

# Investigation Report

## Identification

|                       |                             |
|-----------------------|-----------------------------|
| Type of Occurrence:   | Accident                    |
| Date:                 | 14 February 2010            |
| Location:             | Near Reinhardtsdorf-Schöna  |
| Aircraft:             | Airplane                    |
| Manufacturer / Model: | Cessna 550 B Citation Bravo |
| Injuries to Persons:  | Two persons fatally injured |
| Damage:               | Aircraft destroyed          |
| Other Damage:         | Environmental damage        |
| Information Source:   | Investigation by BFU        |
| State File Number:    | BFUCX001-10                 |

This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FIUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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## Abbreviations

|      |                                                           |
|------|-----------------------------------------------------------|
| AGL  | Above Ground Level                                        |
| AMSL | Above Mean Sea Level                                      |
| ATC  | Air Traffic Control                                       |
| ATPL | Air Transport Pilot's Licence                             |
| BFU  | German Federal Bureau of Aircraft Accidents Investigation |
| CPL  | Commercial Pilot's Licence                                |
| CVR  | Cockpit Voice Recorder                                    |
| FDR  | Flight Data Recorder                                      |
| FL   | Flight Level                                              |
| ICAO | International Civil Aviation Organisation                 |
| PF   | Pilot Flying                                              |
| PNF  | Pilot Non Flying                                          |
| CSMU | Crash Survival Memory Unit                                |
| CRM  | Crew Resource Management                                  |
| PIC  | Pilot in Command                                          |
| FAR  | Federal Aviation Requirement                              |

## Synopsis

On 14 February 2010 at 2038 hrs<sup>1</sup> the German Federal Bureau of Aircraft Accident Investigation (BFU) was informed by phone that close to Reinhardtsdorf-Schöna, Saxon Switzerland, an airplane had disappeared from the radar screen of the air traffic service provider. A little while later the crash of a Cessna 550 B Citation Bravo was confirmed. A BFU investigation team arrived at the accident site that same night and began with the field investigation.

### Investigation Results:

During climb after reaching Flight Level (FL) 270 the crew began to fly a rolling manoeuvre to the right. During the manoeuvre the crew lost control of the aircraft, the airplane shot steeply toward the ground and crashed. Both pilots were fatally injured and the airplane was destroyed.

The accident was due to:

- The crew tried to conduct a flight manoeuvre (roll) which is not part of commercial air transport.
- The crew suffered loss of spatial orientation and subsequently did no longer have the ability to recover the flight attitude.

The following factors contributed:

- The pilots were not trained in aerobatics.
- It was night and therefore there were no visual references.
- The relationship between the two pilots resulted in the departure from professional behaviour in regard to crew coordination.
- The airplane was neither designed nor certified for aerobatics.

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<sup>1</sup> All times local, unless otherwise stated.

# 1. Factual Information

## 1.1 History of the Flight

During the early evening, at 1946 hrs, after a flight time of one hour and 50 minutes the airplane came back to Prague, Czech Republic, after a flight to France. For the Pilot in Command (PIC) it was the first flight of the day. The co-pilot left the airplane after the landing and was replaced by the copilot of the subsequent accident flight. The co-pilot had already flown two flights that day - around midday - with a total flight time of one hour and 40 minutes. There were no passengers on board.

The aircraft departed Prague at 2008 hrs for a ferry flight to Karlskrona, Sweden. The flight was conducted in accordance with Instrument Flight Rules (IFR).

The course of events is described based on the analysis of the recordings of the Flight Data Recorder (FDR), the Cockpit Voice Recorder (CVR), radar and radio communications. The appendix shows two different FDR recording diagrams.

Diagram 1 shows the entire flight (time in UTC) and diagram 2 shows the flight from 1918:30 UTC on.

Take-off took place on runway 31. The co-pilot was Pilot Flying (PF). The flight was conducted manually, neither of the two autopilots was engaged. From 2012 hrs on, after a right hand turn, the flight proceeded toward the north. The airplane was in climb attitude. At 2014:16 hrs, still in climb, the PIC said "I didn't fly night time for long time". The co-pilot asked: "Have you already experienced a roll during night?" She answered laughing: "Yes, really." He: "Better we won't." She laughing: "Do you enjoy that thing?" Co-pilot: "You are the first one with whom I talked about it, don't tell it [...]" PIC: "Whom shall I not tell?" [...] She again: "I also do it always, but I persuade [...] to do that." Co-pilot: "[...] Bravo does it better." At 2015:00 hrs, during this short conversation, the crew received the instruction from ATC Prague to climb to FL260 and to level off above reporting point DEKOV. The conversation in the cockpit continued. Co-pilot: "Bravo does the roll faster with the ailerons but the spoilers are slower." At 2015:33 hrs ATC repeated the instruction. At 2015:40 hrs the PIC acknowledged the instruction.

Between 2017:10 hrs and 2017:20 hrs the airplane rolled about its longitudinal axis; initially to the left up to a bank angle of 30°, and right afterwards to the right up to a bank angle of 20°, then back again to the horizontal. At 2017:20 hrs the PIC responded to it with the words: "Let's go, we are already high enough, you nettle me - come on [...]" At 2017:22rs ATC Prague instructed the crew to contact ATC Munich;

at 2017:35 hrs the PIC confirmed the instruction. At 2017:42 hrs she said: "Later but." The co-pilot replied: "Let's do it at higher altitude."

At 2018:29 hrs, the PIC contacted ATC Munich. At 2018:36 hrs the crew received the instruction from ATC Munich to climb to FL330. This was confirmed at 2018:44 hrs.

Between 2018:51 hrs and 2019:00 hrs the following conversation took place:

- 2018:51 hrs PIC: "Sufficient, is it sufficient?"
- 2018:53 hrs Co-pilot: "For what?"
- 2018:54 hrs PIC: "Sufficient."
- 2018:56 hrs PIC: "The altitude."
- 2018:58 hrs Co-pilot: "For what?"
- 2018:58 hrs PIC: "For that,"
- 2019:00 hrs Co-pilot: "It is sufficient."

At 2019:00 hrs the airplane levelled off in FL270, at 2019:05 hrs the airplane nose moved upward until a pitch angle of about 14° was reached. At 2019:09 hrs the aircraft began to roll about its longitudinal axis to the right. Within 4 seconds the airplane reached the inverted flight attitude and in another 4 seconds it rolled another 90°. Simultaneously the heading changed right toward the east, then toward the south and finally toward the west. During the roll the pitch angle decreased to almost -85° which is almost a vertical nose dive. The computed airspeed increased significantly.

The airplane crashed near Reinhardtsdorf-Schöna, Saxon Switzerland, about 500 m north of the border to the Czech Republic.

## 1.2 Injuries to Persons

Both pilots were fatally injured.

## 1.3 Damage to Aircraft

The aircraft was destroyed.

## 1.4 Other damage

The forest surrounding the accident site was severely polluted by sprayed and spilled fuel.

## 1.5 Personnel Information

### Pilot in Command (PIC)

The 27-year-old PIC held an Air Transport Pilot's Licence (ATPL(A)) including the commensurate class and type ratings issued by the Czech civil aviation authority in accordance with ICAO and JAR-FCL regulations. She had a class 1 medical certificate.

The PIC had been employed by the operator since 2009. According to the operator's statement the PIC had a total flying experience of about 1,700 hours. The PIC had participated in the preparation of the Operations Manual. The last proficiency check was passed on 4 January 2010; the last simulator training took place on 2 June 2009.

In the last 24 hours prior to the accident she flew two hours and 15 minutes on the type; in the last 90 days she flew 50 hours and 48 minutes. In the last 24 hours she was on duty for two hours and 30 minutes and prior to that had a rest period of 19 hours and 30 minutes.

The PIC had participated in the following Crew Resource Management (CRM) trainings:

1 December 2009 Initial CRM Training

15 July 2009 Command CRM Training

3 May 2007 Recurrent CRM Training

Some of the pilots of the operator were asked to give an impression of the crew. Regarding the PIC the impression was:

The operator had employed her to establish quality management procedures since she was experienced in this field. At that time she was still flying for another operator, but changed soon afterwards to the current operator. She showed good flying performance, could familiarize herself quickly with new technologies and became PIC quickly. Initially she flew together with experienced co-pilots so that she could gather more experience in the field of business aviation. She was described as a distinguished person who did not open up to everyone but to some people and said what she thought. She was very athletic and interested in technology.

### Co-pilot

The 32-year-old co-pilot held a Commercial Pilot's License (CPL(A)) issued by the Czech civil aviation authority in accordance with ICAO and JAR-FCL regulations. He had the commensurate class and type ratings and a class 1 medical certificate.

The operator had employed the co-pilot in 2005 and he had a total flying experience of 1,600 hours according to the operator. He completed his last proficiency check on 4 January 2010.

In the last 24 hours he had flown one hour and 42 minutes. In the last 90 days prior to the accident he flew 55 hours; 16 hours and 42 minutes of which on the type. He had a 48-hour rest period prior to reporting for duty. On this day he had already been on duty for 3 hours and 48 minutes.

The co-pilot had participated in the following CRM trainings:

1 December 2009 Initial CRM Training

15 July 2009 Command CRM Training

18 December 2008 Recurrent CRM Training

Some of the pilots of the operator were asked to give an impression of the crew. Regarding the co-pilot the impression was:

He wanted to fly combat aircraft but could not do so for reasons he was not responsible for. He acquired his Private Pilot's Licence (PPL) in the USA. After three years he came back with an airline transport pilot's license and a rating to fly multi-engine airplanes. Friends described him as a charismatic, friendly and open person who had a lot of friends and who was always willing to do someone a favour. He showed good flying performance and could quickly familiarize himself with new technology.

## 1.6 Aircraft Information

The Cessna 550 B Citation Bravo is an all-metal, low-wing airplane with a retractable landing gear in nose wheel configuration. The aircraft with the Manufacturer's Serial Number 550-1111 was built in 2005. It was powered by two Pratt & Whitney PW 530 A turboprop engines. The airplane had a Maximum Take Off Mass (MTOM) of 6,713 kg (14,800 lbs). It had a Czech certificate of registration and was operated by a Czech operator.

Up until 13 February 2010 it had completed 1,830 hours of flight time and 1,686 flight cycles. The Airworthiness Review Certificate (ARC) was valid until 8 July 2010. The last scheduled maintenance action took place on 29 January 2010 with no irregularities.

The aircraft had the required equipment for flights in accordance with instrument flight rules.

The aircraft type was certified in accordance with Federal Aviation Regulation (FAR) 25. The FAR 25 stipulates the certification requirements of large airplanes. Aerobatics are not intended for these airplanes.

The airplane was equipped with a Honeywell Primus 1000 instrument panel.

The Primary Flight Display (PFD) indicated the orientation angles (yaw and pitch). VG-14 gyroscopes were used as sensors for the orientation angles. The manufacturers of the gyroscope and the aircraft stated that during a roll about the longitudinal axis of the airplane the yaw angle through 360° will be displayed correctly. The allowable pitch is +/- 85°. Between +/- 85° and 95° (the aircraft is at an almost right angle in relation to the horizon) the gyroscope no longer works correctly and, therefore, the display is unreliable.

If the aircraft has a very high or very low pitch the PFD shows essential information only (DECLUTTER). Arrows indicate the direction of a normal flight attitude.

## 1.7 Meteorological Information

According to the Deutscher Wetterdienst (German meteorological service provider, DWD) the weather in the accident area was characterised by a sinking inversion between 5,000 and 6,000 ft Above Ground Level (AGL). The moist base layer was unstable and at times there was light snowfall. Above the inversion there were thin cirrus clouds with lower limits between FL200 and FL220.

The cloud base was at about 2,000 to 3,000 ft AMSL; cloud tops were maximally at FL60. Ground visibility was below 2,000 ft mostly by 10 km and more; there were slight limitations during the light snowfall. In FL270 there were no clouds and no significant weather phenomena. At the time of the accident it was night and there was new moon.

## 1.8 Aids to Navigation

During the flight until the accident there were no indications of problems with the navigation.

## 1.9 Radio Communications

Radio communications were recorded. The communication between the aircraft and Munich Radar was made available to the BFU as transcript.

## 1.10 Aerodrome Information

Not applicable

## 1.11 Flight Recorders

The aircraft was equipped with a Honeywell Solid State Flight Data Recorder (SSFDR), P/N 980-4700-025 and an L-3 COM Cockpit Voice Recorder (CVR), model FA2100, P/N 2100-1020-02; both were made available to the BFU for analysis.

### Cockpit Voice Recorder

The visual inspection of the CVR showed that the housing was destroyed. The Crash Survival Memory Unit (CSMU), however, showed only slight mechanical damage and no traces of fire. The inside of the CSMU did not show any physical damages of the memory units. The read-out of the recorded data was successful.

The Czech investigation authority assisted in the analysis of the CVR recordings.

### Flight Data Recorder

The visual inspection of the FDR showed that the housing was destroyed. The CSMU of the FDR showed slight mechanical damages and no traces of fire. The inside of the CSMU did not show any physical damages of the memory units.

The first read-out of the FDR recording occurred on 18 February 2010 with the Honeywell RPSGE Playback-32 Software (P/N 998-3414-504, ©2004) and was not successful. Eight KBytes of the downloaded FDR data were missing because a malfunction of the RPSGE software had overwritten it. Thus the decisive part for the investigation was missing.

Based on experiences the BFU had gained with the Honeywell software the read-out was repeated on 31 August 2010. During the second download the ADRAS ATU, SSFDR Breakout Box, P/N 704-2458-011 was used. This time the download was successful. Usable flight data of 15 complete flights and the accident flight were available.

## 1.12 Wreckage and Impact Information

The crash site was about 4.5 km south-west of Reinhardtsdorf-Schöna, close to the mountain "Großer Zirkstein". The terrain rose by about 20° to the north, was forested with conifers and snow covered. The snow was 30 to 40 cm deep.

The impact crater had a depth of approximately two meters and an expansion of about 16 m x 16 m. Most of the wreckage was in the crater or near its vicinity. The wreckage distribution was 180° (toward the south). Several heavier wreckage parts were found about 120 metres from the main wreckage. In the immediate vicinity of the impact crater traces of an impact fire were found. The snow around the accident site was soaked with fuel. Due to the destruction only bigger and more solid components, such as the engines, the two main landing gears and the tail section, could be identified during the field investigation. For further examination the parts were salvaged and transported to the BFU.

For the examination of the wreckage parts, the wreckage was laid out in the BFU hangar where the completeness of important structural parts and rudder surfaces was determined.

## 1.13 Medical and Pathological Information

Cause of death of the two pilots was the high degree of destruction of the bodies due to the high impact forces. Since the bodies were severely contaminated with fuel a chemical toxicological examination did not take place because the results would not have been conclusive.

## 1.14 Fire

There was an impact fire in the area of the impact crater.

## 1.15 Survival Aspects

The crash was not survivable.

## 1.16 Tests and Research

Not applicable

## 1.17 Organisational and Management Information

The Czech operator operated five airplanes on behalf of their owners. The airplane were operated as private business jets. In addition, the airplanes including crews were chartered out to other customers.

At the time of the accident the operator had not established a safety management system.

## 1.18 Additional Information

Not applicable

## 1.19 Useful or Effective Investigation Techniques

Not applicable

## 2. Analysis

The examination of the wreckage and the technical documentation did not reveal any accident-related defects of the aircraft. The high degree of destruction suggests a high impact energy. Due to this high energy the accident was non-survival for the crew.

The CVR recording described the interaction between the two pilots starting with the take-off clearance. During the take-off run the call-outs and confirmations required by crew concept occurred; they show unambiguously that the co-pilot was Pilot Flying (PF).

The CVR recording shows the following work distribution: The PIC was responsible for navigation and radio communications and was therefore Pilot Non Flying (PNF) and the co-pilot flew the airplane and was therefore PF.

During the climb to cruising altitude a situation developed between the two pilots in which they no longer paid appropriate attention to airmanship and engaged in something neither they nor the airplane could handle. The FDR and CVR recordings confirm this unambiguously. The content of the conversation shows they had begun talking about flying a roll. Within a short time the attitude toward flying such a manoeuvre was enquired of the other crew member and since no resistance was felt a more and more definite intention to fly a roll arose.

At no time during the conversation did the PIC exercise her leadership role and stopped the situation. The impression arose that there existed a close relationship between the two and that there was no real cockpit hierarchy. It seemed the PIC encouraged the intention of the co-pilot until he finally initiated the roll to the right.

The flight manoeuvre spiralled out of control because both pilots suffered loss of spatial orientation which they could not counteract in the time remaining.

Neither of the two pilots had been trained in aerobatics and the moonless night did hardly present any visual orientation. The result showed that the provoked situation could not be remedied successfully.

The situation found at the accident site and the conducted investigations as to the completeness of all significant aircraft components have shown that even though such manoeuvres were not intended for this type of aircraft, up until the impact the aircraft structure remained intact. Therefore, the conclusion can be drawn that the aircraft endured the loads while airborne.

The CVR recording showed, among other things, that the pilots had flown aerobatics in the past with other airplanes of the company. This resulted in the publication of Safety Recommendation 10/2010.

At the time of the accident the company did not have a quality and safety management. Therefore, the BFU published Safety Recommendation 11/2010.

## 3. Conclusions

### 3.1 Findings

- The crew held the respective licenses and ratings to fly the airplane.
- The pilots had not been trained in aerobatics.
- The pilots had adhered to their duty times.
- The pilots had encouraged each other to fly an aerobatics manoeuvre.
- The PIC did not try to stop the manoeuvre.
- The co-pilot had initiated the roll.
- Both pilots suffered a loss of spatial orientation.
- The aircraft had a valid certificate of registration.

- The airplane was certified in accordance with the airworthiness requirements of large aircraft (FAR 25).
- The airworthiness requirements for large aircraft does not include provisions for aerobatics.
- The airplane was technically in good condition.
- The artificial horizon was not designed for inverted flights.
- Up until the initiation of the roll there were no indications of technical problems.
- The weather conditions had no causal effect on the course of events.
- It was tried to fly a roll at night.
- The initially used FDR analysis software malfunctioned.

## 3.2 Causes

The accident was due to:

- The crew tried to conduct a flight manoeuvre (roll) which is not part of commercial air transport.
- The crew suffered loss of spatial orientation and subsequently did no longer have the ability to recover the flight attitude.

The following factors contributed:

- The pilots were not trained in aerobatics.
- It was night and therefore there were no visual references.
- The relationship between the two pilots resulted in the departure from professional behaviour in regard to crew coordination.
- The airplane was neither designed nor certified for aerobatics.

## 4. Safety Recommendation

On 1 March 2010 the BFU issued the following Safety recommendations:

Recommendation No 10/2010

The CAA-CZ responsible for air operators within the Czech Republic should arrange for an inspection of the involved air operator's aircraft in regard to structural overload.

Recommendation No 11/2010

The CAA-CZ should determine actions for the improvement of the air operator's Quality Management System and the Safety Culture.

In the meantime, both safety recommendations have been implemented. The inspection of the aircraft involved did not produce any negative results. The operator has established a quality and safety management system.

Investigator in charge: Dietmar Nehmsch

|             |                                         |                        |
|-------------|-----------------------------------------|------------------------|
| Assistance: | Human factors:                          | Karsten Severin        |
|             | Site plan of the wreckage distribution: | Frank Stahlkopf        |
|             | CVR analysis:                           | Andreas Bresky         |
|             | Wreckage display                        | Uwe Berndt             |
|             | FDR/CVR analysis:                       | Dieter Ritschel        |
|             | FDR/CVR analysis:                       | Hans-Werner Hempelmann |
|             | Avionics:                               | Philipp Lampert        |

Field investigation: Dietmar Nehmsch  
Frank Stahlkopf  
Thomas Kostrzewa

## 5. Appendices

### Appendix 1: FDR Recordings (Times in UTC)

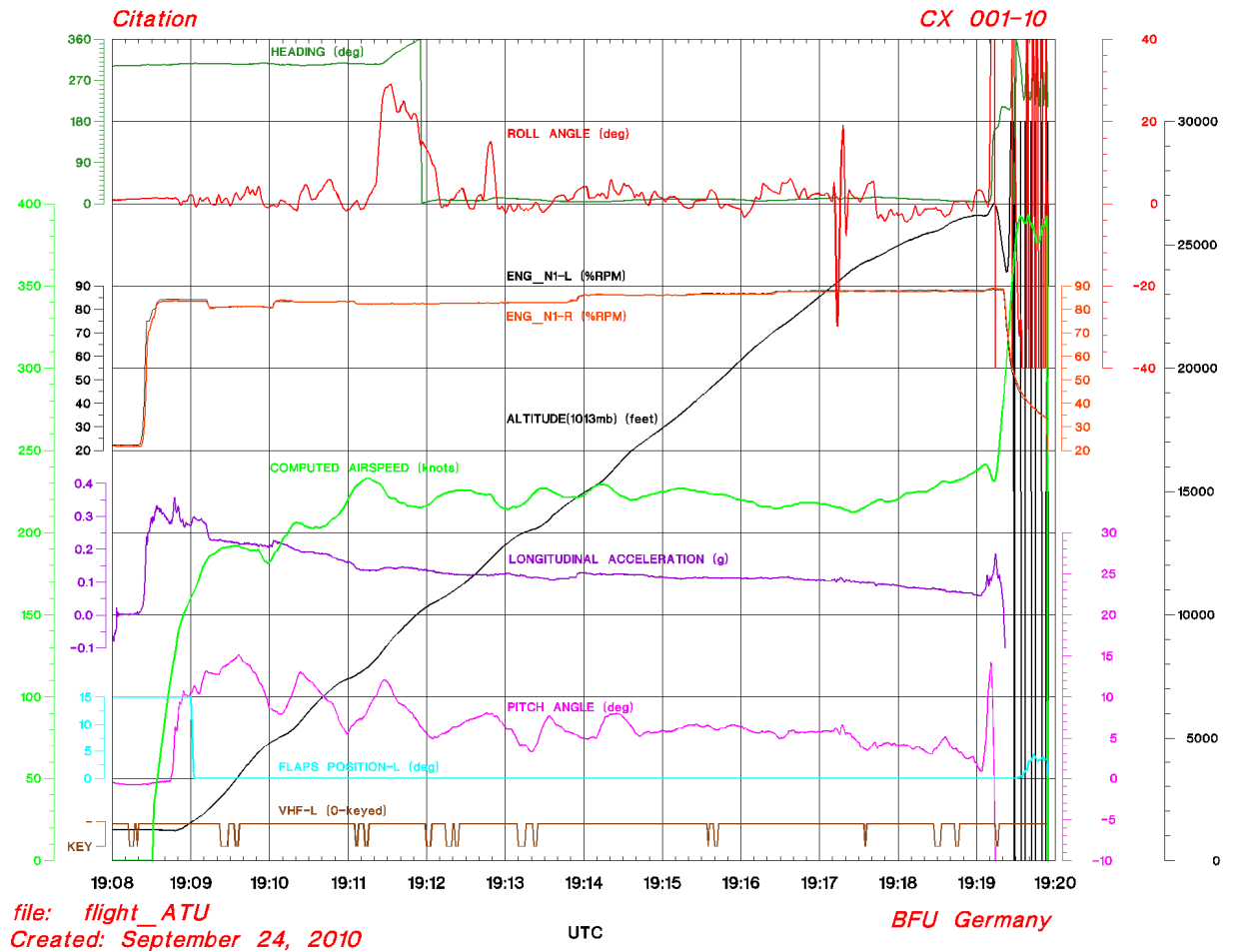


Image 1: Entire flight

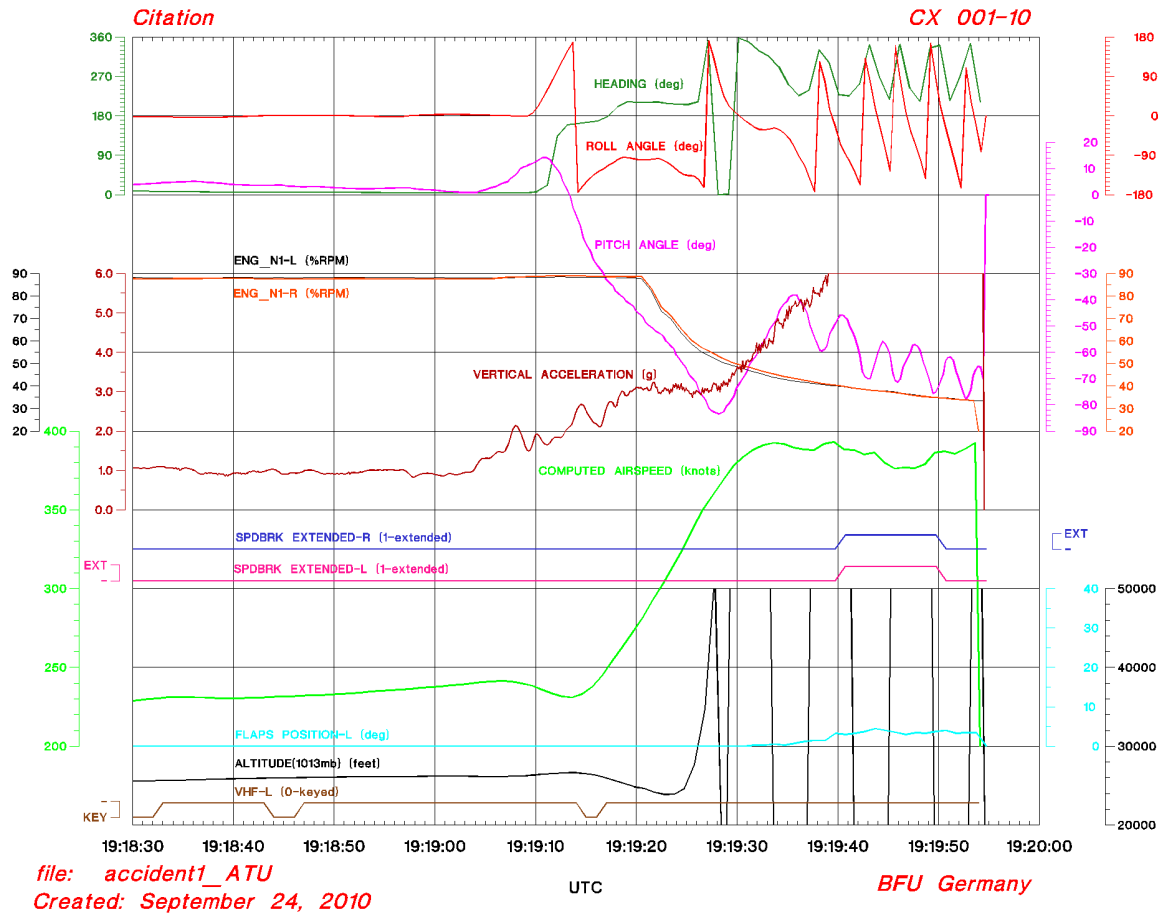


Image 2: Initiation of the roll and the consequences

## Appendix 2: Accident site and wreckage



Accident site

Photo 1: BFU



Wreckage parts in the BFU hangar

Photo 2: BFU