Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	24 April 2019
Location:	Siegerland Airport
Aircraft:	Airplane
Manufacturer:	Cessna Aircraft Company
Type:	551 Citation II/SP
Injuries to Persons:	No injuries
Damage:	Aircraft substantially damaged
Other Damage:	Asphalt of the runway damaged
State File Number:	BFU19-0411-3X

Abstract

During approach to runway 13 of Siegerland Airport, the aircraft touched down in the grass ahead of the runway. The main landing gear collapsed and damaged the left wing tank. The aircraft slid along the runway on the fuselage until standstill. A fire broke out which the airport fire brigade extinguished.

Factual Information

History of the Flight

The flight was a training flight to acquire the type rating for the aircraft. The flight instructor sat in the right-hand seat and was pilot in command. The student pilot sat in the left-hand seat and was pilot flying. For the student pilot it was his second day of flying as part of the training program on the Cessna 551 Citation II/SP. The day before, he had already flown about 3 hours with the airplane.

Take-off took place at 1330 hrs[1] at Reichelsheim Airfield. The flight was conducted under Visual Flight Rules (VFR) to Siegerland Airport. At Siegerland Airport, three precision approaches using the Instrument Landing System (ILS) of runway 31 were conducted. After the third landing, the aerodrome controller changed the landing direction to runway 13 due to the wind. The flight crew taxied to the end of the runway, turned, and took off from runway 13 at 1434 hrs. A left traffic circuit followed at 3,500 ft AMSL. This time, the approach to runway 13 was conducted as VFR approach without using the ILS. According to the statements of both pilots, during the traffic circuit the checklists were completed and the landing prepared for runway 13. During the final approach the aircraft was configured for landing and the landing checklist completed.

The student pilot stated that shortly before the landing the airspeed decreased, he had had the impression they were flying too low, and the approach angle had to be corrected. He pushed the thrust levers fully forward. The flight instructor stated he assisted this by also pushing the thrust levers forward with his hand. According to the statement of the flight instructor the time remaining until touch-down ahead of the runway was not sufficient to accelerate the engines to maximum rpm so they could supply the necessary thrust. He also said that at the time the aircraft’s speed had been close to stall. He did not notice any stall warning, though.

At 1442 hrs, the aircraft touched down with landing gear extended in the grass ahead of the asphalt area of threshold 13. The left main landing gear collapsed and damaged the left wing tank. The right main landing gear also collapsed but the right wing tank remained undamaged. The kerosene leaking from the left wing tank caught fire.

[1] All times local, unless otherwise stated.

The aircraft slid along runway 13 on the retracted landing gears, the lower surface of the fuselage and the extended flaps. It came to a stop about 730 m past the runway threshold 13. After the airplane had stopped, the student pilot noticed flames coming from the left side of the airplane.

The flight instructor stated he had shut off both engines. Then the two pilots left the aircraft via the emergency exit door at the right side. The student pilot stated that for the evacuation the emergency checklist of the Quick Reference Handbook (QRH) had not been used. Both pilots remained uninjured.

Personnel Information

Flight Instructor

The 70-year-old pilot held a Private Pilot Licence (PPL(A)) issued on 28 January 2015 by the Luftfahrt-Bundesamt in accordance with Part-FCL. According to the licence copies, in 2017 he acquired the type rating and in January 2018 the instructor rating for the Cessna 501/551. He had flown about 170 hours on Cessna 551 Citation II/SP.

Since 1976 he had been active as flight instructor for gliders and from 1978 on for single-engine helicopters. His licence also listed SEP[2] since 1983 and MEP[3] since 1984.

He had a total flying experience on helicopters of 10,800 hours and on airplanes of about 6,800 hours. According to his written statement he had conducted about half of them as flight instructor.

The licence listed the following ratings:

Aircraft type	**Licence entry:**	**Valid:**
Cessna Citation C501/551	PIC IR	30 September 2019
Cessna Citation C501/551	TRI	31 January 2021
Piper PA31T/42	PIC IR	31 May 2020
Piper PA31T/42	TRE[4]	31 October 2021

[2] Single Engine Piston
[3] Multi Engine Piston
[4] Type Rating Examiner

Ratings:	Licence entry:	Valid:
MEP (Land)	PIC IR	31 May 2020
SEP (Land)	PIC IR	31 May 2020
SEP (SEA)	PIC	31 October 2020
FI (A)[5]	PPL, SEP, MEP, Night	31 August 2021

The BFU was provided with a class 2 medical certificate with the restrictions TML (Time Limitation), VNL (Have available corrective spectacles and carry a spare set of spectacles), and SIC (Specific regular medical examination(s) contact licensing authority) valid until 13 May 2020.

For him this was the first flight of the day.

Student Pilot

The 36-year-old student pilot held a Commercial Pilot Licence (CPL(A)) issued on 9 July 2015 by the Luftfahrt-Bundesamt in accordance with Part-FCL. Approximately one week prior to the occurrence he passed the theoretical test for the Cessna 551 Citation II/SP.

The licence listed the following ratings:

Aircraft type	Licence entry:	Valid:
Piper PA31T/42	PIC IR	31 September 2019
Ratings:	**Licence entry:**	**Valid:**
MEP (Land)	PIC IR	30 June 2019
SEP (Land)	PIC	31 June 2020
SEP (Land)	IR	30 June 2019

The BFU was provided with a class 1 medical certificate valid until 18 December 2019. He had a total flying experience of approximately 1,300 hours, of which he had flown about 137 hours on Piper PA31T/42.

For him this was the first flight of the day.

[5] Flight Instructor LAPL and PPL

Aircraft Information

The Cessna 551 Citation II/SP of the American manufacturer Cessna Aircraft Company is a low-wing aircraft in all-metal construction. The airplane is equipped with two JT15D-4 fan jet engines of Pratt & Whitney Canada Ltd. It was designed as short and medium range business jet.

The three-way view in Figure 1 shows the dimensions of the aircraft type and the location of the door on the left and the emergency door on the right side of the aircraft. The drawing is part of the Pilot Operating Handbook (POH). The BFU converted the American measuring units to the metrical system.

Cessna 551 Citation II/SP

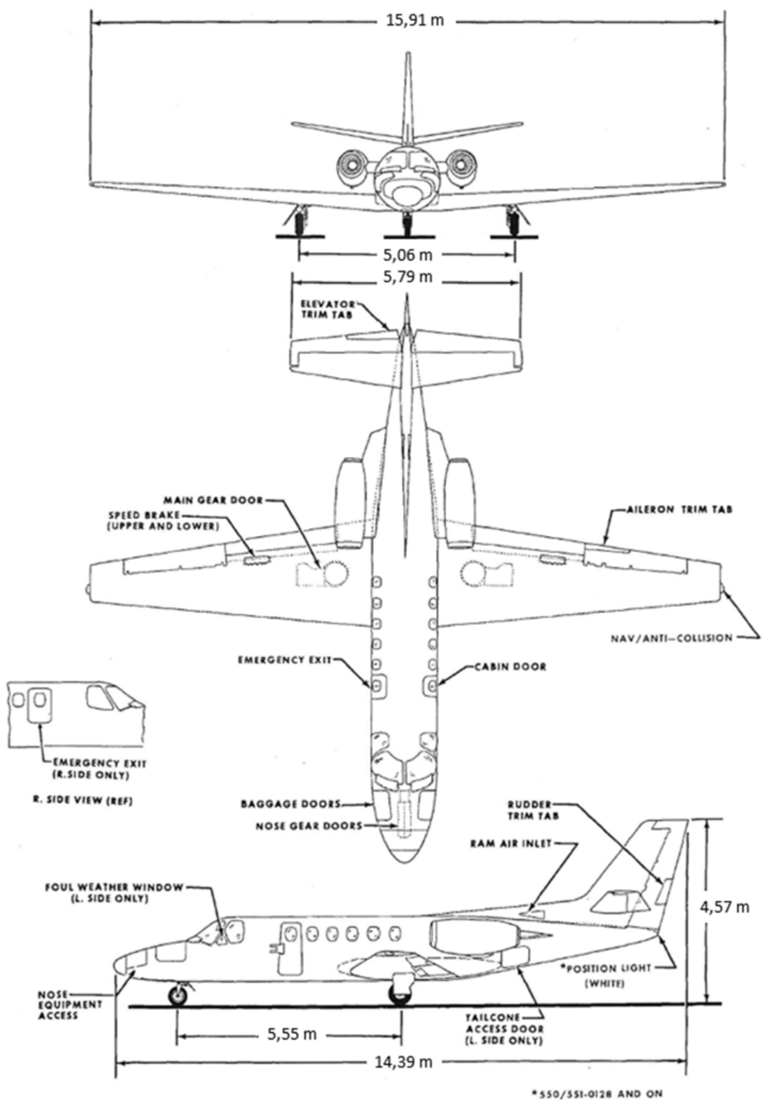

Fig. 1: Three-way view Cessna 551 Citation II/SP Source: POH, adaptation BFU

Manufacturer	Cessna Aircraft Company
Year of manufacture	1987
Manufacturer's Serial Number	551-0552
Operating Time	8,479 hours
Landings	7,661
Maximum take-off mass	12,500 lbs
Maximum landing mass	12,000 lbs
Empty weight[6]	7,482 lbs

Documentation

The aircraft Journey and Technical Log did not list any technical deficiencies.

Remaining Fuel on Board

The flight instructor stated that prior to take-off at the aerodrome of departure (Reichelsheim Airport) approximately 2,000 lbs (about 907 l) kerosene had been in each wing tank[7]. According to the fuel receipt of the day before, 2,001 l fuel were refuelled. On that day no other flights were conducted with the aircraft. The flight instructor stated that prior to the last take-off on runway 13 of Siegerland Airport approximately 1,322 lbs (about 600 l) kerosene had been in each wing tank.

Aircraft Landing Mass

Based on the empty weight, the two pilots and the fuel on board, the BFU calculated the landing mass prior to the last approach to runway 13 as about 12,000 lbs.

Aircraft Speed

Figure 2 shows the approach speed V_{REF} of 106 kt[8] based on the landing mass of 12,000 lbs.

[6] Empty weight, Engine oil, Two crew & furnishing. Source: Cessna Citation II, Flight Planning Guide, 3/1/86
[7] According to the POH, Revision 5 Chapter Specifications each wing tank has a maximum capacity of 2,500 lbs
[8] AFM

V_{REF} - (GEAR DOWN AND FLAPS - LAND)

	WEIGHT - POUNDS						
	13,300	13,000	12,500	12,000	11,500	11,000	10,500
SPEED - KIAS	111	110	108	106	104	101	99

Fig. 2: Table of the approach speed

Source: AFM Model 550/551 Unit-0002 Thru -0505 Citation II Pilots´ Abbreviated Checklist, Revision 4, 7 March 2000, Chapter N-18.1

Figure 3 shows the stall speed (V_S) according to the Airplane Flight Manual (AFM). According to the table, V_S was 80 kt given the landing configuration and the landing mass.

ANGLE OF BANK DEG.	FLAP SETTING – FULL WEIGHT – POUNDS										
	12500	12000	11500	11000	10500	10000	9500	9000	8500	8000	7500
0	81	80	78	76	75	73	71	69	67	65	63
10	82	80	79	77	75	74	72	70	68	66	64
20	84	82	81	79	77	75	73	72	70	68	65
30	87	86	84	82	80	78	77	75	73	70	68
40	93	91	89	87	85	83	81	79	77	75	72
50	101	99	97	95	93	91	89	87	84	82	79
60	115	113	110	108	106	103	101	98	95	93	90

Fig. 3: Table stall speed

Source: AFM Model 550Citation II, Unit-0550 Thru -0626, Revision 2, 8 December 1997

Engine

The following is an excerpt of the manufacturer's Engine Service Bulletin No. 7124, Rev. No. 3, 28 June 1979 for the engine JT15D-4. At an outside air temperature of 15°C and a barometric air pressure of 1,013.25 hPa acceleration from idle to 95% N1 takes up to 4.5 seconds.

Meteorological Information

At the time of the occurrence it was daylight. According to the aviation routine weather report (METAR) of Siegerland Airport of 1420 hrs horizontal visibility was more than 10 km. The wind came from 220° with 6 kt, variable 100° to 240°. There were no clouds below 5,000 ft AMSL. The temperature was 21°C, dewpoint 8°C, and QNH 1,003 hPa.

Wind Conditions

The Deutscher Wetterdienst (German meteorological service provider, DWD) recorded the wind data (Tab. 1) which Siegerland Tower provided to the BFU. The table shows the wind conditions during the respective approach (No.). The mean ground speed (GS) and the time (local daylight saving time) are based on radar data which end at about 500 ft AGL[9] above the airport. During the fourth approach the aircraft touched down in the grass ahead of runway 13.

No.	**Approach type and runway**	**Time**	**Ground Speed (GS)**	**Wind direction and speed**	**Wind component in relation to runway**
1	ILS 31	13:47:52	114 kt	155° / 04 kt	Tailwind about 4 kt
2	ILS 31	14:10:37	122 kt	181° / 05 kt	Tailwind about 3 kt
3	ILS 31	14:33:22	128 kt	140° / 05 kt	Tailwind about 5 kt
4	Visual Approach 13	14:42:56	97 kt	094° / 03 kt	Headwind about 2 kt

Tab. 1: Radar analysis and wind conditions at Siegerland Airport Source: Calculations by BFU

Due to the wind changing from south-west to east, the tower controller changed the landing direction after the third approach from runway 31 to runway 13.

Aids to Navigation

The last approach to runway 13 was conducted as visual approach. According to the statements of the technical operations manager of Siegerland Airport and the student pilot, at the time of the occurrence the Precision Approach Path Indicator System (PAPI) installed at the left-hand side of runway 13 was not in use.

[9] Due to technical reason, the radar recording ended at 500 ft AGL (about 2,000 ft AMSL).

Aerodrome Information

Siegerland Airport (EDGS) is located 8.6 NM south of the city of Siegen and has the coordinates N50° 42.46′, E08° 04.98′. Airport elevation is 1,966 ft AMSL.

Runway 13 has the orientation 126° and runway 31 306°. The asphalt runway 13/31 had the dimensions: 1,620 m long, 30 m wide. For both runways a PAPI with an approach angle of 3° was installed. Runway 31 was also equipped with an ILS.

Radio Communications

According to the tower controller’s statement, radio communications with the flight crew were conducted in German, but were not recorded due to the lack of recording options.

Flight Recorder

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder. There were no legal requirements for such equipment to be fitted.

The BFU seized and analysed the Garmin GTN 725 GPS which had been on board. It had not stored any data.

The installed Emergency Locator Transmitter (ELT) had not been triggered and therefore did not send any signal.

The BFU was provided with the radar data of the flight path DFS[10] had recorded. The primary radar data of the DFS allows an approximate position and time determination of the aircraft and gives the altitude as secondary radar information.

The data of the first approach (on approach from Reichelsheim), the two other approaches to runway 31 and the occurrence flight to runway 13 at Siegerland were analysed. Figure 4 shows all four approaches.

According to the flight crew’s statement, the first 3 flights were conducted using the ILS of runway 31. From a distance of about 9 NM from Siegerland Airport, the subsequent traffic pattern ran right with a straight ILS approach segment. The mean airspeed during the three ILS approaches were analysed and compared with the wind condition at the airport (Tab. 1).

[10] Deutsche Flugsicherung GmbH

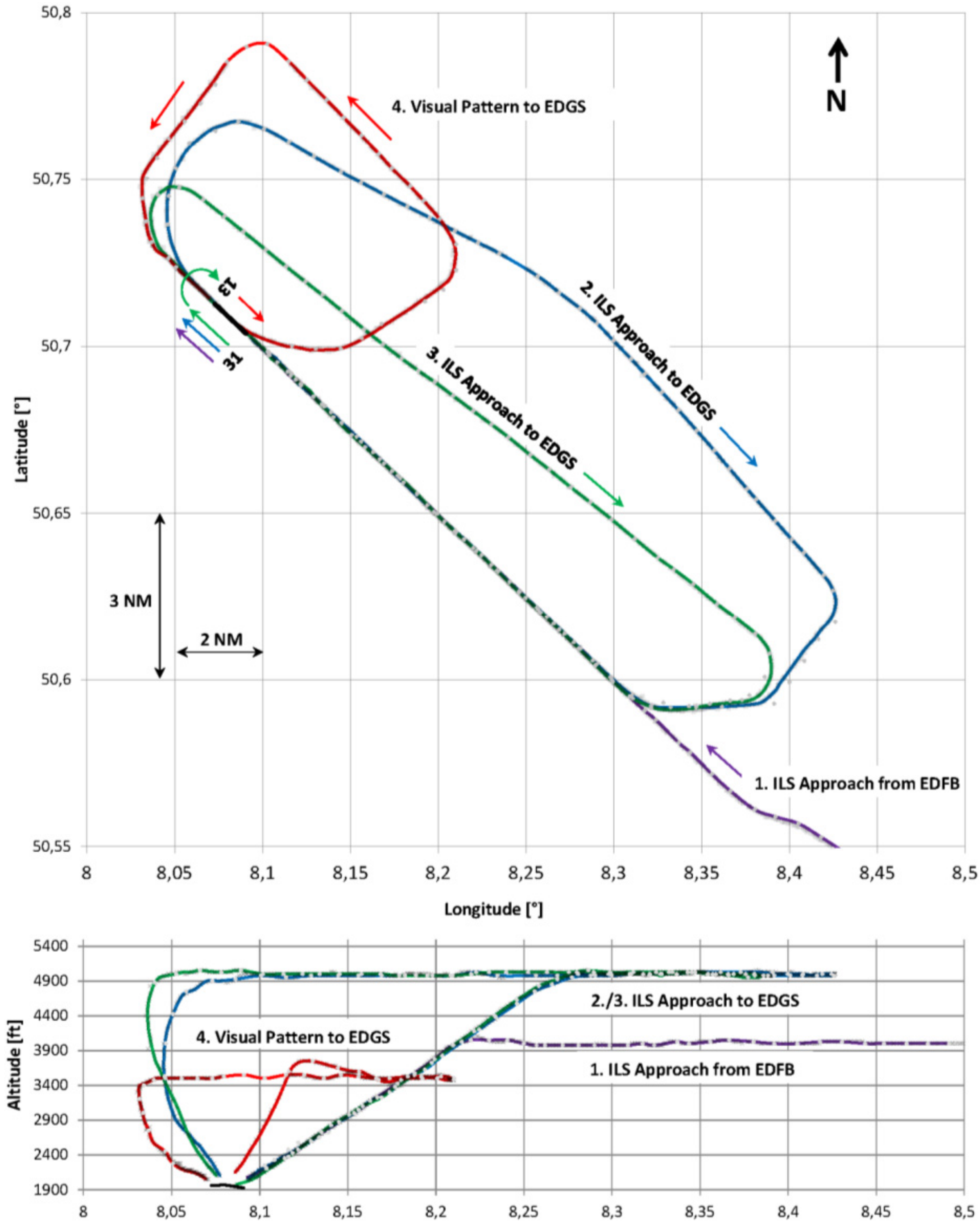

Fig. 4: Flight and altitude profile of the Cessna 551 Citation II/SP at Siegerland Airport

Source: DFS, adaptation BFU

The fourth approach was conducted as visual approach under visual meteorological conditions to runway 13. At about 3,500 ft AMSL, the flight crew conducted a traffic pattern. During the segment between downwind leg and base leg, the aircraft descended in a left-hand turn from about 3,500 ft AMSL to about 2,800 ft AMSL. The radar recording showed a straight approach segment of about 1.5 NM (Fig. 5) from this altitude. In the last 20 seconds of this segment (highlighted red) airspeed decreased by about 20 kt and the sink rate increased by about 100 ft/min.

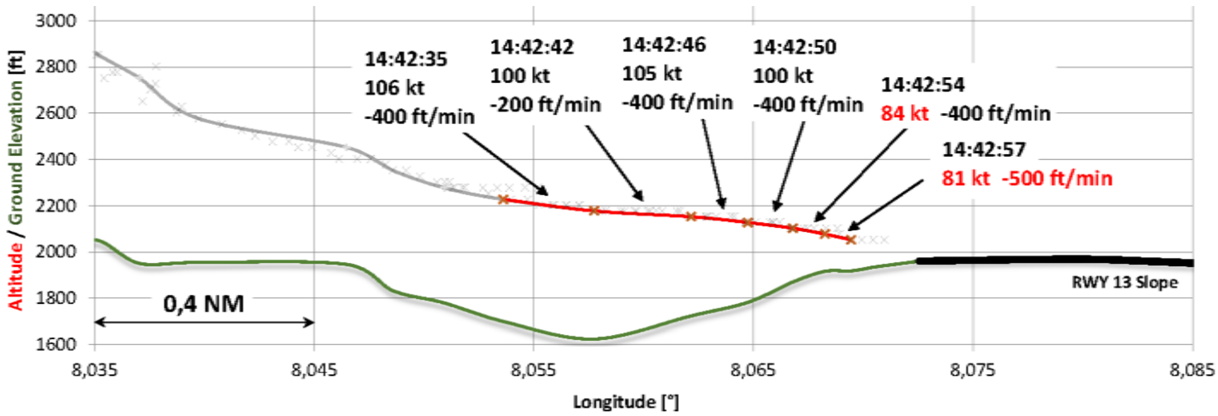

Fig. 5: Radar data of the occurrence flight Source: DFS, adaptation BFU

Wreckage and Impact Information

During the on-site investigation the BFU determined that the aircraft touched down in the grass first with the wheel of the left main landing gear approximately 5.20 m ahead of the asphalt strip of runway 13.

The right wheel of the main landing gear touched down about 3.40 m ahead of runway 13 in the grass (Fig. 6).

There was an edge of about 10 cm between the grass and the asphalt.

Fig. 6: Touchdown traces of the main landing gears ahead of runway 13

Source: Siegerland Aiport, adaptation BFU

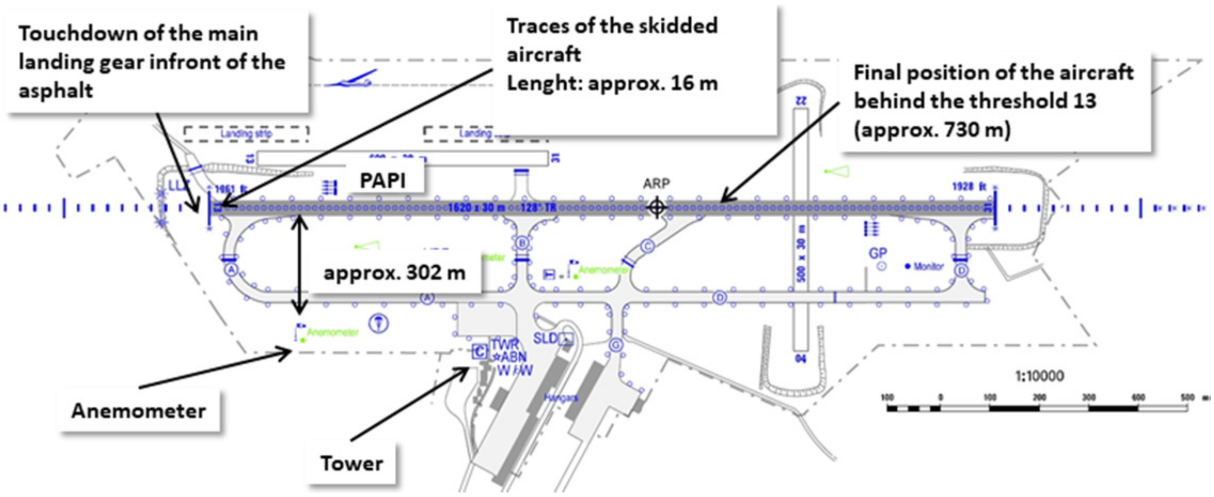

Fig. 7: AIP aeronautical chart of Siegerland Airport

Source: DFS, adaptation BFU

The traces on the asphalt of the runway and on the aircraft show that it skidded on the fuselage underside along the runway until it came to a stop approximately 730 m past the runway threshold (Fig. 8 and 9). Antennas, flaps, and panelling on the fuselage underside were damaged. A kerosene trail ran along the left runway side, from the threshold to the final position of the airplane. The aircraft's nose pointed toward 140°. It was lying about 5 m left of the runway centreline (Fig. 8).

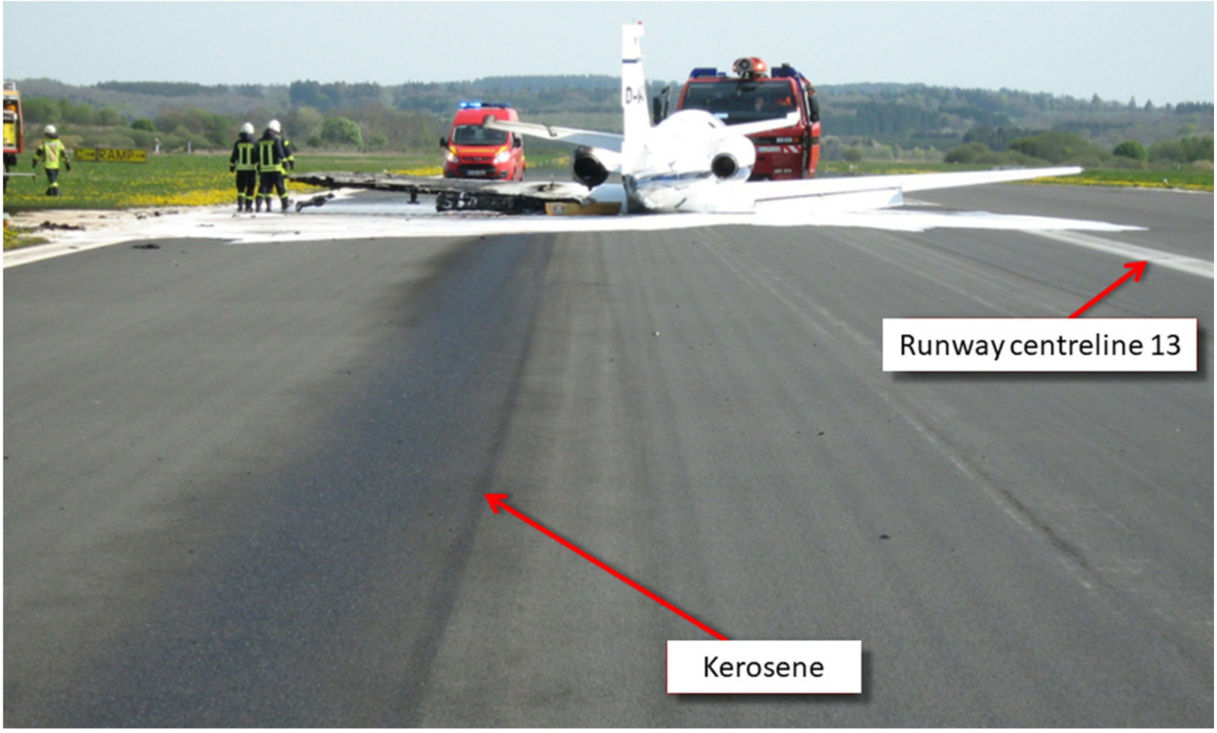

Fig. 8: Kerosene trail and final position of the aircraft Source: Siegerland Aiport, adaptation BFU

Fig. 9: Damage on the left wing and left engine Source: BFU

The BFU checked the function of the control surfaces. The aileron of the right wing, the elevator, and the rudder could be moved with little effort. The flaps on both wings corresponded with the position of the flap control lever in the cockpit. It was in the landing position.

The left main landing gear mounting damaged the left wing tank. The right wing tank was not damaged. The fire destroyed the left wing (Fig. 9). Due to the damage, function test of the left aileron was not possible. The underside of the left engine cowling was substantially damaged. The inside of the engine did not show any traces of fire. The left and right engine shafts could be rotated without effort. The engine inlets and fan blades showed no damage.

Both main landing gears were substantially damaged. They were laying bend beneath their respective wings. The nose landing gear was compressed; there was no damper spring deflection anymore.

The field investigation determined that the terrain ahead of runway 13 sloped downward. The terrain ahead of runway 31 did not slope downward to the same degree.

Fire

At 1443 hrs, the airport fire brigade of Siegerland Airport was notified by the tower controller. After 142 s fire extinguishing foam was applied.

In their mission report the fire brigade noted that approximately 500 l kerosene from the left wing tank had flowed into the ground. They had pumped about 650 l kerosene from the right wing tank.

Organisational and Management Information

Pilot Training

The BFU was provided with pilot training documentation describing the training to acquire the type rating for the Cessna Citation. The training program included training by a flight instructor on the aircraft type and emergency, evacuation and fire procedures. The flight training included flight manoeuvres with different configurations and engine power settings[11].

[11] Trainings program according to JAR.FCL 725

Procedures in the Pilot's Operating Handbook

The Pilot's Operating Handbook of the manufacturer Chapter Normal Procedures - Amplified Procedures described the engine performance management during the approach and landing. The following is an excerpt of that procedure:

> *[…]*
>
> *NORMAL PROCEDURES*
>
> *Power management during the approach/landing phase is relatively easy in the Citation II because an N setting in the 60 – 65 % range will normally result in desired indicated airspeeds for the various configurations. Depending on air traffic control requirements, thrust necessary for the entire approach can often be set during descent keeping in mind that fan (N1) RPM will decrease slightly for a fixed throttle setting with a decrease in altitude or indicated airspeed. Using a sea level airport with zero wind at a typical landing weight (10,000 pounds), a throttle setting that results in about 60 % N1 in close will give approximate level flight indicated airspeeds of 160 knots clean and 140 knots with flaps APPR. Gear extended, flaps FULL and commencing an average descent (500 FPM[12]) will result in approximately V_{REF} airspeed. Higher field elevations, landing gross weights and / or headwind component will require a greater power setting.*
>
> *[…]*

The manufacturer recommended in the Pilot's Operating Handbook Chapter Normal Procedures to apply the following procedure:

> *[…]*
>
> *For maneuvering prior to final approach, minimum airspeeds of V_{REF} +25, V_{REF} +20 and V_{REF} +10 should be maintained clean, flaps APPR[13] and flaps LAND respectively to provide an adequate margin above stall. Speed control on final should be precise for optimum landing performance and this is best accomplished by establishing V_{REF} airspeed.*
>
> *Speed control on final should be precise for optimum landing performance and this is best accomplished by establishing V_{REF} airspeed well before crossing*

[12] Feet per minute
[13] Approach

the threshold. In gusty wind conditions, it is recommended that one half the gust factor in excess of 5 knots be added to V_{REF}.

Approaching within approximately 50 feet of airport elevation, power should be gradually reduced to counter the acceleration induced by ground effect. Wind velocity and direction will dictate the rate at which the throttles are retarded. In very high surface headwind conditions, as an example, it may be necessary to maintain at or near approach power until close to touchdown. With a tailwind, a fairly rapid power reduction may be necessary in the final descent to landing phase for accurate speed control.

[…]

The manufacturer described in the Pilot's Operating Manual Chapter 18 - Manoeuvres and Procedures the approach procedure as follows:

[…] Plan to reach the […] final approach fix (FAF) with the landing gear down, flaps set, and speed set. If flying a straight-in two-engine approach, plan to have flaps set at 35° by the FAF; this permits a stabilized approach throughout final. […]

Additional Information

Stabilised Approach

In 2016, the International Air Transport Association (IATA) published a study[14] as to improvement options of unstable approaches. The aim of a stabilised approach was described as follows:

[…] The Aim of an Approach

A safe landing and completion of the landing roll within the available runway is the culmination of a complex process of energy management that starts at the top of descent, from which point the sum of kinetic energy (speed) and potential energy (altitude) must be appropriately dissipated to achieve taxi speed before the runway end. […]

[14] Unstable Approaches: Risk Mitigation Policies, Procedures & Best Practices, IATA

The study described criteria which should be adhered to acquire a stabilised approach:

> *[…] A stabilised approach provides a basis for a good landing, it provides the crew with the optimum conditions to flare, land, and stop the aircraft*
>
> - *An approach must be stabilised by 1,000 ft in IMC and by 500 ft in VMC*[15]
> - *The aircraft must be on the correct flight path*
> - *Only small changes in heading and pitch are required to maintain the correct flight path*
> - *The aircraft speed is < V_{REF} + 20 kts, < V_{REF} + 15 kts at the threshold*
> - *The aircraft is in the landing configuration*
> - *Sink rate < 1,000 feet per minute*
> - *Power setting appropriate for configuration*
> - *All briefings and checklists have been performed*
> - *Instrument landing system (ILS) approaches - must be flown within the equivalent of one dot of the glideslope or localizer*
> - *Visual approaches - wings must be level on final before 500 ft*
> - *Circling approaches - wings must be level on final before 300 ft*
> - *An unstable approach is an undesired aircraft state which is recoverable only with the execution of a missed approach or go around […]*

Approach angle

In order to conduct a stabilised approach, a sufficiently long straight final approach to the runway in use is required. The common approach angle is 3°. Figure10 shows an example of such an approach.

[15] Visual Meteorological Conditions

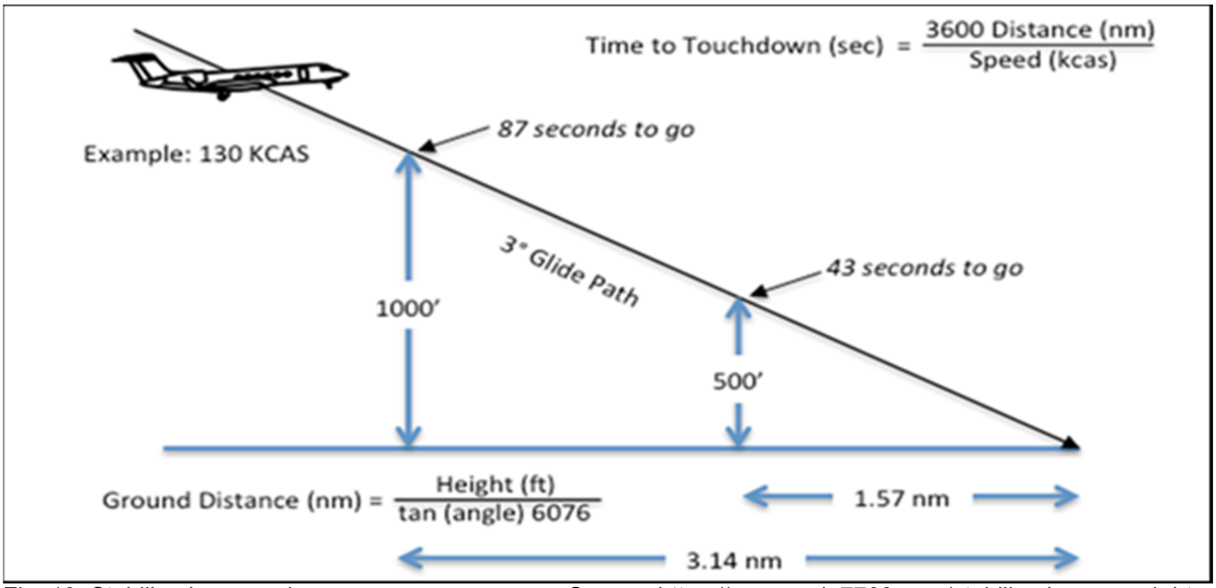

Fig. 10: Stabilised approach Source: https://www.code7700.com/stabilized_approach.htm

Visual Illusion during Approach

The operator's headquarters and home base was Reichelsheim Airport. According to the AIP, the runway at Reichelsheim Airport had a width of 23 m. The runway at Siegerland Airport was 30 m wide.

Different runway widths can prompt a pilot to correct the approach angle. Is the runway wider than a pilot is used to, the approach can suggest that the aircraft is too low. This results in the decrease of the sink rate.

Rising terrain ahead of the runway can suggest that the aircraft is too high during the approach and/or that the approach angle is too steep (Fig. 11). A possible reaction of the pilot could be to increase sink rate. The result would be an approach angle which is too low; below the approach angle of the approach chart.[16]

[16] Flight Safety Foundation / FSF ALAR Briefing Note 5.3 - Visual Illusions

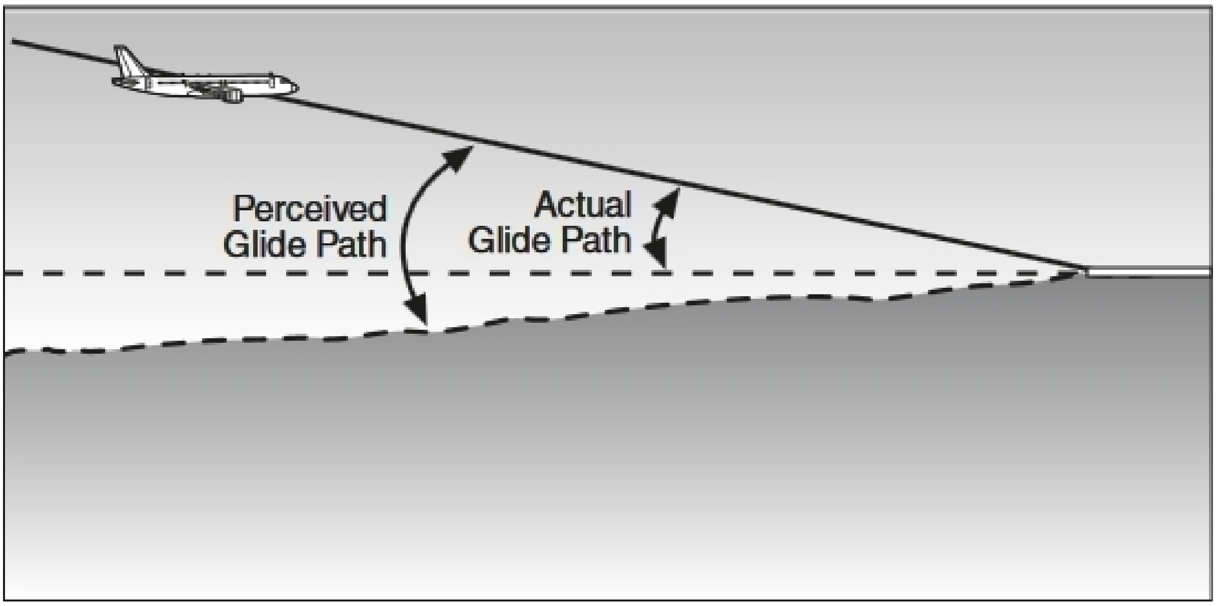

Fig. 11: Visual perception of the approach angle with rising terrain ahead of the runway

Source: Flight Safety Foundation / ALAR Briefing Note 5.3 - Visual Illusions

Flight Data Recording

Due to the lack of objective data or unclear causes for air accidents worldwide involving commercially operated aircraft, which so far have been exempt from installing flight data recorders and cockpit voice recorders, in the past several international investigation authorities have issued safety recommendations concerning this matter. The BFU stated this lack of flight data in the report BFU17-1604-CX also and abstained from issuing safety recommendations. However, the BFU cited safety recommendations of other investigation authorities:

> *AAIB UNKG-2005-101: The EASA should promote the safety benefits of fitting, as a minimum, CVR equipment to all aircraft operated for the purpose of commercial air transport, regardless of weight or age.*
>
> *NTSB Safety Recommendation A-06-017: TO THE FEDERAL AVIATION ADMINISTRATION: Require all rotorcraft operating under 14 Code of Federal Regulations Parts 91 and 135 with a transport-category certification to be equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR). For those transport-category rotorcraft manufactured before October 11, 1991, require a CVR and an FDR or an on board cockpit image recorder with the capability of recording cockpit audio, crew communications, and aircraft parametric data.*

TSB Recommendation A13-0: The Department of Transport should work with industry to remove obstacles to and develop recommended practices for the implementation of flight data monitoring and the installation of lightweight flight recording systems by commercial operators not currently required to carry these systems.

In the scope of the legislative procedure (RMT.0271 (MDM.073 (a)) & RMT.0272 (MDM.073 (b))), in 2017 ESASA published the Notice of Proposed Amendment (NPA) 2017-03 In-flight recording for light aircraft[17].

[…] This Notice of Proposed Amendment (NPA) addresses safety and regulatory harmonization issues related to the need of in-flight recordings for accident investigation and accident prevention purposes. 12 safety recommendations were addressed to the European Aviation Safety Agency (EASA) by 7 safety investigation authorities, recommending an in-flight recording capability for light aircraft models which are outside the scope of the current flight recorder carriage requirements. In addition, new Standards (recently introduced in ICAO Annex 6) require the carriage of lightweight flight recorders for light aeroplanes and light helicopters. […] This NPA proposes to mandate the carriage of lightweight flight recorders for some categories of light aeroplanes and light helicopters when they are commercially operated and manufactured 3 years after the date of application of the amending regulation. In addition, this NPA proposes to promote the voluntary installation of in-flight recording equipment for all other light aeroplanes and light helicopters and for all balloons. The proposed changes are expected to increase safety with limited economic and social impacts. […]

17 EASA definition of light aircraft: […] New rules are created in Annex IV (Part-CAT) and in Annex VIII (Part-SPO) to Regulation (EU) No 965/2012. These rules require that aeroplanes and helicopters which: are commercially operated; are manufactured on or after [date of application of the amending regulation + 3 years]; are not specified by the current Part-CAT and Part-SPO requirements on carrying flight data recorders; and have an MOPSC of more than 9 (for aeroplanes) or are turbine-engined with an MCTOM of 2250 kg or more (for aeroplanes and helicopters), be equipped with a flight recorder which records flight data and/or images that are sufficient to determine the flight path and the aircraft speed (ground speed or indicated airspeed). […]

Analysis

Persons

Flight Instructor

The flight instructor conducted most of his instructor duties on helicopters and single and multi-engine airplanes. He also was a long-term flight instructor on PA31T/42. His licence listed FI (A) for SEP and MEP. The BFU is therefore of the opinion that in general he was a very experienced flight instructor.

At the end of 2017 and the beginning of 2018, he acquired the type rating and instructor rating on the Cessna 551 Citation II/SP. His flying experience on type was about 170 hours. In purely mathematical terms this is approximately 9 flight hours per month (flight instructor duties included). Therefore, the flying experience on type has to be considered as low.

In addition to the regular process of a flight with the corresponding tasks in the cockpit, during training flights training program items are completed. The student pilot was still inexperienced on the aircraft type. Therefore, supervision of him in regard to errors, his reaction and subsequent counter measures posed some challenge for the flight instructor. On this day, these tasks increased the work load for the flight instructor. It cannot be ruled out that the flight instructor missed action errors of the student pilot.

The analysis of the radar data of the approach to runway 13 showed that ground speed decreased continuously. Since the airplane had touched down ahead of the runway reduction of ground speed had to have continued until touch-down. The flight instructor did not realise the continuously decreasing speed in time. If he had, he would have intervened earlier and set full engine power. The situation was realised too late and intervention did not occur in time.

Student Pilot

During the week prior to the occurrence, the student pilot, as pilot flying, passed the theoretical exam. On the day prior to the occurrence, he had conducted a practical flight training of about 3 hours together with the flight instructor. The total flying experience showed that he had acquired his flying experience solely on twin-engine piston aircraft. His flying experience on aircraft with jet engines was very low due to the flight training he had just begun on Cessna 551 Citation II/SP.
During the flight training the student pilot was busy with: familiarizing himself with the aircraft type, airspace observation, system observation, aircraft configuration, use of

the thrust levers, aircraft controls, traffic pattern and the respective speeds. Due to the low flying experience on type the pilot was subject to high work load. This poses the risk of overwork and the latent possibility of mistakes. The radar data allows the conclusion that a continuous instrument scan was not performed; otherwise the two pilots would have recognised the decrease in speed and the infringement of the approach angle.

Approach

During the three ILS approaches each of the final segments was about 9 NM long. During the fourth approach (visual approach) it was only 1.5 NM long. This approach was begun at about 500 ft AGL. It was not a straight approach, because it was begun from a continuous turn. Among other things, IATA recommends in their study Unstable Approaches: Risk Mitigation Policies, Procedures & Best Practices that aircraft flying in accordance with visual flight rules should be established at 500 ft AGL. The criterion to begin the visual approach at 1.5 NM was adhered to.

During flight training, the student pilot should receive enough time to perform all flight actions in the cockpit and for the traffic pattern to conduct a visual approach. In addition, the flight instructor should be a role model for the student pilot. This includes anticipatory thinking and subsequent actions. In this case, a longer approach would have been helpful in order to control the approach speed and the approach angle.

The organisation of the final approach was conducted in insufficient distance to the runway threshold. Therefore, the remaining distance was not sufficient to stabilise the approach.

Visual Perception

The approach to runway 13 of Siegerland Airport included the fact that the terrain ahead of the runway threshold ascended. It is highly likely that for the pilot this created the visual illusion to being too high during the final approach. Subsequently, the sink rate was increased which resulted in a shallow approach angle.

Aircraft

The Cessna 551 Citation II/SP documentation provided showed that there were no technical malfunctions. The pilots did not indicate any technical malfunctions either. It can therefore be assumed that the aircraft systems functioned properly during the approach and that there were no malfunction indications in the cockpit which would have served as distractions.

Meteorology

At the time of the occurrence it was daylight. The wind came from 220° with 6 kt, variable 100° to 240°. Visual approach occurred under visual meteorological conditions. Table 1 shows a constant headwind component for the last approach to runway 13. This means influence of the wind, as tail wind component, can be ruled out as contributory factor.

Airport

The BFU is of the opinion that both pilots were familiar with the vertical profile of a 3°-approach and the corresponding flight parameters, due to their IFR experience. During the three ILS approaches to runway 31 they used the PAPI as additional visual aid.

The PAPI for runway 13 was not in use. According to the statement of the student pilot he was aware of it. An operational PAPI would have certainly been a useful visual aid during the visual approach. Therefore, the lack of approach lighting was a contributory factor for the non-adherence to the 3° approach angle.

Flight Data Recording

The Garmin GPS GTN 725, the BFU had seized, did not contain any data for the analysis of the flight path. For technical reasons, the radar recording of the DFS of the three approaches to runway 31 and the occurrence flight to runway 13 ended with a recorded altitude of about 500 ft AGL. Had the aircraft been fitted with an FDR the last pivotal flight data could have been read out and analysed. Therefore, the BFU could neither verify the flight instructor’s statement that no stall warning was observed nor the airspeed during the last decisive part of the flight path.

Since the aircraft was neither equipped with a FDR nor a CVR the communication of the pilots is also missing. This means that essential information for the analysis of the occurrence was not available. In the past, numerous accidents occurred worldwide in commercial air traffic which could not be explained due to the lack of data. Subsequently, numerous recommendations of safety investigation authorities were issued in regard to fitting aircraft with FDR and CVR.

Nowadays, the necessary technical solutions exist; hence the BFU is of the opinion that the aeronautical regulations for equipping aircraft with FDR and CVR or Cockpit Recording Image Systems should be amended.

Conclusions

The accident, during which the airplane touched down ahead of the runway, was caused by an unstabilised approach and the non-initiation of a go-around procedure.

The following factors contributed to the accident:

- The organisation of the traffic pattern was performed too close to the airport.
- The final approach was flown too short and conducted in a way that it resulted in an unstabilised approach.
- During the final approach the approach angle was not correctly maintained until the runway threshold.
- During the final approach speed was too low.
- Both pilots did not recognise the decrease in speed early enough and had not increased engine performance in time.
- The flight instructor intervened too late and thus control of the flight attitude of the aircraft was not regained soon enough.

The ascending terrain ahead of the runway threshold was also a contributory factor. It is highly likely that the student pilot had the impression of being too high and deliberately maintained a shallow approach angle.

Safety Recommendations

Safety Actions

Based on the already published safety recommendations and the planed aeronautical changes regarding the mandatory installation of flight data recorder and cockpit voice recorder (EASA - RMT.0271 (MDM.073 (a)) & RMT.0272 (MDM.073 (b)) 'In-flight recording for light aircraft' and EASA NPA 2017-03 / CRD to NPA 2017 - 03 / Opinion No. 02 / 2019) the BFU will not issue another safety recommendation.

Investigator in charge:	Norman Kretschmer
Assistance:	Ekkehart Schubert
Braunschweig,	10 September 2021

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 - FlUUG*) 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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Bundesstelle für
Flugunfalluntersuchung
Hermann-Blenk-Str. 16
38108 Braunschweig

Phone	+49 531 35 48 - 0
Fax	+49 531 35 48 - 246
Mail	box@bfu-web.de
Internet	www.bfu-web.de