilots involved in the accident. If necessary, recourse could be made to three part-time pilots. One of these pilots, who worked for the manufacturer of the aircraft type involved in the accident, was responsible for the line training of the pilots involved in the accident.

The commander involved in the accident was responsible for the operation of the aircraft.

The crew were responsible for the documentation onboard N906JW.

1.17.1.3 Flight planning

Transport flights using N906JW were as a rule notified to the commander between five and seven days in advance. The latter then chose an appropriate airport and also organised any necessary onward transport of the passengers to their final destination. Suitable means of transport were chosen. As soon as the aircraft had left Warsaw, the crew also remained with it until it returned to Warsaw.

Flight planning was performed by a company in Warsaw, which transmitted the flight documents to the crew in a suitable form. These documents were then checked by the crew prior to departure.

[8] FAR: Federal Aviation Regulations

1.17.2 The airport operator

1.17.2.1 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.

1.17.2.2 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 Flight information service

Since 29 December 2006, a FOCA-approved flight information service has been operated by Engadin Airport AG for Samedan airport. Five full-time FISOs are available for this service. In 2008, Engadin Airport AG founded the Sky Watch AG air navigation services training school to train the FISOs. Before Sky Watch AG was established, the FISOs were trained in Sweden by the Entry Point North company, Nordic ATS Academy, Malmö. FISOs were to be licensed by the FOCA after appropriate training by Sky Watch and an examination. A corresponding pledge was made by the FOCA on the basis of the new Ordinance on licences for air traffic control personnel (VAPF). These licences had not yet entered into force at the time of the accident. The corresponding FISO ratings were, however, issued by the FOCA.

As a rule, up to three FISOs are on duty each day. If traffic volumes are low, when operations commence in the morning and at the end of operations in the evening, one FISO is generally present. Working time is 10 hours, including a one-hour lunch break.

FISOs report to the Chief Operating Officer (COO) of Engadin Airport AG who is responsible for training, operation and operating regulations.

The FISO does not give any clearances, with one exception. This exception concerns crossing the runway. Otherwise, information only is forwarded to crews. In particular, this is information relating to the landing and take-off runway, weather information and traffic information within the Flight Information Zone (FIZ).

1.17.3.1 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.

1.18 Additional information

1.18.1 Cold weather operation

The manufacturer's flight crew operating manual (FCOM), in the sub-section on supplementary procedures, contains additional procedures relating to cold weather operation.

According to the definitions in this section, the conditions for cold weather operation were met.

Among other things, the following instructions from the operating manual were to be obeyed:

"(...)

PHASE OF FLIGHT PROCEDURES (CONT'D)

*G. Descent – **Approach***

- *Accomplish the normal Descent checklist.*

(...)

- *Be aware of reduced airplane performance and limitations.*
- *Check landing distance as per Airplane Flight Manual.*

(...)

- *Ensure that cleared runway width available is sufficient.*
- *Take note of PIREP's on braking conditions, if any.*
- *Plan the approach ahead of time and take particular attention to the final approach. Aim for a stabilized approach (i.e. on speed, on glide path) using the lowest approach speed (highest flap setting with all relevant factors considered) possible, and to touchdown in the touchdown zone, on the centerline.*

H. Landing

(1) Landings on contaminated runways are prohibited when the depths of contaminant are equal to or greater than:

CONTAMINANT	*LANDING*
Standing Water	*12.7 mm (0.50 in)*
Slush	*15.2 mm (0.60 in)*
Loose Wet Snow	*30.5 mm (1.20 in)*
Loose Dry Snow	*61.0 mm (2.40 in)*

(2) Landings are prohibited with a tailwind of more than 10 kts.

> *CAUTION*
> *Landings on contaminated runways should be avoided in tailwind conditions, whenever possible.*

(3) When operating from wet, snow covered or slush covered taxiways, the following steps are applicable in order to prevent freezing of the wheel brakes:

When landing, carry out a positive landing to ensure initial wheel spin up and breakout of frozen brakes if icing has occurred.

During the landing roll and subsequent taxi, use the brakes to prevent progressive build-up of ice on the wheels and brakes. Monitor BTMS during taxi.

(4) Lower the nosewheel immediately and hold light forward control column pressure.

> *CAUTION*
> *Use of thrust reversers on snow covered surfaces can create a white-out situation which can preclude the safety of the airplane and the passengers.*

(5) Use maximum reverse thrust as soon as possible after touchdown. Thrust reversers are most effective at high speed. At low speed, minimize the intensity and duration of reverse thrust, however, maximum reverse thrust may be used to a complete stop in case of an emergency situation.

(6) DO NOT pump the brakes as this will only diminish braking effectiveness. Apply brakes normally with steadily increasing pressure, allowing the anti-skid system to modulate brake pressures to obtain maximum braking.

(7) Maintain directional control with the rudder as long as possible and use nosewheel steering with extreme care.

(8) Anticipate skidding and hydroplaning to occur, and be prepared to make the necessary corrections.

> *CAUTION*
> *If a skid develops, reduce reverse thrust to idle reverse and if necessary, return the engines to forward idle thrust to return to the centerline. Regain the centerline with rudder and/or differential braking. Use nosewheel steering with caution.*

(...)"

1.18.2 Landing distance

1.18.2.1 General

In the airplane flight manual (AFM) and the quick reference handbook (QRH), different landing parameters are defined on the basis of mass and with reference to the external conditions to be expected. Furthermore, these parameters can also be referred to in corresponding entries in the NMS.

1.18.2.2 Calculation of landing distance

In the present case, a runway length of 1800 m, corresponding to 5906 ft, was available in Samedan. The landing mass of N906JW was 60 752 lb. The resulting reference speed for landing was 113 kt. On a dry runway, 2540 ft or 775 m would have been necessary for landing.

Considering the prevailing runway conditions, in the worst case the landing distance would have had to be multiplied by a factor of 2.54 for icy conditions, producing an actual landing distance (ALD) of 6452 ft or 1968 m. In this case, the NMS would also have issued a landing out of limit message.

With regard to the conditions for compact snow, the factor would have been 1.54. Hence 3912 ft or 1194 m would have been necessary.

The crew stated that the NMS was programed for dry conditions.

1.18.2.3 Calculation of landing distance in the event of a spoiler system fault

The flight spoiler fault addressed whilst cruising resulted in a consultation of the QRH. According to the DFDR data, this related to the multifunction spoiler - MFS 1L and 1R. The following instruction is included in the corresponding section of the QRH:

"FLT SPOILERS FAULT

[One pair of flight spoilers is inoperative. Inhibited if panels are retracted.]

Prior to landing:

(1) Actual landing distance ..... INCREASE

as applicable by factor given below:

WITHOUT THRUST REVERSERS	*WITH THRUST REVERSERS*
1.35 (35%)	*1.30 (30%*

——— END ———"

Therefore the landing distances established in section 1.18.2.2 would have had to be multiplied by a factor of 1.3, producing the following landing distances:

Conditions	ALD (ft)	ALD (m)
Icy runway	8388	2557
Compact snow	5086	1550

1.19 Useful or effective investigation techniques

No new methods applied.

2 Analysis

2.1 Technical aspects

2.1.1 Spoilers

According to the DFDR, all the spoilers functioned normally during the flight preceding the flight involved in the accident.

It was not possible to establish whether the MFS 1L and 1R spoilers were operating correctly during the flight involved in the accident. However, a fault was indicated to the crew. According to the manufacturer, a subsequent correction of the necessary landing distance would have been indispensable.

2.1.2 Thrust reverser system

At 16:47:29 UTC, N906JW touched down on runway 03 at a speed of 120 KIAS. The crew then tried to activate reverse thrust for 16 seconds. However, this only worked for the left engine thrust reverser system. It was not possible to activate the right engine thrust reverser system.

Since an inspection of the thrust reverser system after the accident revealed no anomalies and the additional tests with different operating forces applied to the throttle quadrant produced normal manipulation processes for the thrust and thrust reverse levers, malfunction of the thrust reverser system can be excluded with a high degree of probability.

Experience of operation of the thrust reverser system on the BD-700 indicates that the manipulations on the thrust and thrust reverser levers must be initiated step by step. In the present case it can be assumed that, not least because of the stress situation, which among other things was additionally aggravated by the late touchdown, the thrust reverser system was activated too early, although not all the necessary conditions were met. The result was that the right reverse thrust lever got stuck and could not be brought to the interlock baulk position.

This did not apply to the left thrust reverser system. According to the DFDR recordings, however, almost 16 seconds elapsed before the desired reverse thrust could be generated. One possible explanation would be that the crew were anxious to release the right thrust reverse lever and in the process also operated the left reverse thrust lever in parallel. The result was that the thrust reverse buckets on the left engine modulated in the transit phase; this would explain the relatively long time of 16 seconds. The DFDR only registers the two final positions, stowed and deployed.

2.1.3 Autobrake system

In the roll-out phase, at 16:47:40 UTC, the EGPWS generated the message "*two thousand remaining*", indicating the remaining runway length in feet. At that time the aircraft was still travelling at a speed of 72 kt. Shortly before this the AUTO-BRAKE FAIL message was registered.

From the DFDR data is it clear that the aircraft was continuously braked after touchdown with the aid of the autobrake system, which had been pre-selected in the MED position before landing. The AUTOBRAKE FAIL caution message virtually coincides with the point in time at which the commander's left brake pedal was depressed by more than 20% of its possible travel. After this had happened, the autobrake system was de-activated as per the system design and the AUTO-BRAKE FAIL message was generated.

Given the fact that even the HI setting of the autobrake system does not correspond to the maximum possible braking effect, it was not appropriate in the present case to use the autobrake system.

The following instruction is given in the manufacturer's handbook regarding braking on contaminated runways: *"DO NOT pump the brakes as this will only diminish braking effectiveness. Apply brakes normally with steadily increasing pressure, allowing the anti-skid system to modulate the brake pressures to obtain maximum braking."*

2.2 Human and operational aspects

2.2.1 Flight crew

The two pilots had not been flying the BD-700 for very long. Moreover, on the day of the accident they were making their first flight to Samedan. The cockpit voice recording proves that the workload must have been relatively high. Even though a possible diversion to Zurich had been included in the planning, a degree of pressure to make a successful landing cannot be excluded.

After the crew had listened to the JULIETT ATIS information, the approach to Samedan was discussed. The option of flying to Zurich was not discussed after this time.

The following factors may also have contributed additionally to the workload:

- An approach to an uncontrolled aerodrome in mountainous area according to visual flight rules
- Limited knowledge of the topography around the airport
- Demanding weather conditions
- Onset of twilight

During the last five minutes of the flight, it is not possible on the basis of the CVR recordings to determine which of the two pilots was acting as PF and PNF. This is a further indication that the crew were subject to a heavy workload in this phase and that the elementary principles of work distribution between a two-man crew no longer applied.

Among other things, the result of this was that the chosen flight path was risky. In the process, EGPWS warnings were generated. Both approaches had warnings pointing out to the crew that these approaches were unstabilized. After dicontinuation of the first approach the second approach led to a forced landing. This effect is known in crew resource management as 'target fascination'.

2.2.1.1 Calculation of landing distance

In Samedan the crew had a runway length of 1800 m, corresponding to 5906 ft, available to them. Whilst cruising, the crew addressed the flight spoilers fault message. According to the QRH, the actual landing distance had to be increased by 30%. The crew had a discussion about this between 15:14:50 and 15:19:26 UTC. The commander roughly calculated the values for a necessary landing as 2900 ft without any technical problems and 4000 ft with the correction from the QRH with reference to the flight spoiler fault message. At this time the expected runway conditions did not seem to be addressed by the crew.

At 15:52:14 UTC the crew discussed the JULIETT ATIS information. Even though the runway was reported as “snow covered, snow remove in progress”, the negative effect of the runway condition on the landing distance was not further discussed. A subsequent calculation indicated that given the technical problem with the spoilers, a landing distance between 5086 and 8388 ft would have been required in Samedan, depending on the state of the runway.

It must be assumed that the crew were never clear about how long a runway they required under the prevailing weather and runway conditions in order to make a landing in Samedan.

2.2.1.2 Landing in Samedan

Before the first approach on runway 03, the FISO informed the crew that the runway was covered with snow and that the surface was partly icy. The crew discontinued this approach because it was not stabilised. The aircraft was flying too high and too fast. Any reduced braking action after the go-around was not mentioned by the crew.

The crew seemed to be fixated on landing in Samedan. The possibility of flying to an alternate airport was no longer taken into consideration during this phase. The crew flew a circuit at low-altitude under difficult to critical visual flying conditions. On the second approach, the aircraft touched down at approximately 7 kt above the reference speed and 450 m after the beginning of runway 03. Even if all the means available for braking the aircraft had been available, the crew would probably not have been able to bring the aircraft to a standstill within the remaining 1350 m.

In summary it must be stated that under these circumstances an approach with a subsequent landing should have been abandoned.

2.2.2 Airport operator

2.2.2.1 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.

It is astonishing that the information issued several times by the FISO concerning the runway condition was never discussed by the crew.

2.2.2.2 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.

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.

Publication of the braking action in connection with the ATIS report would enable crews to take this into account when calculating the landing distance during preparations for an approach.

2.3 Meteorological aspects

Full cloud cover prevailed over the south side of the Alps and extended as far as the Engadine. Moderate icing could be expected below FL 150 when flying in this layer of cloud. Moderate to heavy precipitation was observed in the Ticino. With southerly high-altitude winds, isolated gaps in the cloud formed over Graubünden in the lee of mountain slopes. One of these gaps in the cloud allowed the crew to fly into the Engadine.

In Samedan, light snowfall was observed throughout the day.

Under these conditions and in view of the late time of day, flying into the valley and under the cloud cover was risky.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was certified for VFR/IFR transport.
- Both the mass and centre of gravity of the aircraft were within the permitted limits according to the AFM at the time of the accident.
- Whilst cruising, the crew received the advisory message FLIGHT SPOILERS FAULT.
- According to information from the crew, the right engine thrust reverser could not be activated; this is confirmed by the DFDR recordings.
- An inspection of all the elements which are essential for activation of the thrust reverser for both engines showed no indications of a technical fault in this system.
- An A-check was performed from 12 to 17 November 2007. The aircraft's operating hours were 1504.1 hours and 434 cycles.

3.1.2 Crew

- The crew were in possession of the necessary licences for the flight.
- There are no indications of any of the crew suffering health problems during the flight involved in the accident.
- This was this crew's first flight to Samedan.
- The commander successfully completed his training on the aircraft type involved in the accident on 18 April 2008.
- The copilot successfully completed his training on the aircraft type involved in the accident on 30 June 2008.

3.1.3 History of the flight

- The accident flight was a private flight.
- Whilst cruising at FL 360, the crew were alerted to a fault in the flight spoiler system.
- After consulting the quick reference handbook (QRH), the crew determined that the runway in Samedan was sufficiently long to be able to land with the spoiler problem.
- At 15:52:14 UTC the crew discussed the JULIETT ATIS information. The negative effect of the runway condition on the landing distance was not discussed.
- A subsequent landing distance calculation indicated that given the technical problem with the spoilers, a landing distance between 5086 and 8388 ft would have been required.
- Before the first approach, at 16:42:10 UTC, and at 16:44:44 and 16:46:12 UTC respectively, before the landing, the FISO informed the crew that the runway was covered with snow and that the surface was partly icy.

- A first approach on runway 03 was discontinued by the crew because this approach was not stabilised.
- On the second approach, the crew touched the aircraft down some 450 m after the beginning of runway 03 and at a speed of approximately 7 kt above the reference speed.
- Travelling at approximately 17 kt, the aircraft overran the end of the runway and came to a standstill some 30 m beyond the runway in snow between 0.80 and 1.70 m high, after rotating 80° clockwise around its vertical axis.
- None of the occupants was injured.
- The aircraft was badly damaged.

3.1.4 General conditions

- Samedan airport can be approached only under visual flight rules.
- The runway length is 1800 m, corresponding to 5906 ft.
- The runway was covered with snow and parts of its surface were icy.
- The Snowtam published by Samedan airport was not part of the crew's flight planning documentation.
- Snow removal on the runway was interrupted because of the incoming flight.
- The airport Samedan renounces of measuring and publishing any braking action or braking coefficient.
- Under the prevailing meteorological conditions that day and in view of the late time of day, flying into the valley and under the cloud cover was risky.

3.2 Causes

The accident is attributable to the fact that after an unstabilised approach the aircraft touched down on runway 03 too late and too fast and could not be brought to a standstill within the remaining distance on the snow-covered and partly iced runway.

The following factors contributed to the accident:

- Inadequate flight preparation
- An approach on a aerodrome in mountainous area under critical weather conditions

4 Safety recommendations and measures taken since the accident

4.1 Safety recommendations

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 since the accident

Six days after the accident, on 12 February 2009, another accident occurred on Samedan airport, involving a Marcel Dassault/Bréguet Aviation Falcon 10/100, in which both pilots suffered fatal injuries and the aircraft was destroyed.

The corresponding AAIB final report (No. 2074) stated the cause as follows:

"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."*

Three days after this 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 order to ensure the conditions conforming to the regulations, Engadin Airport AG must implement the following measures:

a) The runway's lateral snow banks must be cleared in accordance with the ICAO regulations (Airport Services Manual Part 2, Point 7.3.5). The procedure is to be prioritised as follows:

   1. area of thresholds 03 and 21;
   2. RWY – TWY - crossings;
   3. other areas.

b) Engadin Airport AG shall submit to the FOCA a stand concept for the snowpark with reference to compliance with the minimum distances, the heights and operations of the different aircraft types in this area.

(...) Operation may be resumed only after the explicit and written consent of the FOCA.]

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."
[In general helicopter operations continue to be permitted on Engadine Airport].

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."
[Bern, 20.02.2009 – The Federal Office for Civil Aviation (FOCA) has cleared the runway at Samedan airport closed at the beginning of the week, after the excessively high snowbanks had been removed correctly].

Samedan airport resumed operation 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 clearing concept, which was approved by the FOCA.

Within this snow clearing 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
   [Compliance with the standards and recommendations of the ICAO Annex 14 Volume I and ICAO Airport Service manual Part 2 – Part 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."*
   [Compliance with the decision of the Federal Administrative Court of 02.10.2009, "Accordingly the Federal Administrative Court recognises: Para. 3: "Flying operations on the take-off and landing runway are to be suspended if friction characteristics and rolling resistance do not meet the requirements of para. 10.2.8 of the ICAO Annex 14/I and the corresponding technical implementation provisions or if the runway is not recognisable over its entire width as a homogenously black surface with clear lateral delimitation.]

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).

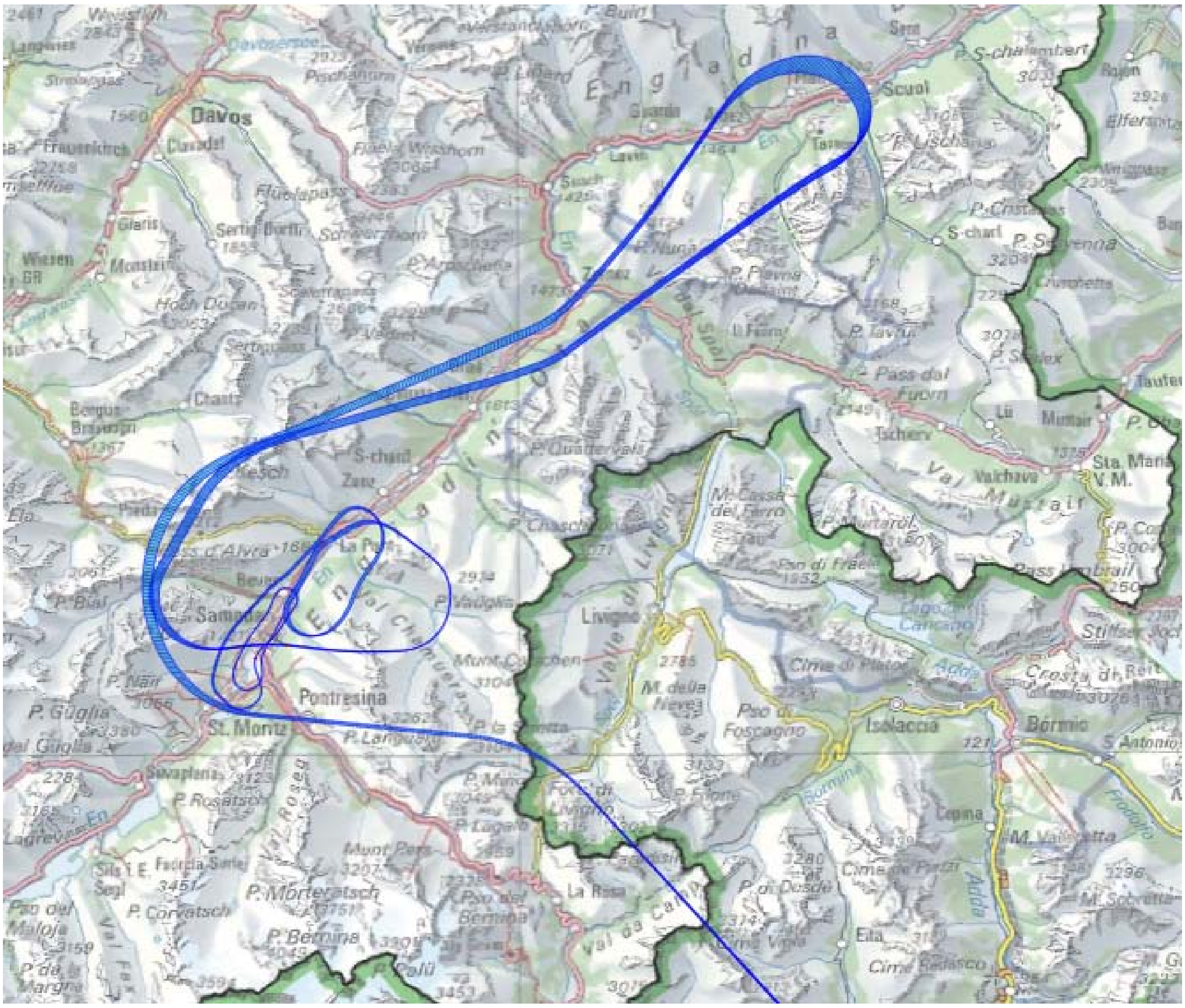
According to the FOCA an examination of the conversion and a possible specification of the guidelines put in force in Switzerland on 15 March 2008 according art. 15 of the "Flugplatzleiterverordnung" regarding friction measuring is initiated. Measuring and publishing of braking coefficient and expected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

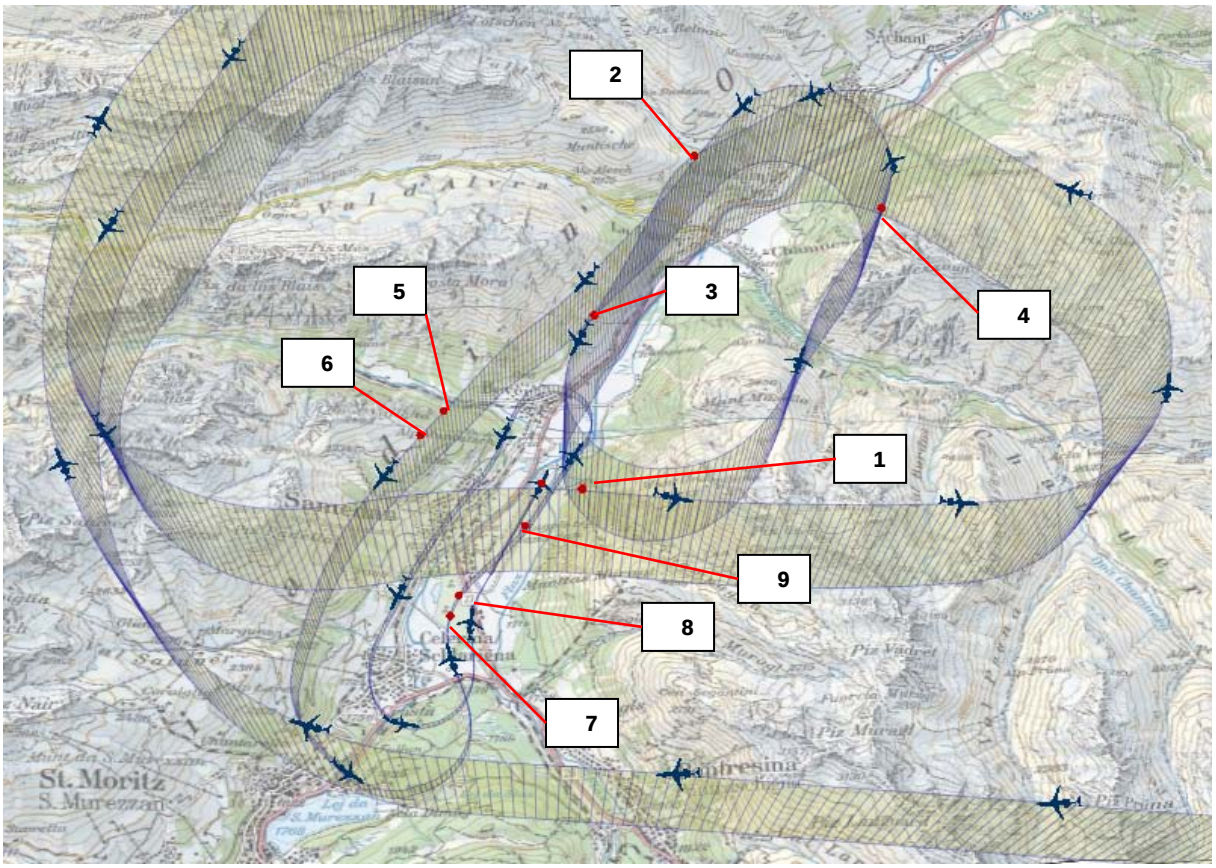
In a letter, dated 8 October 2009, the FOCA refused that request in regard to the "Verordnung über die Infrastruktur der Luftfahrt" (VIL, SR 748.131.1). But at the same time the FOCA stated that the director of a licensed airport has at any time the competence to release restrictions of any kind. Until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

Payerne, 22 September 2010 Aircraft Accident Investigation Bureau

Annex 1: Overview of the flight path of N906JW



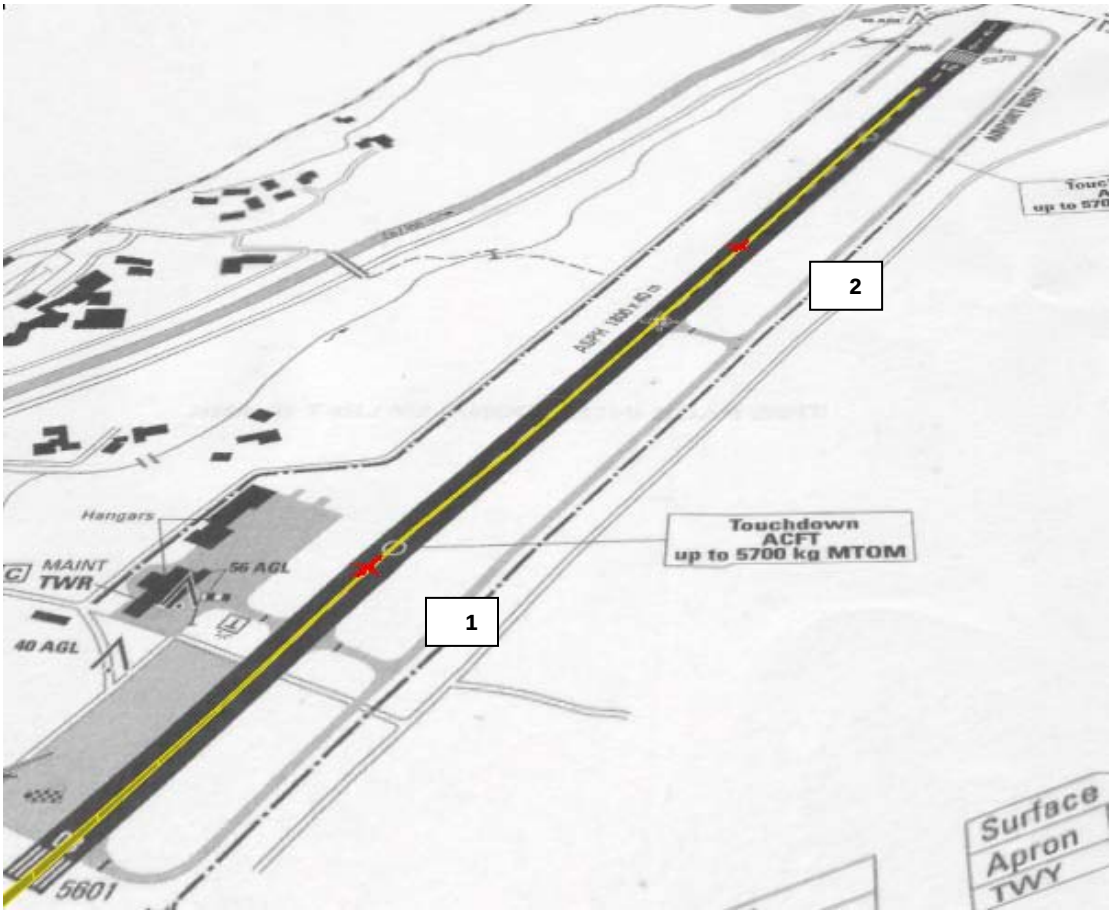
Annex 2: Final phase of the flight path of N906JW



Markings along the flight path

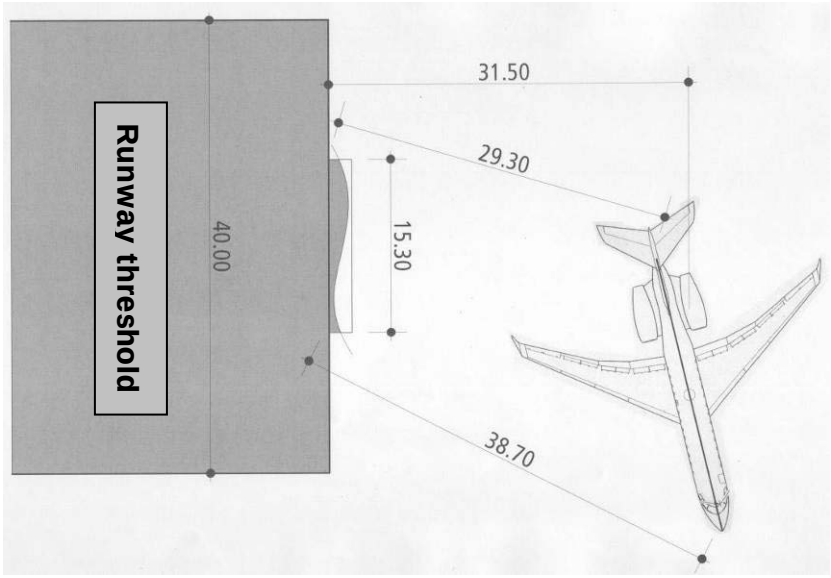
	Time UTC		Altitude	Radio altitude
1	16:35:40	Autopilot is switched off	16 518 ft	
2	16:38:23	Crew: *"Runway in sight, right overhead...."*	16 070 ft	
3	16:38:55	ATC: *"IFR cancel time"*	15 552 ft	
4	16:40:12	Landing gear extended	13 922 ft	
5	16:42:04	Crew: *"slightly southeast of the field"*	9980 ft	
6	16:42:10	FISO: *"Runway covered with wet snow and little bit ice"*	9844 ft	
7	16:44:08	Crew: *"looks like a slight missed approach..."*	6290 ft	640 ft
8	16:44:12	EGPWS: "*Caution terrain"*	6320 ft	674 ft
9	16:44:30	Copilot to commander: *"speed, speed,..."*	6614 ft	968 ft

Annex 3: Landing and final position of N906JW



Markings on runway

	Time UTC		Speed
1	16:47:29	Touchdown point	120 KIAS
2	16:47:40	EGPWS: *"Two thousand remaining"*	72 KIAS



Final position of N906JW after the accident