BUNDESREPUBLIK DEUTSCHLAND

Federal Republic of Germany

Report

on

the accident to the aircraft

Cessna 560 on January 2, 1996
at Augsburg

File no. : C X 001-0/96

Accidents Investigation Bureau
at the LBA

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Index

Summary

On January 2, 1996, at 0545 pm*) the Flight Investigations Bureau (FUS) was informed by Augsburg aerodrome of the accident to the aircraft Citation V Ultra. Two staff members of the FUS were sent to the accident site, starting the investigation on January 3, 1996 at 0030 am.

The aeroplane was on a non-commercial business flight from Lugano to Augsburg, with two pilots and three passengers aboard.

When approaching runway 25 at Augsburg, the aeroplane suddenly stalled at a height of about 50 m first to the right, then to the left and stroke the ground with the left wing approximately 130 m before the threshold. In the following crash both the main and the nose landing gear broke off. After approximately 230 m, the aeroplane came to a stop at the left shoulder between runway and taxiway. The aeroplane was severely damaged. One passenger suffered a slight back injury, the other occupants were unhurt.

The cause for the accident were icing conditions during the approach to Augsburg, leading to wing icing. The flight characteristics, unknown and undocumented by that time, resulted in unexpected banking and stalling of the aeroplane under icing conditions immediately prior to the landing. The fact that there was no response from the stall warning system prior to stall had a critical influence on the circumstances.

*) all times in MEZ

1. Factual information

1.1 History of the flight

The aeroplane departed from Lugano at 0500 pm local time for a non-commercial business flight to Augsburg. Aboard were two pilots and three businessmen of the company that operates the aeroplane. The aeroplane was registered at the Bermuda Islands.

The aeroplane was taken over by Munich radar station on the frequency 128,25 MHz and guided by radar at 3 300 ft to the extended centreline for runway 25 at Augsburg. At about 0530 pm, Munich radar station consigned the aeroplane to Augsburg tower on the frequency 124,97 MHz. By that time, the autopilot was still engaged and the aeroplane was performing an automatically controlled precision approach to runway 25.

By the time of the accident, the visibility was about 2 000 m and the cloud base amounted to about 500 ft. From the ground up to a height of 5 000 ft, icing conditions prevailed. A crew that approached approximately 2 hours later spoke of unusual heavy icing during the approach.

According to the statements of the pilots and the passengers, there was nothing remarkable; the aeroplane was stable on the centreline and glide path. The landing gear and flaps were extended, the speed brakes, which had been used during descent, had been retracted in time.

Different statements were made about the icing. As the pilot on the right seat controlled the icing by using the icing detection lights and judged the ice accretion inconsiderable, a passenger, sitting with his back to the direction of flight and able to face the wing leading edge, estimated the ice one centimetre thick.

When preserving traces at the accident site, the members of the FUS found both wings showing ice accretion approximately 2 mm thick, progressing from the wing leading edge approximately 30 cm towards the lower surface (Appendix 1).

The approach speed was calculated in correspondence with the weight as 105 kts and according to the statements of the pilots, was also maintained. As from approximately 400 ft, they had visual contact to the runway, the pilot-in-command desengaged the autopilot and controlled the aeroplane manually.

According to the statements of the pilots, three red and one white light of the visual approach slope indicator system (VASI) were visible, i.e. the aeroplane was slightly below the established glide path as the pilot-in-command wanted to touch down immediately at the beginning of the 1 250 m long runway.

At a height of approximately 50 m the aeroplane suddenly stalled unexpectedly over the right wing. The pilot-in-command immediately set take-off power for a go-around, the aeroplane banked to the other side and stroke the ground with the left wing approximately 130 m before the threshold of runway 25. In the further course of events, both the main and the nose landing gear broke off. The aeroplane came to a stop on the left shoulder between runway and taxiway „F" after approximately 230 m (Appendix 2).

1.2 Injuries to persons

Both pilots and two of the passengers were unhurt, one passenger suffered a slight back injury.

1.3 Damage to aircraft

The aeroplane was severely damaged in the crash. When the aircraft first stroke the ground, the left wing broke off upwards at about 2,50 m from the wingtip. Both the main and the nose landing gear were torn off, the bottom side of the aeroplane was considerably damaged.

1.4 Other damage

A slight field damage resulted from leaking fuel. Any runway lights were damaged.

1.5 Personnel information

1.5.1 Pilot-in-Command

male

title of licence:	airline transport pilot licence (ATPL) issued on 26.09.1995 at Bern, valid until 31.05.1996 in connection with a licence validation issued at the Bermuda Islands.
type ratings:	Cessna C 500/501/551/550/560 as pilot-in-command.
other ratings:	instrument rating
medical fitness:	medically fit, no limitations or restrictions.
total flying hours:	2 579 flying hours on all types, 164 flying hours on C560, including 135 as pilot-in-command.

1.5.2 Co-Pilot

male

title of licence:	airline transport pilot licence (ATPL) is issued on 28.11.1995 at Bern, valid until 31.05.1996 in connection with a licence validation issued at the Bermuda Islands.
type rating:	Cessna C 500/501/551/550/560, DO 228, PA 42 as pilot-in-command, F 27 as co-pilot
other ratings:	instructor rating on PA 42
medical fitness:	medically fit with glasses
total flying hours:	approx. 5 800 hours on all types.

1.5.3 Human factors

According to their own statements, both pilots were well rested. The flight duty period by the time of the accident was 2 hours. Both had not been acting in the pilot role in the 10 days prior to the accident.

On the basis of the communication, between the pilots as well as to the air-ground communication stations, it could be established that the pilots gave the impression of being balanced and calm. There were no indications for rash or uncoordinated actions.

1.6 Aircraft information

manufacturer:	Cessna Aircraft Company
type:	Citation V Ultra C 560 U
serial no.:	560-03-01
year of manufacture:	1995
maximum mass:	16 300 lbs
total time of operation:	approx. 200 hours

The aircraft was orderly registered at the Bermuda Islands in the „Private" aircraft category. By the time of the accident the mass and balance were within the limitations.

1.7 Meteorological information

According to the German Meteorological Service, the Augsburg area was covered with high fog. The cloud base (8/8 stratus) was at 500 ft AGL. When reaching 2 500 ft to 3 000 ft, the aircraft entered the high fog and moderate icing occurred. The surface wind was light, with mean wind speeds of 2 to 3 knots, prevailing from 270° to 320°.

The weather conditions prevalent by the time of the accident were the following:

wind:	calm
visibility:	approx. 2 000 m
temperature and dew point:	-2°C
altimeter setting (QNH):	1 010 hPa

An aeroplane that landed about two hours after the accidented aircraft reported of severe icing in the clouds.

1.8 Aids to navigation

The aeroplane was guided by Munich radar station via the left base leg to the extended centreline of runway 25. The approach was carried out, with the autopilot on the instrument landing system (ILS) on the frequency 108,5 MHz. In the approach track, at a distance of 3,6 NM from the threshold, an outer marker with a crossing altitude of 2 870 ft and, at a distance of 0,6 NM, a middle marker are located. Furthermore, the aerodrome VHF omnidirectional radio range (VOR/DME) on the frequency 115,9 MHz, identification „AUG", can be used for determining distance and direction.

1.9 Communications

After entering German airspace, the aeroplane was first on the frequency 128,25 MHz of Munich radar and later, at a distance of about 10 NM from the threshold of runway 25, changed to Augsburg TWR to the frequency 124, 97 MHz. The radiotelephony, carried out in English, was recorded and corresponded to the international rules.

1.10 Aerodrome information

The Augsburg airfield for public use is located at the northern periphery of the town with an elevation of 1 515 ft above sea level and has an asphalt runway of 1 280 m length and 30 m width. The true bearing of the runway is 072°/ 252°. The runway 25 is provided with an instrument landing system (ILS). At the aerodrome a non-directional radio beacon (NDB) and a distance-measuring equipment (DME) are located (Appendix 3).

1.11 Flight recorders

According to the certification requirements at the Bermuda Islands, which are legally subordinated to the English Civil Aviation Authority (CAA), the aircraft was equipped with a flight data recorder and a cockpit voice recorder. The flight data recorder was in-operative for technical reasons. The cockpit voice recorder had been in operation and could be evaluated. In Germany, there is no obligation for a flight recorder in this aircraft category.

1.12 Wreckage and impact information

The first mark of ground contact of the left wingtip could be found approximately 130 m in front of the beginning of the runway and about 2 m on the right side of the runway centreline. In the further course of events both the main and nose landing gear broke off. The aeroplane skidded over the threshold of runway 25, left the asphalted part of the runway to the left after approximately 40 m and came to a stop about 90 m behind the threshold between runway and taxiway, severely damaged.

1.13 Medical and pathological information

Not applicable

1.14 Fire

When the left wing touched the ground, the fuel tank was damaged whereby fuel leaked out and was finely vaporised. These aerosol vapours caught fire from the still running engines but did not cause any damage to the aircraft.

1.15 Survival aspects

Not applicable

1.16 Tests and research

Within the scope of a technical investigation, the following systems were tested or evaluated with regard to possible malfunctions and internally stored error messages.

1.16.1 Stall Warning System

According to the flap position and the information provided by the angle of attack (AOA)-sensor, the stall warning computer calculates a lift information. The stall warning computer triggers an angle of attack indicator (AOA Indexer) and the stick shaker at the controls.

The above mentioned components were tested at the manufacturer „Safe Flight Instruments Corporation", White Plains, USA. The tests were carried out according to the „Functional Test Procedure DWG. 3606-1126 and DWG. 1703-1115".

The testing results of the stall warning computer did not show any alterations to the theoretical values. However, it did not consider the increasing stalling speed during the wing icing.

1.16.2 Air Data Computer and Auto Flight System

Observations of the Honeywell Primus 1000 system is an integrated automatic flight and flight control system, including an electronic display.

The system components were tested at the manufacturer „Honeywell", Phoenix, Arizona. All components were tested in their function by means of an automatic testing equipment (ATE) according to criteria that are applied within the framework of the unit inspection after manufacture. The integrated avionics computer (IC-600) use non-volatile memories for internal status and maintenance information which were read out and evaluated. A connection between the stored information and error messages and the accident could not be established. It could not be clarified whether the auto flight system had been activated by the time of the accident.

A statement of the flight crew that the auto flight system had engaged itself automatically on previous flights were not established by the evaluation of the internal error messages.

1.17 Information on organisation and procedures

The aeroplane is registered at the Bermuda Islands and is owned by a local resident company.

The operator of the aircraft was a Swiss company with seat in Lugano which however, did not have an approval for the conduct of commercial flights by the time of the accident. Therefore the flight was declared as non-commercial.

1.18 Additional information

Incidents and accidents during recent years emphasise the suspicion that the aeroplane was susceptible to unexpected banking and stalling at speeds close to stalling speed, in particular during approach and landing.

This was the reason for the American Federal Aviation Authority (FAA) to test the flight characteristics of the Cessna 560-series once again. These tests established the suspicion that the C 560-series aeroplanes tended to show critical banking and stalling characteristics under icing conditions at speeds exceeding stalling speed.

As a result of the flight tests carried out by Cessna, the FAA examined and approved the „Alert Service Letter SLA 560-3007" issued by Cessna, dated November 14, 1996.

On November 19, 1996 the FAA published the Airworthiness Directive AD 96-24-06 in which these problems were described and the operators were requested to amend the „Limitations", „Normal Procedures", and „Performance"-sections in the Aircraft Flight Manual (AFM).

1.19 Investigation techniques

No specific investigation techniques were used.

2. Analysis

An indication for a technical fault could not be found.

The accidented aeroplane was operated by the pilots according to the provisions applicable by that time. Completely unexpectedly the aeroplane entered due to icing an uncontolled flight attitude and touched the ground with the left wing shortly before landing.

The hot-air heated „Anti Ice System", including the engine inlets and one wing segment each, was engaged during the approach. The remaining wing leading edge was de-iced with the help of compressed air by so-called „boots". According to the manual, this system should be engaged not before the ice at the leading edge is about 8 to 13 mm thick. According to the opinion of the flight crew, the ice accretion by the time of the landing was such insignificant that it was not necessary to use the system.

The flight tests carried out by Cessna revealed that the series C 560-aeroplanes showed very critical wing stall characteristics under icing conditions. In these cases banking and stalling occurred at airspeeds exceeding the published stalling speed.

Furthermore, it was established that the stall warning system did not consider the increasing stalling speed resulting from the ice accretion at the wings. This means the aeroplane stalled without response of the stall warning system which was confirmed by the evaluation of the cockpit voice recorder.

The AD, basing on the flight tests carried out by Cessna, includes the requirement to amend the AFM in the „Limitations", „Normal Procedures" and „Performance"-sections, which must be considered by the flight crew for an approach under prevalent or presumable icing conditions.

In particular, the following points must be taken into consideration:

- Increase of approach and landing speed
- Procedures for use of the de-icing system
- Correction of landing distance and landing weight

Both pilots had by then no information about the critical performance of this aircraft type under icing conditions.

According to the opinion of the FUS, the present case concerns a type deficiency regarding the missing response of the stall warning system under icing conditions. According to the American airworthiness requirements (FAR § 25.207/ § 25.1301/ § 25.1419), the stall warning system has to function properly also under icing conditions. Flight tests have established undoubtedly that during the test flights under icing conditions wing stall occurred at airspeeds exceeding the response of the stall warning system.

The manufacturer has recognised this deficiency and has announced a modification of the stall warning system of the series 560-aeroplanes. In anticipation that this deficiency will be eliminated at the earliest possible time, the FUS dispenses with a safety recommendation.

3. Conclusions

3.1 Findings

- The pilots held the licences and ratings applicable for the flight.
- The aeroplane was registered at the Bermuda Islands and properly approved for the flight.
- Technical deficiencies were not discovered, mass and balance were within the limitations.
- The weather corresponded to the meteorological forecast; icing conditions prevailed.
- Approach was carried out manually upon reaching visual contact.
- At a height of approximately 50 m, the aeroplane stalled unexpectedly first over the right, then over the left wing and touched the ground.
- After approximately 230 m, the aeroplane came to a stop on the shoulder between runway and taxiway „F".
- Slight ice accretion with a thickness of approximately 2 mm was discovered at the wing.

- The flight tests revealed that the aeroplane was susceptible to unexpected banking and stalling under icing conditions and at speeds close to stalling speed.

- The stall warning system did not consider the increasing stalling speed under icing con ditions, thus it could not alarm the pilots of the imminent stall.

3.2 Causes

The cause for the accident were icing conditions during the approach to Augsburg, leading to wing icing. The flight characteristics of the aeroplane which had not been known and not been documented by then, resulted in unexpected banking and stalling of the aeroplane under icing conditions immediately prior to the landing. The lacking response of the stall warning system prior to the approach to stall had a critical influence on the course of the accident.

4. Recommendation

None

5. Appendix

1. Location sketch of the wreckage
2. Ice accretion at the wing leading edge
3. Aerodrome Chart

Braunschweig, June 20, 1997

Flight Accidents Investigation Bureau
at the Luftfahrt-Bundesamt

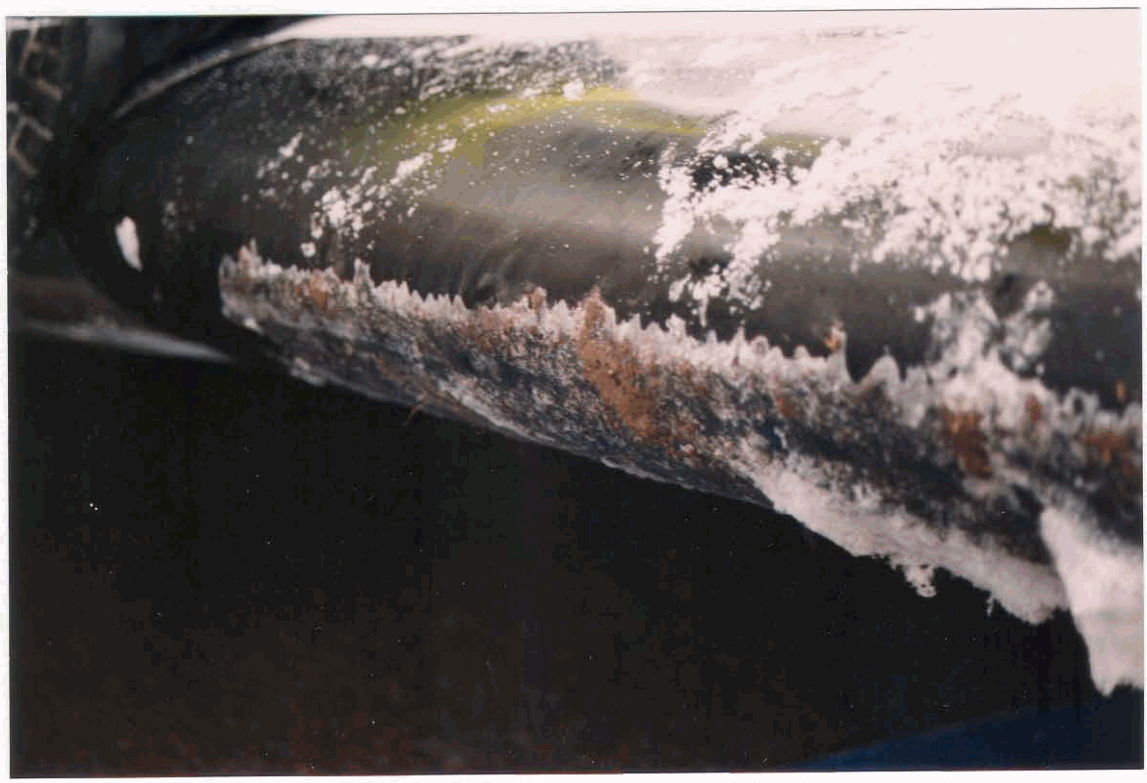
by order

Löthar Müller
Investigator-in-charge

The following staff members of the FUS participated in the investigation:

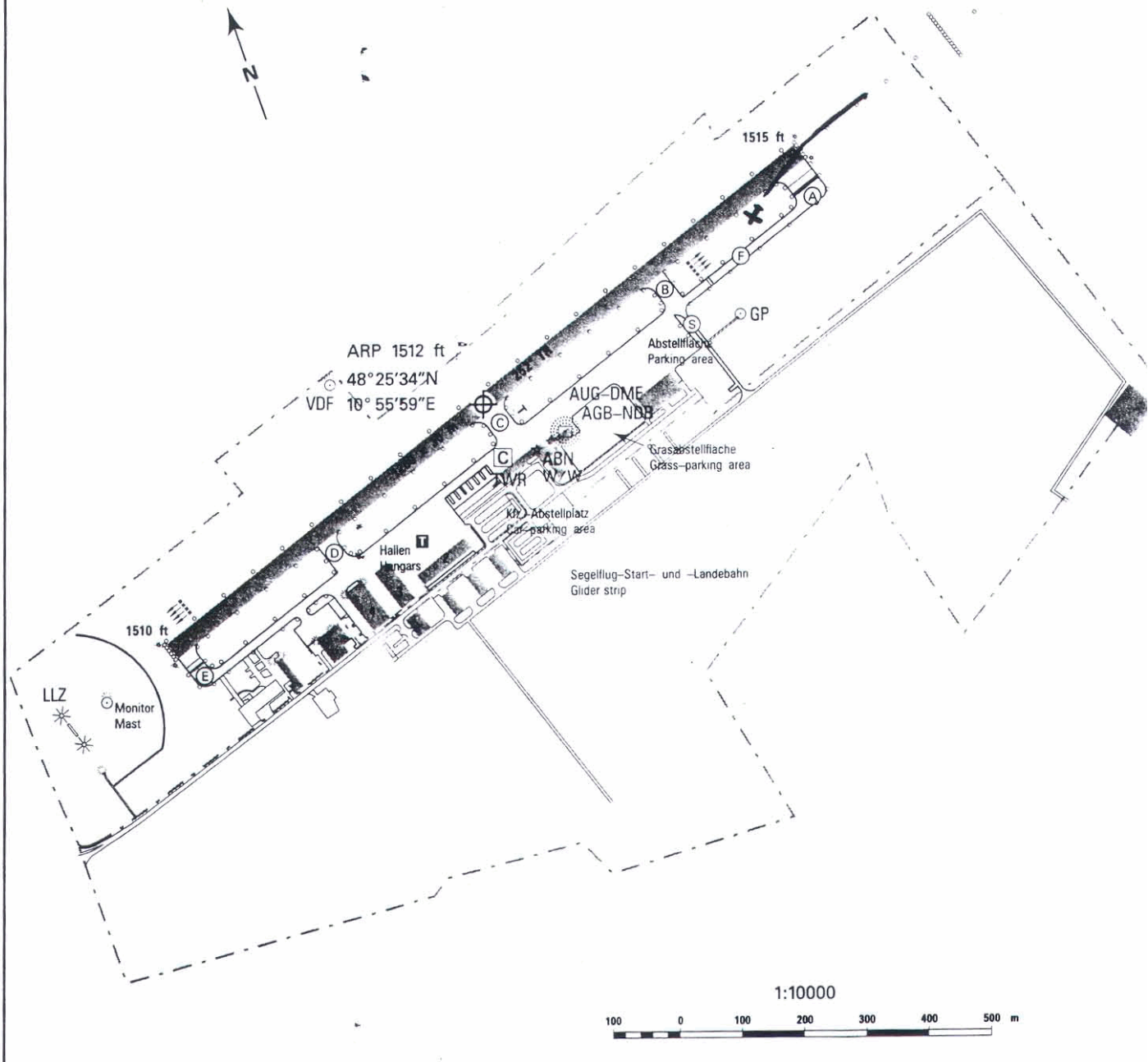
George Blau	Aerodynamics and Performance
Johann Reuß	Avionics

Position of crashed airplane



Ice accumulation at the lower survice of the leading edge

FLUGPLATZHÖHE IN FUSS
AERODROME ELEVATION IN FEET 1515



Correction: Revision.