

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	6 October 2010
Location:	Gotzenalm close to Schönau am Königssee
Aircraft:	Helicopter
Manufacturer / Model:	Eurocopter France / AS 350 B3
Injuries to Persons:	Pilot slightly injured
Damage:	Aircraft severely damaged
Other Damage:	Minor crop damage
Information Source:	Investigation by BFU
State File Number:	BFU CX012-10

Factual Information

History of the Flight

On the day of the accident, the pilot conducted several transport flights with a helicopter AS 350 B3 and external loads. During the last flight, a tree trunk, about 20 m long, had to be transported approximately 500 m to the Gotzenalm close to Schönau am Königssee.

One of the operator's ground assistants prepared the tree trunk for the transport. The trunk was fastened with a lifting strap in the form of a loop which was hooked into the external load rope which in turn hung on a shock absorber which itself was hooked into the helicopter's cargo hook (Appendix 1).

According to the pilot's statement, he flew slowly to the intended place of deposit after he had picked up the load. At about 1210 hrs¹ shortly before the place of deposit was reached, inexplicable vibrations occurred in the helicopter. Because he could no longer see the external load in his mirrors, he disengaged the external load immediately. The vibrations increased, however, and the helicopter began to yaw towards the left. The pilot tried to stop the rotation by decreasing power and increasing speed. The helicopter crashed rotating and rolled over.

A witness standing close to the huts at the Gotzenalm saw the helicopter with its external load slowly approaching. He observed the tree trunk having ground contact for two or three times before there was a loud bang and the tree trunk hit the ground. He then saw the tail flapping upward and the helicopter began to rotate and a little while later it crashed.

A short video sequence shows a bent tail shortly before the crash.

After the impact, the pilot shut down the engine, closed the engine fuel shut off valve and cut off the power supply. He was slightly injured but could leave the helicopter unaided.

Personnel Information

The 48-year old pilot held a Commercial Helicopter Pilot's License issued according to JAR-FCL 2 and valid until 13 October 2014. The license contained the valid type ratings as pilot in command for AS350/350B3, Bell 206/206L, HU369/MD500N/600 and HU269. Since 23 April 2010, the pilot held an aerial spraying and dusting permit. He furthermore held an Austrian Commercial Pilot's License and had completed mountain flight training. He held a class 1 medical certificate without restrictions issued according to JAR-FCL 3; it was valid until 20 April 2011.

He had a total flying experience of about 944 hours; 500 of which were on the type in question. In the last 90 days, he had flown 102 hours and had conducted 285 landings. He had a flying experience with external loads of about 150 hours.

¹ All times local, unless otherwise stated

He wore a helmet during the flight.

Aircraft Information

The single engine helicopter manufactured by Eurocopter France is a lightweight multi-purpose helicopter for up to seven occupants. It was certified according to FAR/JAR Part 27 in 1997. It is equipped with Turbomeca Arriel 2B1 engine, a three-blade main rotor, landing skids and a tail rotor for anti-torque. Maximum weight is 2,250 kg; 2,800 kg with external load.

The helicopter was built in 2007 and had the manufacturer's serial number 4364. The empty weight was about 1,277 kg. The last annual inspection was conducted on 9 March 2010; about 211 operating hours before. At the time of the accident, the helicopter had a total of 838 operating hours. The helicopter was registered in Austria and the operator was also Austrian.

According to the calculations of the operator and given the atmospheric data, the altitude, the weight of the pilot and the fuel on board, about 1,105 kg transport capacity were available. The helicopter's manufacturer confirmed these calculations.

The helicopter was equipped with a cargo hook for external loads and a set of mirrors.

The load handling device used came from a specialist company. It consisted of several parts: One shock absorber which was directly hooked into the helicopter's cargo hook, one 10 m x 16 mm Textile-Dyneema-Core-Cover rope, a line load element, a coupling, a low-torque swivel with a lifting strap (EN 1492-1, Length 5 m) to fasten the tree trunk. The total weight of the load handling device was about 30 kg (Appendix 1). According to the manufacturer's instructions manual for the use and maintenance of this load handling device (Edition 20 October 2010) a safety factor of seven was used which corresponds with Directive 2006/42/EC on machinery. Logging, i.e. transportation of tree trunks, is not permitted with this device.

The lifting rope was manufactured in 2006 and the manufacturer had given it a service life until 2012. Until the accident, it had been in service for 250 – 300 hours with about six load cycles per hour.

Meteorological Information

Witnesses described the weather as follows:

Light, variable wind with 3 – 5 kt, clear skies with a visibility of more than 8 km. The temperature was about 12°C and air pressure (QNH) 1,022 hPa. High fog and stratus clouds prevailed in the valleys.

Flight Recorders

The helicopter was not equipped with a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR). There were no legal requirements for such equipment to be fitted.

The Vehicle & Engine Multifunction Display (VEMD) in the helicopter records operating hours, engine start cycles and error messages; during an engine test it also records exceedance of threshold values and performance data.

The manufacturer of the VEMD read out the data and determined that the last flight was recorded with the number 1625. Flight time was about seven minutes. Thereby, six error messages were recorded. The first one after 6 minutes 30 seconds: error in the Collective-Pitch-Potentiometer (XPC). According to the manufacturer, such an error message is caused by a structural deformation of the helicopter and points to the beginning of the accident sequence on the ground. All further error messages occurred later.

Wreckage and Impact Information

The accident site was on the Gotzenalm in approximately 5,540 ft AMSL, on a very bumpy meadow with deep dips. One impact point of the tree trunk with the ground was on the edge of one of these bumps (Appendix 2 and 4). When viewed from the flight approach direction, the terrain declined.

The helicopter lay on the right fuselage side. The tail boom had been severed. The three main rotor blades were destroyed, the main gear box was torn out of its mounting, the engine cowling was torn off and the engine severely damaged. The tail rotor drive shaft was torn in several places. The tail rotor gear box could be rotated by hand. Except for a small piece on the trailing edge, the tail rotor did not show any damage. There was no fuel leakage at the accident site. About 150 l fuel was removed from the tank.

During the field investigation no indications for a technical defect of the helicopter were found.

The external load was found about 110 m from the wreck.

The load handling device was torn into several parts. The lifting strap to fasten the tree trunk including coupling, low-torque swivel, line load element and the lower part of the lifting rope with a length of about 0.9 m including the cargo hook were still attached to the tree trunk. The shock absorber including about 0.9 m of textile rope were found approximately 67 m north of the tree trunk. About 5 m north of the wreck, an 8.20 m long piece of the rope was found (Appendix 1, 2 and 3).

Medical and Pathological Information

There was no indication of any physiological or health problems on the part of the pilot.

Fire

There was no fire.

Tests and Research

The external load suspension was examined by the Wehrwissenschaftliches Institut für Werk- und Betriebsstoffe (WIWeB). The institute came to the following conclusion:

Based on the identified marks and other data presented, it can be assumed that the fracture of the suspension rope was caused by overload due to impact stress during the transportation of the tree trunk. No indications for a manufacturing defect or a pre-damage (e.g. cutting, abrasion or crushing) of the rope were found. Both fractures were found in the transition area of splice and free rope. For this rope construction, this area is to be viewed as typical point of rupture by overload. The fracture occurred at this point of rupture in the quasi-static tension test also. [...]

Due to an overload breakage in the area of the splice at the lower part of the rope, the rope shot upward. Thereby it had contact with the tail boom fin and the main rotor. [...]

The analysed marks allow the conclusion that the first rupture of the rope was caused by a sudden stress due to the impact of the external load with the ground. This is also confirmed by melting marks on the absorber which were found in the area of the fittings. Such massive melt down traces do not occur in normal operation. By longer use one can find abrasions on the rope cover at most.

The operator of the helicopter made another similar external load rope available. The University Stuttgart, Institut für Fördertechnik und Logistik conducted another tension test. The institute came to the following conclusion:

The test sample showed a maximum tensile load of 64.43 kN, the place of rupture was found in the transition area of the splice zone. Therefore, the maximum tension exceeded the allowed Working Load Limit (WLL) by the factor 4.6 (460%). The rupture characteristics of the test sample were classified as typical for this kind of rope construction. [...]

The operator stated that the rope provided for the test had been used approximately half as often as the rope which ruptured.

In the scope of further examinations, it was attempted to estimate possibly occurring load peaks in an external load suspension by use of physical approximation calculations. This was done in the scope of a Two-Mass-Model and under consideration of energy conservation and energy difference, respectively, before and after the external load's impact with the ground. Thereby it was determined that great load peaks can occur which can exceed the allowed WLL (14 kN) of the external load rope and even exceed the breaking load of the rope provided for the test (64.43 kN).

Organisations and their Procedures

The operator, registered in Austria, and its subsidiary, an operator registered in Germany by the Luftfahrt-Bundesamt (LBA) according to JAR-OPS 3, were specialised for external load flights in mountains. For those working flights in mountains, they had a low level flight permit.

The Flight Operations Manual, Part A, Appendix, Chapter 2 – Transportation of suspended external loads – Item 2.5.3 requires: *As a basic principal, at all take-off and landing sites radio communication (Two-Way Communication) between pilot and ground assistant must be established, to ensure that the pilot will be informed about all information relevant for a safe conduct of the assignment. [...]*

Directive 2006/42/EG on machinery describes the requirements of load handling devices. According to Directive 2006/42/EG Item 4.1.2.5 textile ropes for load pick up should have an operating coefficient of no less than seven during the entire service life. According to the EASA Certification Specification small Rotorcraft CS-27 Item CS 27.865 „External loads“ requires that a load handling device can resist 2.5 times

the value of a static load and according to CS 27.303 an additional safety factor of 1.5 is to be guaranteed.

The transportation of tree trunks (Logging) is in Germany a rather rare use of helicopters, but in countries with difficult to access woods it is a well-established practice.

Additional Information

Already before the accident occurred, the manufacturer of the external load suspension had reduced the service life of the textile ropes from six to four years. This action was published on the Internet in the manufacturer's instructions manual for use and maintenance (Edition C 2010-07-01). Since 2009 all customers had gradually been contacted by mail asking them to replace their ropes by newer and stronger ones. The operator involved was contacted and informed by mail on 20 October 2010.

In Germany in 2006 and 2008, the Berufsgenossenschaft für Transport und Verkehrswirtschaft has conducted tests series regarding the suitability of external load suspensions and their rebound behaviour. Thereby, a test was conducted with a similar 16 mm chemical-fibre core-cover rope. It was determined that with twice the load factor of the rope's bearing strength, the rope shot upward by 100% of its length. As a consequence from the test series it was recommended, among other things, that shock absorbers should not be used with short load suspensions because they could influence the rebound behaviour of load suspensions.

During transports of external loads with helicopters, fatal accidents have occurred in the past. In 2003 the BFU has issued the following safety recommendation:

Recommendation no.: 18/2003:

The Ministry for Transport, Building and Urban Affairs (BMVBW) should establish the legal requirements for licensing and inspection requirements of aircraft external load suspensions.

This safety recommendation was not implemented.

Analysis

The pilot held the required licenses and ratings. Based on his total flying experience and type experience he was qualified to conduct the working flight. His training level was good because he had flown so many hours in the last 90 days.

The helicopter was properly registered and maintained. It did not show any technical defects. The analyses of the Vehicle & Engine Multifunction Display (VEMD) did not reveal any exceedance of threshold limits during the accident flight before the helicopter impacted the ground. The controls of the helicopter were not impaired technically. Centre of gravity was within the prescribed limits, the maximum take-off weight was within the limits given the outside temperature and the altitude.

Flight weather was good. The light wind coming from various directions could have had an influence on the performance of the helicopter.

The short transport flight did not correspond with the requirements of the operator's operations handbook. There was no ground assistant at the place where the tree trunk was to be deposited. During the approach, the tree trunk impacted the ground several times. It is highly likely that the pilot misjudged his flight altitude since the terrain sloped and was bumpy in the approach direction. Had there been a ground assistant, he could have informed the pilot of the low flight altitude and the danger of hitting the ground with the external load. When the tree trunk then hit the edge of a dip a high load peak occurred which caused the external load rope to rupture. The rope shot upward, got into the main rotor, was swept along and whipped into the vertical fin and tail boom. The drive system to the tail rotor was interrupted. Because of the low air speed at this time, there was no air flow on the tail boom and the helicopter began to yaw. The accident occurred due to this chain of events.

At the time of the accident, a special load handling device was used which had been manufactured by a specialised company. The lifting rope was still within the permitted service life printed on the rope and it is highly likely that it did not have any pre-damage. The operator learned only after the accident that the service life had been reduced. In the past, flight accidents involving helicopters with external load suspensions occurred due to unsuitable sling load gear. Therefore, the BFU issued a safety recommendation in 2003, which was not implemented. In this case, the gradual information of customers over the years about the reduced service life was disadvantageous. In case of a possible technical defect, everyone involved should be

informed immediately. The BFU is of the opinion that the Safety Recommendation 18/2003 is still valid.

The rope used for the test ruptured at 64.43 kN (factor 4.6 of the net load). This value was above the requirements of CS-27 (factor 3.75) but below the requirements of Directive 2006/42/EG on machinery (factor 7). The BFU could not determine if the rope used in the test corresponded with the accident rope in regard to use frequency and therefore generated stress. It can be assumed, however, that the aging process of the textile rope was not sufficiently taken into account during the design of the load handling device. The BFU could not determine with absolute certainty if this reduced safety contributed to the accident because it is not possible to calculate occurring load peaks during an inadvertent external load impact.

According to the documentation, the use of the load handling device for logging was not permissible. The BFU is of the opinion, however, that the flight was more a typical external load flight than a classic logging flight where tree trunk after tree trunk is flown out of the woods for further processing. The tree trunk with a length of about 20 m, transported vertically in connection with the external load suspension made it difficult for the pilot to estimate his flight altitude and observing clearance height. The vertically transported tree trunk caused hard blows to the rope in case of ground impact. Had the tree trunk been transported horizontally, lower load peaks would have been the result.

Conclusions

The accident occurred because during the approach to the place where the tree trunk was to be deposited, the external load hit the ground, the external load suspension ruptured and shot upward. Thereby the drive system of the tail rotor was interrupted.

Contributing factors:

- the approach to the place of deposit without the help of a ground assistant
- bumpy terrain which also declined in approach direction
- the length of the external load and its mode of assembly

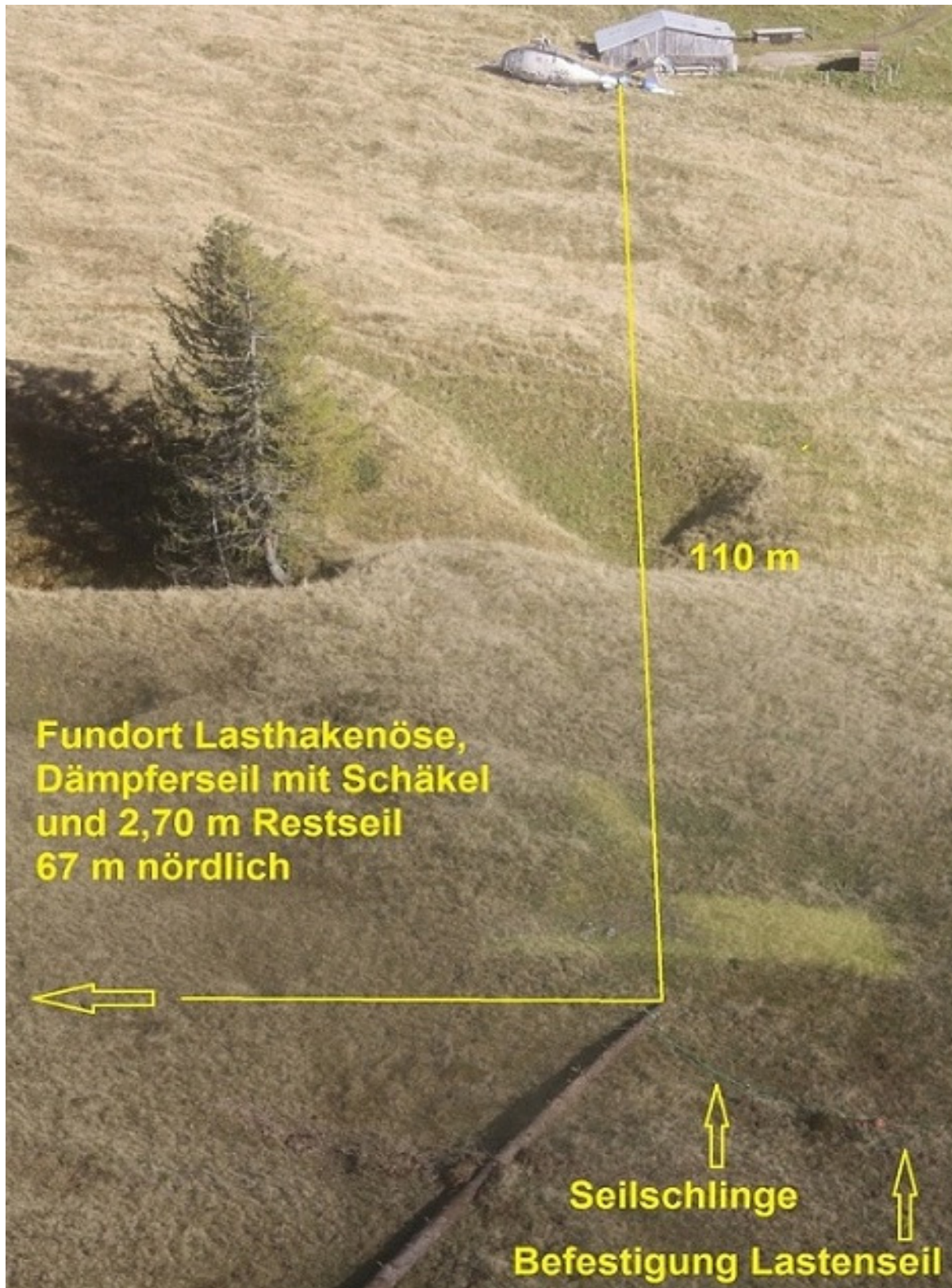
Investigator in charge: Axel Rokohl
Field investigation: Jochen Haag
Braunschweig: 20 September 2011

Appendices



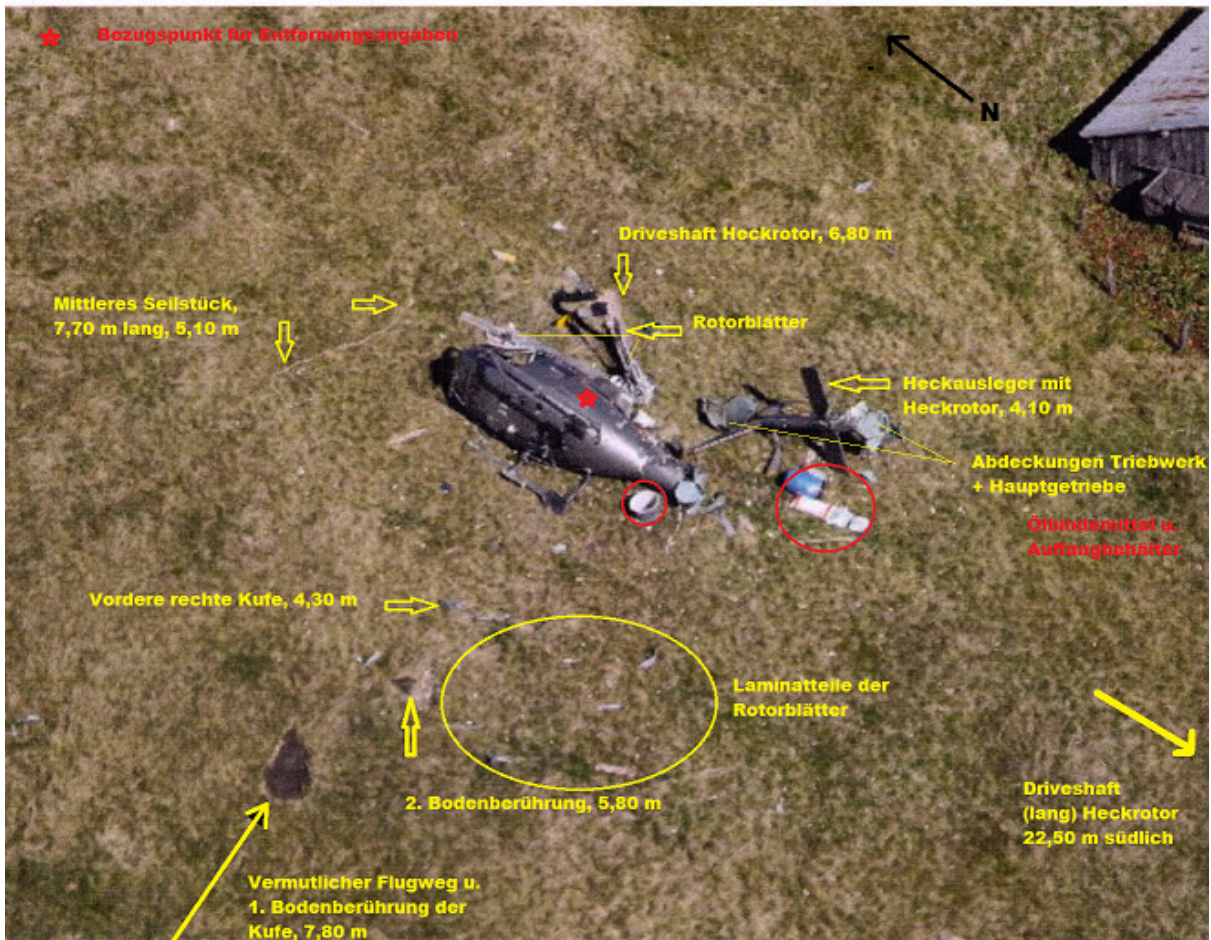
Appendix 1: External Load Suspension

Photo: BFU



Appendix 2: Position Tree Trunk – Helicopter

Photo: BFU



Appendix 3: Wreck Distribution

Photo: BFU



Appendix 4: Place of Impact of the Tree Trunk

Photo: BFU

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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