

# Investigation Report

## Identification

Type of Occurrence: Accident

Date: 11 July 2020

Location: Dülmen

Aircraft 1: Glider

Manufacturer: Rolladen-Schneider Flugzeugbau

Type: LS4-b

Aircraft 2: Glider

Manufacturer: Glaser-Dirks Flugzeugbau

Type: DG-300

Injuries to persons: Both pilots were fatally injured

Damage: Both gliders destroyed

Other Damage: Crop damage

State File Number: BFU20-0502-CX

## Abstract

While conducting cross country flying and approaching a thermal area, both gliders collided and crashed.

## Factual Information

### History of the Flight

#### Course of the Flight from Take-off to the Vicinity of Borkenberge Airfield

According to witnesses, the LS4-b pilot planned a flight from Soesterberg Airfield, Netherlands, and an early return to the aerodrome of departure. He had agreed to meet there with a club mate for the afternoon to work at the launching winch. According to the logger and radar data recordings, take-off was at about 0916 hrs<sup>1</sup>. The pilot initially flew via Nijmegen until about 10 km south-east of Lüdinghausen. Then he turned and flew west towards Borkenberge Airfield.

According to witnesses, the DG-300 pilot planned a cross country flight from Lemelerveld Airfield, Netherlands, via Venlo to Germany in the area of Borkenberge and back. At 1025 hrs, he took off at the winch. The radar data showed that the flight path of the DG-300 passed Venlo and continued east in the area of Borkenberge Airfield. Then the glider turned and flew west towards Borkenberge Airfield.

One witness stated that at the accident time, he had also been approaching a growing cumulus cloud from the direction of Borkenberge Airfield, as had other gliders. The analysis of the flight data showed that this cloud had also been approached by the two pilots involved in the collision.

The BFU was provided with a witness's video which documented a glider crashing to the ground in a flat spin. The video had not recorded the collision of the two gliders.

#### Course of the Flight of the Last Three Minutes

According to the radar data, at about 1338 hrs, both gliders were south-east of Borkenberge Airfield (Fig. 1). At about 1338:30 hrs, the LS4-b began three left circles, ended them at about 1,280 m AGL and continued west with a distance to the DG-300 of about one minute. At the time, the DG-300 was about 150 m below and to the right of the LS4-b.

At about 1341 hrs, the DG-300 began a left circle at 1,080 m AGL with slight increase in altitude, ended it at about 1341:30 hrs and flew a heading of 310° in north-western direction. At the time, the LS4-b passed Borkenberge Airfield at 1,150 m and at 1342 hrs, changed heading to 310°. While passing from one thermal to the next, the

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

LS4-b overtook the DG-300 which was about 80 m below. Shortly before the collision, the DG-300 decreased speed and began to climb straight ahead.

At about 1342:30 hrs and approximately 2 km north-west of Borkenberge Airfield at about 1,100 m AGL, both gliders collided. The DG-300 crashed to the ground. After the collision, the LS4-b pilot left the glider with the emergency parachute. It was found with open leg harness about 140 m south-east of the LS4-b pilot's body in a grain field.

Both pilots suffered fatal injuries. The two gliders were destroyed on impact with the ground.

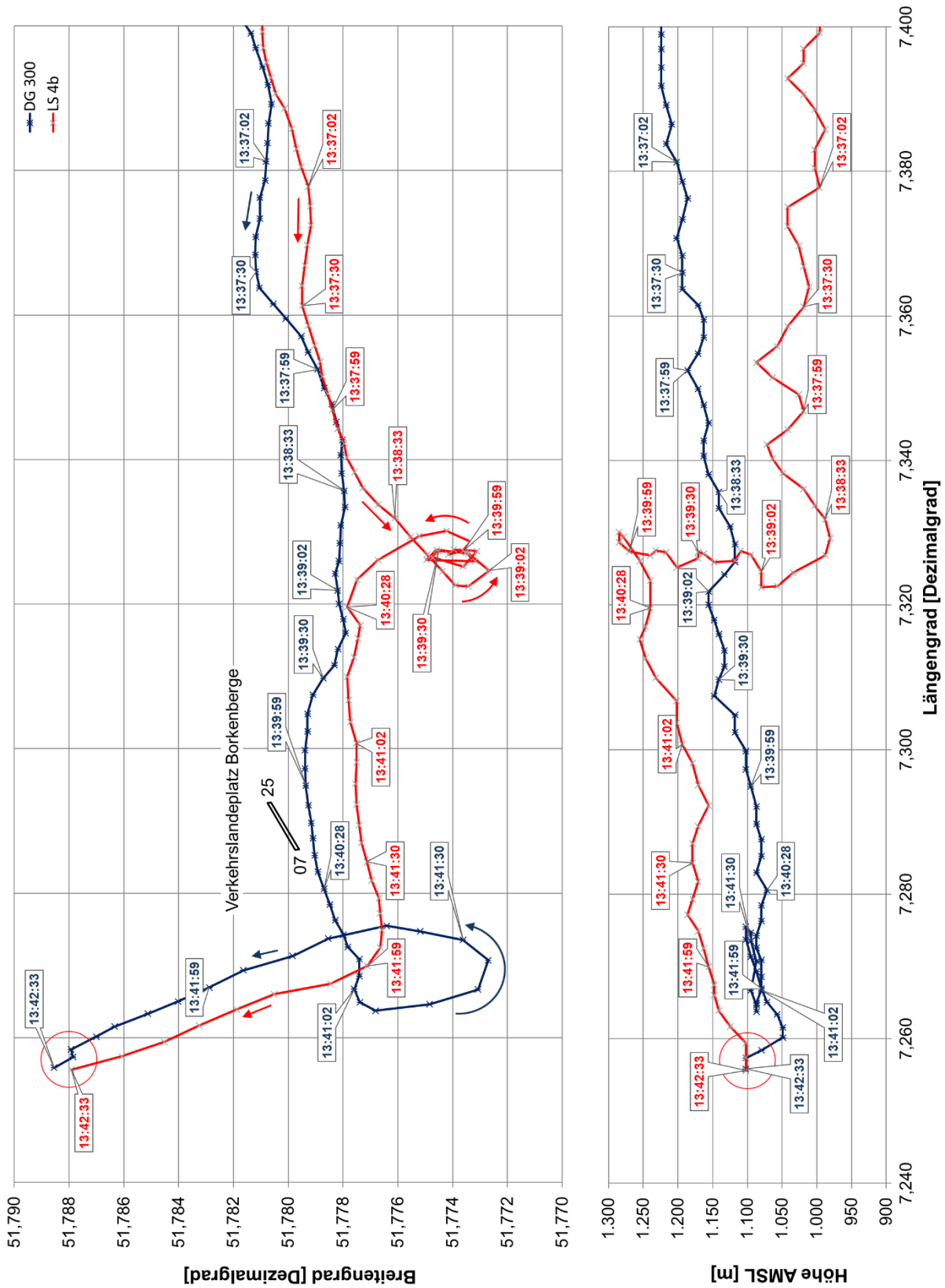


Fig. 1: Flight paths (LS4-b red / DG-300 blue)

Source: Radar data German Armed Forces, adaptation BFU

## Personnel Information

### LS4-b Pilot

The 25-year-old glider pilot was a Dutch citizen. Since 2013, he had held a Dutch gliding licence issued by Koninklijke Nederlandse Vereniging voor Luchtvaart. The licence was valid until 18 July 2021.

The licence listed the ratings to pilot gliders with the take-off types aerotow and winch launching.

His class LAPL medical certificate was issued on 17 February 2020 and valid until 17 February 2025.

The pilot had a total flying experience of 1,008 hours and 1,116 take-offs. On the glider type LS4-b, he had conducted eight take-offs.

In the last 90 days, he had flown about 21 hours and performed 6 landings.

### DG-300 Pilot

The 29-year-old pilot was a Dutch citizen and held a Light Aircraft Pilot Licence (LAPL(S)) since 15 May 2007, issued in accordance with regulations of the European Union. The licence listed the ratings to pilot gliders with the take-off types aerotow and winch launching.

His class LAPL medical certificate was issued on 3 September 2018 and valid until 3 September 2023.

He had a total flying experience of 842 hours and 729 take-offs. On the glider type DG-300, he had a flying experience of 258 hours and 79 take-offs.

## Aircraft Information

### LS4-b Glider

The aircraft is a single-seat glider in composite construction. It is designed as high-wing airplane in T-tail configuration with a retractable landing gear.

Manufacturer: Rolladen-Schneider Flugzeugbau

Type: LS4-b

Manufacturer's Serial Number: 4964

Year of Manufacture: 1985  
MTOM: 525 kg  
Total Operating Time: About 3,000 hours

The aircraft had a Dutch certificate of registration and was operated by a club. The last annual check was conducted on 16 April 2020.

The LS4-b was equipped with a transponder, a LX 9050 navigation system and FLARM (Fig. 2).



Fig. 2: Cockpit of the LS4-b with FLARM indication (right upper corner)

Source: Operator

## Emergency Parachute

The LS4-b pilot wore an emergency parachute.

Manufacturer: Para-Phernalia  
Type: Long Softie 240  
Manufacturer's Serial Number: 11458-5  
Year of Manufacture: 2013  
Minimum jump height: 300-500 ft

The emergency parachute was fitted with the leg harness type „Conventional Harness“ (Fig. 3).

The manufacturer stipulated the following when fastening the emergency parachute:



Fig. 3: Fastening the „Conventional Harness“

Source: Manufacturer's manual

Excerpt from the Owner's Manual and Packing Instructions, Chapter 2.0 User Information:

*2.2.1 Fit Your SOFTIE should be, above all else, comfortable. But, the real reason any pilot or passenger in an aircraft is wearing a parachute is in case an emergency bailout becomes necessary. If that should happen, the person using the parachute will reduce the risk of problems during egress and opening if the harness is worn snugly around the body. Take the time to properly adjust the fit of your Softie whether for yourself or for a less experienced passenger [...]*

The manufacturer indicated that the parachute had to be customized and time to adjust it has to be taken.

The emergency parachute was found with the leg harness open (Fig. 4).



Fig. 4: Emergency parachute with open leg harness

Source: BFU

## DG-300 Glider

The aircraft is a single-seat glider in composite construction. It is designed as high-wing airplane with a T-tail and retractable landing gear.

Manufacturer: DG Flugzeugbau

Type: DG-300

Manufacturer's Serial Number: 3E38

Year of Manufacture: 1985

MTOM: 525 kg

Total Operating Time: About 3,500 hours

The last annual inspection was performed on 26 October 2019. The DG-300 had a Dutch certificate of registration and was held in joint operatorship.

The DG-300 was equipped with a transponder, a LX 7007C navigation system with FLARM option (Fig. 5). At the time of the accident, the pilot was wearing an emergency parachute.



Fig. 5: Cockpit of the DG-300 with FLARM indication and navigation computer (top centre)

Source: Operator

The manufacturer of the navigation system LX 7007C stipulated the following in the Hand Book, Chapter 5.1 Flarm Option

[...] 5.1.9 Limitations

*FLARM is no universal remedy to avoid collisions. The pilot shall not limit his airspace observation and should use FLARM only as support. Not everybody has FLARM fitted, a 100% functions warranty cannot be guaranteed and installation was not always performed properly.*

The FLARM module manufacturer indicated in the Operations Manual FLARM Collision Warning System Chapter 1 Welcome to the FLARM Users:

[...] *Since the update of March 2015 each FLARM must be updated at least once a year (365 consecutive days) with the most current firmware version. [...]*

[...] *If FLARM is not updated once a year it is no longer functional! [...]*

In the FAQs on their website, the manufacturer gave information regarding configuration and updates:

*[...] Firmware expiry is a "last warning" implying that the AMP<sup>2</sup> has not been followed. It has also been implemented to avoid that devices that have not been updated are broadcasting obsolete data. 1 month before the firmware expiration date, the system will issue a "soft warning" for 30 seconds, after which it will continue to operate normally. After the expiration date, the system will issue a continuous hard warning and will not operate. [...]*

The operator stated that a FLARM firmware update had failed because the accident pilot (as joint operator) had downloaded an incompatible version for the LX 7007C. The system had shown a corresponding indication.

### **Emergency Jettison of the Canopy**

According to the DG-300 Flight Manual, Chapter 3 Emergency Procedures, 3.2 Canopy jettison/Bail out:

*Caution: To bail out open the canopy opening lever [...] and then the emergency release knob [...]. The installed spring pushes the canopy so far forward that the airstream will tear it away.*

### **Meteorological Information**

According to the statement of the Flugleiter<sup>3</sup> of Borkenberge Airfield, visual meteorological conditions prevailed. Visibility was more than 10 km at a slight wind. In the vicinity of the airfield, some rain showers were observed.

Glider pilots reported good thermal conditions in the area of the airfield, with cloud bases at 1,300 m AGL.

According to the aviation routine weather report (METAR) of Dortmund Airport, located 36 km south-east, of 1320 hrs, the following weather conditions prevailed:

Wind: 290°, 4 kt, wind between 230° and 350°

Visibility: CAVOK

Temperature: 17°C

Dewpoint: 8°C

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<sup>2</sup> Approved Maintenance Programme

<sup>3</sup> A person required by German regulation at uncontrolled aerodromes to provide aerodrome information service to pilots

Air Pressure: 1,024 hPa

At the time of the accident, the elevation angle of the sun was 51.91° and the sun azimuth (horizontal angle) was 129.60°. The sun's maximum altitude was at 1336:26 hrs.

## Radio Communications

None of the pilots involved were in radio contact with the Flugleiter at Borkenberge Airfield on the airfield frequency.

According to witnesses, the two pilots had not been in radio contact. There were conversations on other frequencies with other glider pilots from the respective clubs at the aerodrome of departure.

## Aerodrome Information

Borkenberge Airfield (EDLB) is located about 30 km south-west of Münster. Airport elevation is 158 ft AMSL (48 m). It had a 619/721 m long asphalt runway with the direction 073/253, which was certified for motor airplanes and helicopters up to 2 t MTOM and the aircraft type Dornier Do 28. Operation of powered gliders, gliders and ultralight was also approved.

South of the asphalt runway was a partially paved, parallel take-off strip for glider aerotow operation with the dimensions 974 x 30 m.

South of it ran a parallel grass strip with the dimensions 850 x 96 m for glider operations. And south of this were four paved winch launching strips with parallel directions. The available area was 1,095 x 110 m.

According to the Flugleiter, a lot of gliding activity took place the entire day.

## Flight Data Recording

Radar data of the German Armed Forces and the air navigation service provider of both gliders were made available to the BFU for the reconstruction of the flight paths. In addition, the BFU also had available FLARM data, received by ground stations, and from the LS4-b collision warning system.

At the time of the accident, at about 1342 hrs, several aircraft were in the air around the accident site. On the airspace depiction of the civil air navigation service provider, 10 targets with transponder signals were visible (Fig. 6).

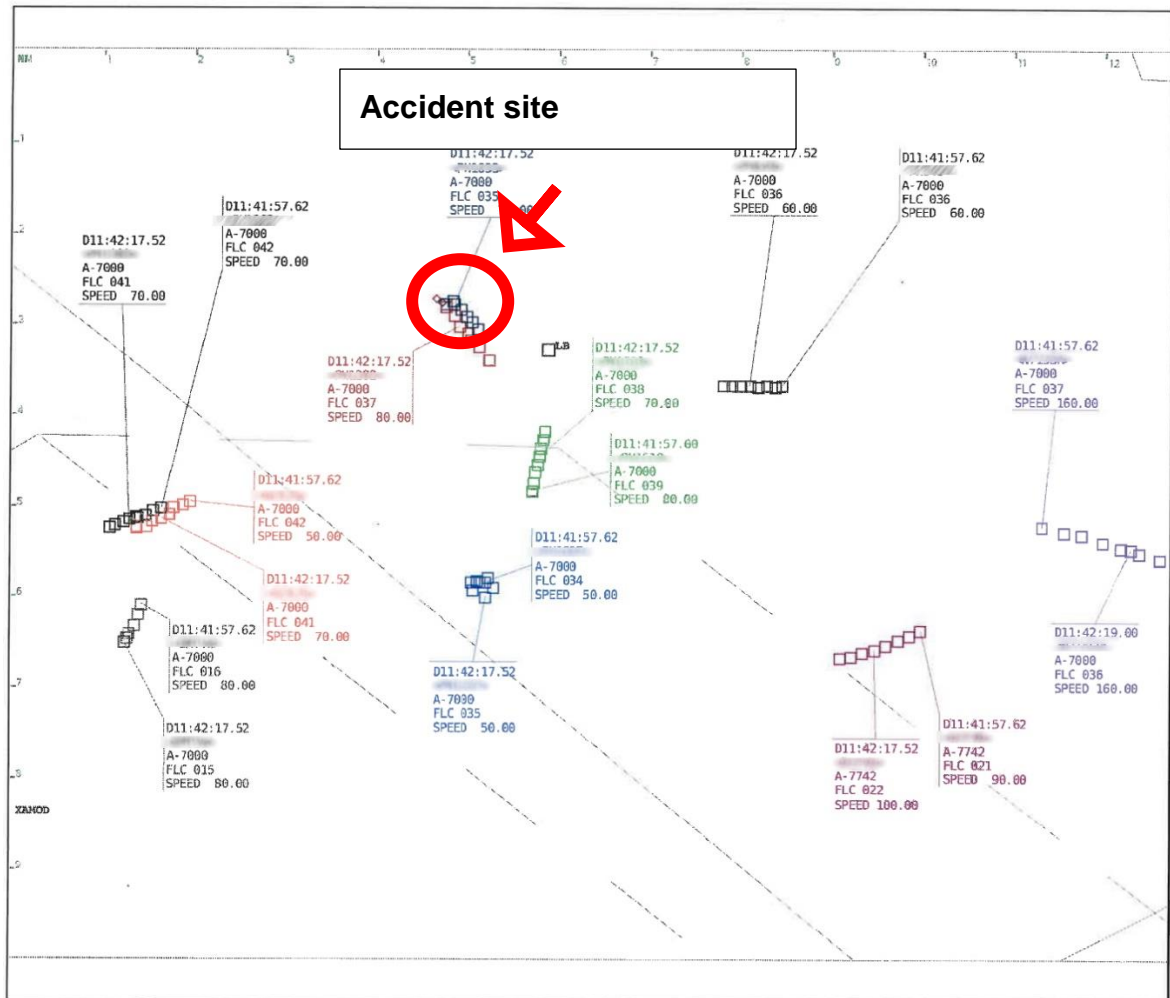


Fig. 6: Radar data of the area of the accident (at about 1342 hrs)

(Note: The aircraft markings were edited with a blur filter)

Source: Air navigation service provider, adaptation BFU

In Figure 6 the primary targets without transponder signal, e. g. gliders or ultralights, which are only equipped with FLARM, are not depicted. The BFU had available five FLARM data sets of gliders which were not equipped with a transponder or whose transponder had not been switched on. Therefore, the actual number of aircraft in the vicinity of the accident site was significantly higher as depicted in Figure 6.

Based on FLARM and radar data, the flight path of the LS4-b could be determined. The flight path of the DG-3300 was reconstructed based on radar data only. For comparisons reasons, Figure 1 shows only radar data.

## Wreckage and Impact Information

The collision of both gliders occurred about 2 km north-west of Borkenberge Airfield at 1,100 m AGL.

The wreckage of the DG-300 was lying on a road about 128 m north-east of the LS4-b lying in a forest (Fig. 7 and 8).



Fig. 7: Accident site DG-300

Source: BFU



Fig. 8: Accident site LS4-b in the forest

Source: BFU

## Findings on the DG-300

The pilot was found in the cockpit with the seat belt fastened but fatally injured.

The cabin area was destroyed. The canopy was lying about 250 m east of the wreckage on the roof of a farm. The canopy's latch was closed. On the fuselage side, the canopy's hinge had been bent up on the mounting bolts.

The right wing had fractured and was lying about 110 m south-south-east of the main wreckage's point of impact in a forest.

Fuselage and left wing had fractured in several places. The elevator had fractured. The fuselage's lower surface, in the area of the wheel well and the cockpit, showed traces of the collision. Blue and red paint transfer marks, which could be assigned to the LS4-b, were found in the landing gear area (Fig. 9). The lower surface of the fractured right wing showed paint transfer marks which corresponded with the elevator of the LS4-b.



Fig. 9: Collision traces at the DG-300 fuselage and the LS4-b

Source: BFU

The connections of the control surfaces and control elements could be traced to the fracture points.



Fig. 10: Corrosion on the control rods and the bearing blocks in the wing of the DG-300

Source: BFU

The technical examination of the wreckage on site determined that the control rods and bearing blocks in the wings were corroded (Fig. 10).

The DG-300 canopy was found about 300 m east of the wreckage on a roof top.

### Examination of the Canopy

The manufacturer was asked to help with the assessment of the canopy damage. They came to the following conclusions:

*According to the flight manual "Canopy jettison/Bail out" the canopy opening lever (red flip lever) and the emergency release knob (red ball) both have to be actuated.*

*According to your photo with the torn-out hook, it has to be assumed that the canopy opening lever (red flip lever) was not actuated.*

*In combination with the photos of the damage on the hinge, it has to be assumed that the canopy was not manually separated by the pilot in flight, but flew off due to mechanical force.*

### Findings on the LS4-b

The LS4-b was lying inverted between trees on the ground. The fuselage had fractured behind the cockpit and prior to the tail boom. The elevator had fractured. The right wing had fractured at the spar and been severed from the fuselage. Both wings were connected in the spar bridge.

The canopy frame was lying on top of the fuselage. At the impact site, no plexiglass parts of the canopy were found.

The connections of control surfaces and control elements were intact. No technical defects were found in the aircraft controls.

Paint abrasions of the blue type lettering at the left fuselage side of the LS4-b corresponded with the paint transfer marks on the lower fuselage of the DG-300 (Fig. 9). The red paint transfer marks on the DG-300 corresponded with the paint abrasions on the canopy lock of the LS4-b. The leading edge of the right elevator of the LS4-b showed green paint transfer marks which corresponded with the damage on the right wing of the DG-300. The left wing showed paint transfer marks of the DG-300's elevator (Fig. 11).



Fig. 11: Collision traces on the wing of the LS4-b and on the elevator of the DG-300

Source: BFU

## Medical and Pathological Information

A post-mortem examination was performed on the bodies of both pilots. Cause of death of both pilots was polytrauma.

There were no indications of pre-existing physical or psychological impairments.

## Survival Aspects

The LS4-b pilot was found without a parachute outside the wreckage. The harness of the emergency parachute was found with an open leg harness, i. e. it was not closed and separated in freefall. The emergency parachute was complete and did not show any signs of having been triggered.

The DG-300 pilot could not jettison the canopy and exit the glider with the emergency parachute.

## Additional Information

### Urinating during the Flight

According to witness' statements, the LS4-b pilot had the habit to open the leg harness of his emergency parachute in order to being able to urinate into a respective bag or other receptacle.

In order to verify the statement, whether the buckle of the harness has to be opened to urinate, the BFU conducted tests with a LS4-b (Fig. 12). It was determined that opening the buckle was not absolutely necessary to being able to open the pants to urinate.



Fig. 12: BFU test with a LS4-b

Source: BFU

Some articles in gliding forums focus on the topic of bladder management. To prevent dehydration, a pilot should drink enough during cross country gliding. The problem with the filling bladder and when the best time is to urinate is described in the article<sup>4</sup>: “Urinating during cross country gliding - 6 methods”: [...] In a glider the best time to urinate is when you do not need your full attention to fly. For example, while flying from thermal to thermal, crossing a valley, etc. [...]

## Emergency Exit from Gliders

The Flight Safety Office of the German Aero Club (DAeC) focused on the topic emergency exit from gliders: “Emergency Exit a problem? Cable and wires in the cockpit” (Flight Safety Information 09/04) and with the suggestion to change the airworthiness review certificate requirements for gliders and powered gliders JAR-22 “Emergency Exit from Gliders - Emergency jettison of the canopy working paper - Amendment 11/06”. In it a research project of the Luftfahrt-Bundesamt (LBA) from May 1991 is referenced: “Emergency jettison of the canopy of gliders”

*[...] A mid-air collision comes usually totally unexpected for a pilot. Initially, disbelief and shock prevail. The pilot needs some time to overcome the shock, to recognise the situation and to make the decision to exit. He is subject to the temptation to give in to the situation. After the decision to exit is made, the pilot*

<sup>4</sup> [https://www.milvus.aero/pinkeln\\_im\\_segelflugzeug/](https://www.milvus.aero/pinkeln_im_segelflugzeug/) /

*attempts to jettison the canopy as quickly as possible without realising the necessary process to jettison the canopy for the flown type. Often, pilots have not made themselves familiar with the emergency procedure to jettison the canopy. Due to the high sink rate after the accident, the pilot often has only a few seconds to jettison the canopy, to exit and trigger the parachute. It must be considered that about 100 m are required to open the parachute and decrease the drop rate. Everything must be done very quickly. Each second gained increases the probability of a safe rescue.*

*Given this background, the question had to be clarified to what extent the pilots were familiar with the emergency canopy jettison systems of their flown types. To determine the general level of knowledge, the pilots were presented with a questionnaire. The analysis determined that 67% of the pilots could not name the correct lever to be used depending on the type! Most pilots have an unclear perception as to how the canopy separates from the airplane during an emergency. Many are of the opinion that their type has a mechanism which uplifts the canopy at the front after unlocking and there is nothing further for the pilot to do to jettison the canopy. [...]*

## Accidents with Parachutes with open Harnesses

Publications of the Deutsche Gleitschirm- und Drachenflugverband e. V. (DHV) show that accidents where the leg harness was not closed or incorrectly guided resulted in several fatal drops. Tests showed that falling out of the harness was very easy.



Fig. 13: DHV Safety Information Open Harness, 2006

Source: DHV

## Aeronautical Regulations

The Standardised European Rules of the Air (SERA), valid at the time of the accident, defined the regulations and specifications concerning collision avoidance and right of way.

### *SERA.3205 Proximity*

*An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard.*

### *SERA.3210 Right-of-way*

- (a) The aircraft that has the right-of-way shall maintain its heading and speed.*
- (b) An aircraft that is aware that the manoeuvrability of another aircraft is impaired shall give way to that aircraft.*
- (c) An aircraft that is obliged by the following rules to keep out of the way of another shall avoid passing over, under or in front of the other, unless it passes well clear and takes into account the effect of aircraft wake turbulence.*
  - 1. Approaching head-on. When two aircraft are approaching head-on or approximately so and there is danger of collision, each shall alter its heading to the right.*

2. *Converging. When two aircraft are converging at approximately the same level, the aircraft that has the other on its right shall give way, except as follows.[...]*

3. *Overtaking. An overtaking aircraft is an aircraft that approaches another from the rear on a line forming an angle of less than 70 degrees with the plane of symmetry of the latter, i.e. is in such a position with reference to the other aircraft that at night it should be unable to see either of the aircraft's left (port) or right (starboard) navigation lights. An aircraft that is being overtaken has the right-of-way and the overtaking aircraft, whether climbing, descending or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.*

*(I) Sailplanes overtaking. A sailplane overtaking another sailplane may alter its course to the right or to the left. [...]*

## Collision Avoidance with the See and Avoid Principle

All rules of the air are based on the principle: See and Avoid. This requires that air traffic participants see each other and act accordingly. Studies show numerous factors which affect mutual See and Avoid.

In 2017, the BFU published the Study Concerning Airproxes and Collisions of Aircraft in German Air Space 2010 - 2015 (BFU 803.1-17)<sup>5</sup>. Among other things, the study concludes that the consistent use of technical means already available (transponder and ADS-B signals) would decrease the collision risk in airspaces where IFR traffic and uncontrolled VFR traffic occur at the same time.

*The project “Erkennbarkeit von Segelflugzeugen und kleinen motorisierten Luftfahrzeugen“ (Recognisability of gliders and small motorised aircraft, BEKLAS, 2004)” by order of the Ministry for Transport, Building and Urban Affairs has extensively looked into the subject of detecting gliders and small powered aircraft. (BFU19-1124-5X)*

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<sup>5</sup> [https://www.bfu-web.de/DE/Publikationen/Statistiken/Tabellen-Studien/Tab2017/Studie\\_AIRPROX\\_2017.pdf?\\_\\_blob=publicationFile](https://www.bfu-web.de/DE/Publikationen/Statistiken/Tabellen-Studien/Tab2017/Studie_AIRPROX_2017.pdf?__blob=publicationFile)

EASA addressed the topic collision avoidance in General Aviation with different publications, e. g. EGAST Leaflet<sup>6</sup> „Collision Avoidance GA 1 methods to reduce the risk Safety promotion leaflet/JAN 2010“.

In this publication, systems which could help reduce the collision risk are addressed. The chapter Methods to reduce the risk - Operational techniques highlights:

*3 examples of onboard equipment increasing pilot situation awareness [...]  
There are likely to be many other aircraft in the sky without appropriate transmitters, so it is vital to continue to scan visually, [...].*

The Australian Transport Safety Bureau (ATSB) and the United States Department of Transportation / Federal Aviation Administration (FAA) published studies concerning collision risks. The FFA published their results as Advisory Circulars (AC).

One of the FAA studies (Advisory Circular AC No 90-48D<sup>7</sup>) stated 12.5 seconds as reaction time during a collision (Fig. 12)

*Attention and Response to Traffic Movement.*

*The pilot's responsibility is to fly the aircraft safely. All other duties should be secondary while flying. Pilots should remain constantly alert to all traffic movement within their field of vision, as well as periodically scanning the entire visual field outside of their aircraft to ensure detection of conflicting traffic. Remember that the performance capabilities of many aircraft, in both speed and rates of climb/descent, result in high closure rates limiting the time available for detection, decision, and evasive action. Research has shown that the average person has a reaction time of 12.5 seconds. This means that a small or high-speed object could pose a serious threat if some other means of detection other than see and avoid were not utilized, as it would take too long to react to avoid a collision. This is particularly important with small Unmanned Aircraft Systems (sUAS).*

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<sup>6</sup> [https://www.easa.europa.eu/sites/default/files/dfu/EGAST\\_Leaflet\\_Collision-Avoidance.pdf](https://www.easa.europa.eu/sites/default/files/dfu/EGAST_Leaflet_Collision-Avoidance.pdf)

<sup>7</sup> [https://www.faa.gov/documentlibrary/media/advisory\\_circular/ac\\_90-48d\\_chg\\_1.pdf](https://www.faa.gov/documentlibrary/media/advisory_circular/ac_90-48d_chg_1.pdf)

**Table 1. Aircraft Identification and Reaction Time Chart**

Event	Seconds
See Object	0.1
Recognize Aircraft	1.0
Become Aware of Collision Course	5.0
Decision to Turn Left or Right	4.0
Muscular Reaction	0.4
Aircraft Lag Time	2.0
<b>TOTAL</b>	<b>12.5</b>

Tab. 1: Reaction time

Source: FAA AC No 90-48D

The brochure “Safety during mountain gliding - Recommendations for behaviour and training, edition 1.0d, December 2011” of the National Gliding Centre St.-Auban (Centre National de Vol à Voile, CNVV) addressed the reaction time and the distance required to give way. Contrary to the study of the FAA, the study was based on a slightly higher reaction time.

Table of the CNVV

*For approximations*

*Mean reaction time of the pilot = 1.5 s*

*Reaction time of the airplane = 1.5 s*

**Total = 3.0 s**

*At an airspeed of 90 km/h (25 m/s). Distance covered prior to the avoidance manoeuvre:*

*Own airplane 3 x 25 = 75 m*

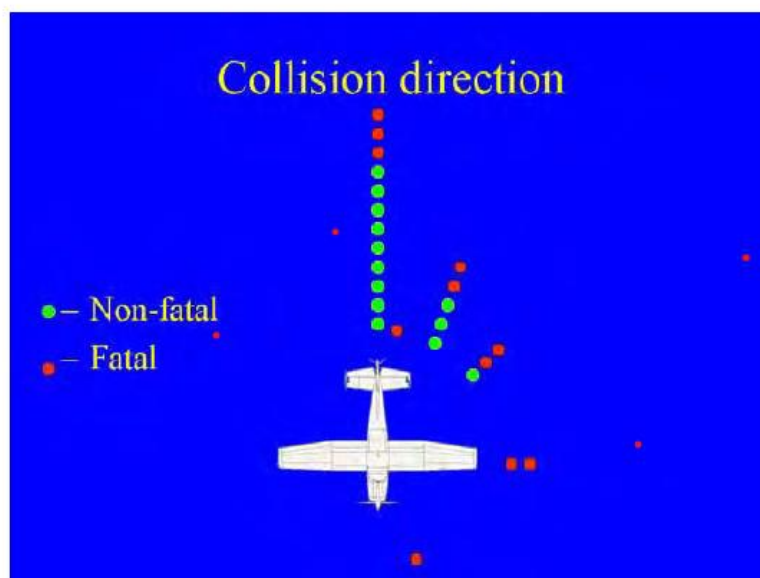
*Other airplane 3 x 25 = 75 m*

*Minimum distance for reaction = 150 m*

*At 110 km/h = 185 m*

The ATSB study RESEARCH REPORT B2003/0114, Publication date 22/05/2004<sup>8</sup>, lists high workload and line-of-sight obstructions for one or both pilots as contributing factors. The study shows that most collisions, where both aircraft approach one another from the same or similar direction (less than 30°), occur from behind (Fig. 13).

**Figure 2: Diagrammatic representation of collision angles involved in collisions not involving deliberately close flying activities**



The diagram does not include collisions with gliders, or collisions where aircraft were flying deliberately close.

Fig. 13: ATSB study with the distribution of the collision direction

Source: ATSB

In the publication *Study to address the detection and recognition of light aircraft in the current and future ATM environment* (Issue 1.0 Final, 2005), Eurocontrol recommends the use of ADS-B devices with Mode-S 1090 Extended Squitter.

In General Aviation, solutions are increasingly used which combine Mode-S, ADS-B (Automatic Dependent Surveillance Broadcast) and FLARM in one device.

## Collision Warning Systems

The present technological progress and the increasing automation in aviation (e. g. Electronic Flight Display (EFD), Multi Function Display (MFD) with GPS, traffic and

<sup>8</sup> [https://www.atsb.gov.au/media/36828/Review\\_of\\_midair\\_col.pdf](https://www.atsb.gov.au/media/36828/Review_of_midair_col.pdf)

terrain indication, autopilot or warning systems, etc.) changed/improved significantly the way information is indicated and which kind is available to the pilot. As the FAA (2013)<sup>9</sup> Pilot's Handbook of Aeronautical Knowledge, Chapter 2 Aeronautical Decision-Making described, these systems may tempt the pilot to rely too heavily on such assistance. More and more pilots rely on electronic data bases for their flight planning and use automated flight planning tools instead of planning the flight with traditional means, where they use maps, draw the course, determine navigation points and use the flight manual to determined weight and performance charts. Nevertheless, it is up to each pilot to maintain his/her basic flying skills, to use them often to ensure the mastery of all tasks. Even though automation has made flying safer, automated systems may make some errors clearer, hide or make others less clear. Thus, concern regarding the effect of automation on pilots increases more and more. Commercial air transport provided findings that dependence on automation may result in a decrease in flying skills and therefore may interfere with the handling of system failures or other unexpected emergencies. The following is an excerpt of the FAA (2013)<sup>10</sup> Pilot's Handbook of Aeronautical Knowledge:

#### *Enhanced Situational Awareness*

*An advanced avionics aircraft offers increased safety with enhanced situational awareness. Although aircraft flight manuals (AFM) explicitly prohibit using the moving map, topography, terrain awareness, traffic, and weather datalink displays as the primary data source, these tools nonetheless give the pilot unprecedented information for enhanced situational awareness. Without a well-planned information management strategy, these tools also make it easy for an unwary pilot to slide into the complacent role of passenger in command.*

#### **FLARM**

Due to a missing update, the FLARM of the DG-300 was not functional. With proper use, FLARM provides useful assistance for collision avoidance. Warning the pilot of possible collisions is its function. This only works if both gliders involved in a possible conflict situation are equipped with a functioning system. Because FLARM devices are not installed in all gliders, there is a probability that warning is not given about all the aircraft flying in the vicinity.

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<sup>9</sup> FAA (2016). Pilot's Handbook of Aeronautical Knowledge. Chapter 2 Aeronautical Decision-Making.  
[https://www.faa.gov/regulations\\_policies/handbooks\\_manuals/aviation/phak/media/04\\_phak\\_ch2.pdf](https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/04_phak_ch2.pdf)

<sup>10</sup> FAA (2016). Pilot's Handbook of Aeronautical Knowledge. Chapter 2 Aeronautical Decision-Making.  
[https://www.faa.gov/regulations\\_policies/handbooks\\_manuals/aviation/phak/media/04\\_phak\\_ch2.pdf](https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/04_phak_ch2.pdf)

When FLARM is used, it is mandatory to perform firmware updates. The manufacturer's handbook included respective notes:

*Operations manual FLARM Collision Warning System<sup>11</sup> Version 278, chapter 13 Operating Limitations*

*FLARM is a non-essential "situation awareness only" device designed to assist the pilot and is not always able to warn reliably. Using FLARM does not allow under any circumstances to change flight tactics or change of conduct of the user and commander. Even if you have installed FLARM you are still responsible for flying and liable for the safety of all passengers and other airplanes. Using FLARM is the sole responsibility of the user and commander [...]*

*[...] FLARM can only warn about airplanes which are equipped with FLARM or a compatible device [...] FLARM does not communicate with transponder Mode A/C/S and therefore is not picked up by ACAS/TCAS/TPAS or air navigation services. FLARM does also not communicate with TIS-B, FIS-B and ADS-B. [...]*

Besides the FLARM devices of the first generation there is the product line Power-FLARM. These can receive transponder codes (Mode S) and ADS-B traffic reports.

On 15 September 2020, FLARM Technology published "Instruction for continued airworthiness / FTD-073". It included detailed instructions regarding maintenance of aircraft with installed FLARM devices:

#### *Scope and summary*

*This Instructions for Continued Airworthiness (ICA) is intended to be used by entities responsible for the continuing airworthiness of aircraft with a FLARM system installed. It is also intended to be used by owners of portable FLARM devices.*

*This document is general in scope and is applicable to all FLARM installations and devices listed herein.*

*FLARM, as all radio equipment, requires considerate care and maintenance for continued high performance. Failure to comply with this ICA may lead to the FLARM system deteriorating in performance or becoming inoperable.*

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<sup>11</sup> Classic FLARM (first generation)

## Analysis

### General

At the time of the accident, the aircraft had a valid certificate of registration.

The damage determined during the examination of the wreckage did not indicate any pre-existing defects which contributed to the accident.

The corrosion of the control rods and bearing blocks in the wings of the DG-300 did not result in an impairment of the controls.

Both pilots held the necessary licenses and ratings required to conduct the flight.

There were no indications of health impairments of the pilots.

Visual meteorological conditions prevailed and the sun was almost at the back of the pilots. Therefore, meteorological conditions can be ruled out as contributing factors.

### Collision Warning System

Both aircraft were equipped with the collision warning system FLARM. This system is not listed in the minimum equipment list for gliders and is purely optional. The collision warning system of the LS4-b recorded flight path data and sent other data to other collision warning systems. The collision warning system of the DG-300 was proven to be without function because a firmware update had not been performed. Therefore, none of the pilots had been warned of the impending dangerous airprox by FLARM.

It could not be determined to what extent the two pilots had relied on the proper function and warning. Commercial air transport showed that certain handling problems and familiarisation effects and overreliance on automation exist.<sup>1213</sup>

Even though the DG-300 FLARM should have indicated during activation that it was not functioning, the pilot decided to conduct the flight. He thus consciously accepted the non-availability of one safety barrier for himself and others which could have been useful to assess the situation and conduct the flight. However, it is probable that during the flight he had become less and less aware of the missing assistance and perhaps even neglected the problem altogether in the end.

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<sup>12</sup> <https://skybrary.aero/articles/operational-use-flight-path-management-systems> © SKYbrary Aviation Safety, 2021-2022.

<sup>13</sup> <https://skybrary.aero/articles/cockpit-automation-advantages-and-safety-challenges> © SKYbrary Aviation Safety, 2021-2022.

The DG-300 was not indicated as conflicting traffic on the LS4-b display, however, other FLARM targets were displayed. It could not be clarified, to what extent the LS4-b pilot was aware that only aircraft with a functioning FLARM-system are indicated in the display and others not.

Thus, both pilots depended on the principle See and Avoid, which failed. It is probable that the LS4-b pilot relied on the FLARM system without realising that there might be other traffic without FLARM in the vicinity.

## Course of the Flight

The radar and FLARM data showed that both gliders had been on almost the same heading and laterally misaligned approached a growing cumulus cloud. Shortly before the collision, speed was turned into altitude and the DG-300 turned left. The rules of the air in accordance with SERA 3210, valid at the time of the accident, stipulated that the LS4-b should have given the DG-300 the right of way. This would only have been possible had the LS4-b pilot been able to see the other aircraft. Since the DG-300 had initially been about 80 m lower the line of sight to the DG-300 had been severely limited (Fig. 2). The BFU is of the opinion that the other glider could not be seen until shortly before the collision. None of the pilots was able to realise the airprox (in time), to assess it and initiate an avoidance manoeuvre.

## Survival of the Collision

### LS4-b Pilot

Pilot and emergency parachute were found outside the wreckage. The spatial separation of pilot, emergency parachute and glider wreckage indicate leaving the cockpit shortly after the collision. It is highly likely that the pilot had slipped out of the harness shortly after leaving the cockpit. Since the parachute's activation handle had not been activated this must have happened immediately after leaving the glider.

It could not be clarified as to why the leg harness had been open. Presumably, the pilot had opened them so that he could urinate during the flight. Since the buckle of the seat harness was open, the BFU assumes that the pilot left the glider on his own.

## DG-300 Pilot

The pilot was found in the wreckage wearing an emergency parachute. Even though the canopy was found east of the wreckage, the manufacturer assumes that the pilot did not consciously open it but that it separated due to the collision. It was not possible to determine the exact reasons why the pilot did not exit the glider. However, suffering from shock or insufficient knowledge about jettison the canopy could have been a contributory factor. It cannot be ruled out that the pilot had been incapacitated due to the collision.

## Conclusions

The collision of the two gliders occurred because the two pilots could not see the respective other glider and therefore could not initiate an avoidance manoeuvre.

### Contributing Factors

- Non-functioning collision warning system of the DG-300
- The harness of the LS4-b pilot's emergency parachute was not closed properly probably in combination with or as a result of distraction when using a urinal.

## Safety Recommendations

The BFU will not issue any safety recommendations concerning the topic of collision warning systems in General Aviation because there are already ones of other national safety investigation authorities.

### Austria

2016

SE/UUB/LF/3/2016

*Ensuring the operability of collision warning systems: Stipulating appropriate measures which ensure that installed collision warning systems function in accordance with regulations. Especially, that correct and for other collision warning systems usable data is broadcast and also is received.*

### Italy

ANSV-8/68-19/6/A/21

*Both aircraft involved in the in-flight collision, although operating in isolated mountainous areas and in class "G" class airspace, where often no flight assistance/information is available, were not equipped with on-board collision avoidance systems or systems designed to detect the proximity of other aircraft. In the type of flight conducted by the two aircraft on the accident day, the principle of "see and avoid", as well as the execution self-information radio calls on the expected frequency represent safety nets sometimes insufficient to prevent in-flight collisions. A further "barrier" against possible in-flight collisions between aircraft operating under VFR could be the presence on board of systems capable of detecting the presence of other aircraft not acquired visually or through radio communications: in this respect, systems based on GPS receivers capable of calculating and transmitting the future position of the aircraft to other nearby aircraft equipped with similar systems have been available for years, preventing the risk of possible collisions by sending alert messages to the respective crews, who thus become aware of the position of the other aircraft with respect to their own position. More advanced versions of such systems also provide for the integration of an ADS-B receiver and transponder, which allows visibility on a greater number of aircraft among those that present a position and flight path with a risk of collision.*

*The ANSV recommends to evaluate the feasibility to install on board of aircraft operating under VFR in class "G" airspace, as mandatory equipment, anti-collision systems or systems designed to detect the proximity of other aircraft.*

## Slovenia

SKA2016001

*AMIA recommends that: Slovak National Aeroclub : At regular winter trainings to analyse the accident with aviation personnel, with stress on compliance with procedures and priority rules in drawing into position, circling, abandonment of uplift currents and avoiding during flight.*

*Transport Authority of SR: When issuing a decision – permit for organisation of public aviation event (“glider competition”) to recommend the organiser in case of planned increased air traffic to require the use of device FLARM (Traffic and Collision Warning for General Aviation – visual and acoustic warning of approaching aircraft) displaying close traffic.*

## Switzerland

499

*In collaboration with the stakeholders and the European Aviation Safety Agency (EASA), the Federal Office of Civil Aviation (FOCA) should develop a concept for introducing compatible collision warning systems for general aviation that are based on international civil aviation standards as well as create and enact a plan of action for short-term, medium-term and long-term implementation.*

500

*The Federal Office of Civil Aviation (FOCA) should initiate the development of a technical procedure that allows the functionality of Flarm collision alert systems to be assessed on the ground.*

## Poland

1033/11

*1. Familiarise all the glider pilots of Polish Aeroclub with the circumstances of the occurrence. Pay special attention to the rules of entering thermals, behaviour in thermals and exiting thermals, especially during competitions when, at the same time, there are many gliders present in relatively small air space. 2. Consider introducing a*

*requirement to use FLARM anti-collision devices, similar to TCAS used in air transport, during gliding competitions.*

#### Safety Actions

FLARM technology stated during the course of commenting that they are working on a method which allows expired software to continue functioning. At the same time, the radio network should not be degraded due to lack of compatibility, while the ability to innovate the network should be largely preserved.

Investigator in charge: Knoll

Field Investigation: Maser, Knoll

Assistance: Schubert, Dr. Winkler

Braunschweig, 27 October 2023

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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