

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	9 September 2012
Location:	Roßfeld Glider Airfield
Aircraft:	Helicopter
Manufacturer / Model:	Eurocopter / EC 120B
Injuries to Persons:	Pilot and passenger suffered minor injuries, one spectator was fatally, two spectators were severely injured and one spectator suffered minor injuries
Damage:	Aircraft severely damaged
Other Damage:	Persons and vehicles
Information Source:	Investigation by BFU external experts for field investigation
State File Number:	BFU 3X133-12

Factual Information

History of the Flight

Every two years an air show takes place at Roßfeld Glider Airfield. The pilot of an EC 120B helicopter wanted to demonstrate several flight manoeuvres and was accompanied by a passenger who also flies this particular helicopter type.

The BFU has available several videos of the take-off of the helicopter until the accident. These videos show that the helicopter was brought into hover after the engine start-up. Then the helicopter turned around about 180° and immediately hovered south toward runway 07 in approximately 50 cm above ground. The fuselage pointed just about south and the helicopter hovered sideways to the right and slowly lost altitude. Initially the rear part of the left landing skid touched the ground. The helicopter rolled right, the end of the right landing skid touched the ground and then the tail skid and the helicopter rolled over to the right. About 21 seconds elapsed between take-off and the accident which occurred at 1615 hrs¹.

During the interview with the police the pilot stated that he had been conducting such demonstration flights for years during airfield festivals in Laichingen and Roßfeld and had always been flying the same programme. He had done so the day before at Roßberg Glider Airfield and on the day of the accident in Laichingen, where also an air show was taking place. Once the tower had told him via radio he could start with his performance he had taken off from the helicopter parking area, marked with saw dust and had hovered to the runway centre. During the lateral hover prior to the performance the helicopter had rolled over. He had not perceived any technical problem or limiting weather conditions.

During the accident the helicopter was severely damaged and the two persons on board suffered minor injuries.

Four spectators were injured and one vehicle was damaged by parts of the main rotor or cube-like weights from the main rotor blades flying through the air. One of the injured spectators died as a result of his injuries at the site.

¹ All times local, unless otherwise stated.



Single image of the accident, the right landing skid "hooks" into the meadow



Parts of the rotor blades and earth flying through the air

(Photos (2): Single images from the videos / police

Personnel Information

The 79-year-old pilot in the right seat held a Private Pilot Licence for Helicopters (PPLH) initially issued on 2 September 1996 and valid until 22 June 2014. The licence carried the entries for Pilot in Command (PIC) for the helicopter type EC 120 and the night flight qualification. He held a class 2 medical certificate with the restriction to wear multifocal glasses (VML) issued according to JAR-FCL 3; it was valid until 22 June 2013. He wore glasses during the flight.

He had a total flying experience on helicopters of about 763 hours; about 600 hours of which on the type in question.

The 57-year-old passenger seated in the left seat also held a Private Pilot Licence for Helicopters (PPLH) with the rating as PIC for the helicopter type EC 120. He regularly accompanied the PIC during demonstration flights or conducted them himself.

Aircraft Information

The helicopter EC 120B manufactured by Eurocopter is a lightweight multi-purpose helicopter for up to five occupants. The type was certified in 1997 in accordance with JAR-27 (EASA Type Certificate R.508). It was equipped with a three-blade main rotor, a Fenestron for anti-torque and skids. According to the manufacturer the flight attitude of the helicopter varies depending on the centre of gravity between -2° "nose down" and $+3.5^{\circ}$ "nose up" and 0.5° to 3.5° to the right.

Weights in the form of cubes are embedded in the main rotor blades for the static and dynamic balancing to decrease vibrations and prevent unnecessary loads on the rotor head.

In normal operation the main rotor has about 400 RPM. The main rotor has a diameter of approximately 10 m. Therefore, the blade tip speed is approximately 209 m/s (750 km/h).

The helicopter manufacturer recommends a hover height of 5 ft (1.5 m).

The accident helicopter was built in 2001 and had the manufacturer's serial number 1278. It was equipped with a Turbomeca Arrius 2F engine. The maximum allowable take-off mass was 1,715 kg, the empty weight was about 1,070 kg and the weight at the time of the accident was about 1,348 kg. The last inspection was conducted on 4 July 2012; at about 616 operating hours. Total operating hours were about

622 hours. Based on the configuration and loading, the helicopter manufacturer estimated the flight attitude during static hover was +1° nose up and 2° to the right.

At the time of the accident dual controls were installed.

Meteorological Information

According to the flight weather report of the Deutscher Wetterdienst (German meteorological service provider, DWD), for the South, the western edge of a high pressure area was above Southern Germany. Dry and mild air drifted in from the south-east. The sky was clear and visibility was 20 to 30 km. The wind was slight coming from different directions. The temperature was about 25°C and air pressure (QNH) 1,017 hPa.

Communication

The pilot had radio contact with the tower at Roßfeld Glider Airfield. The radio communications were not recorded.

Aerodrome Information

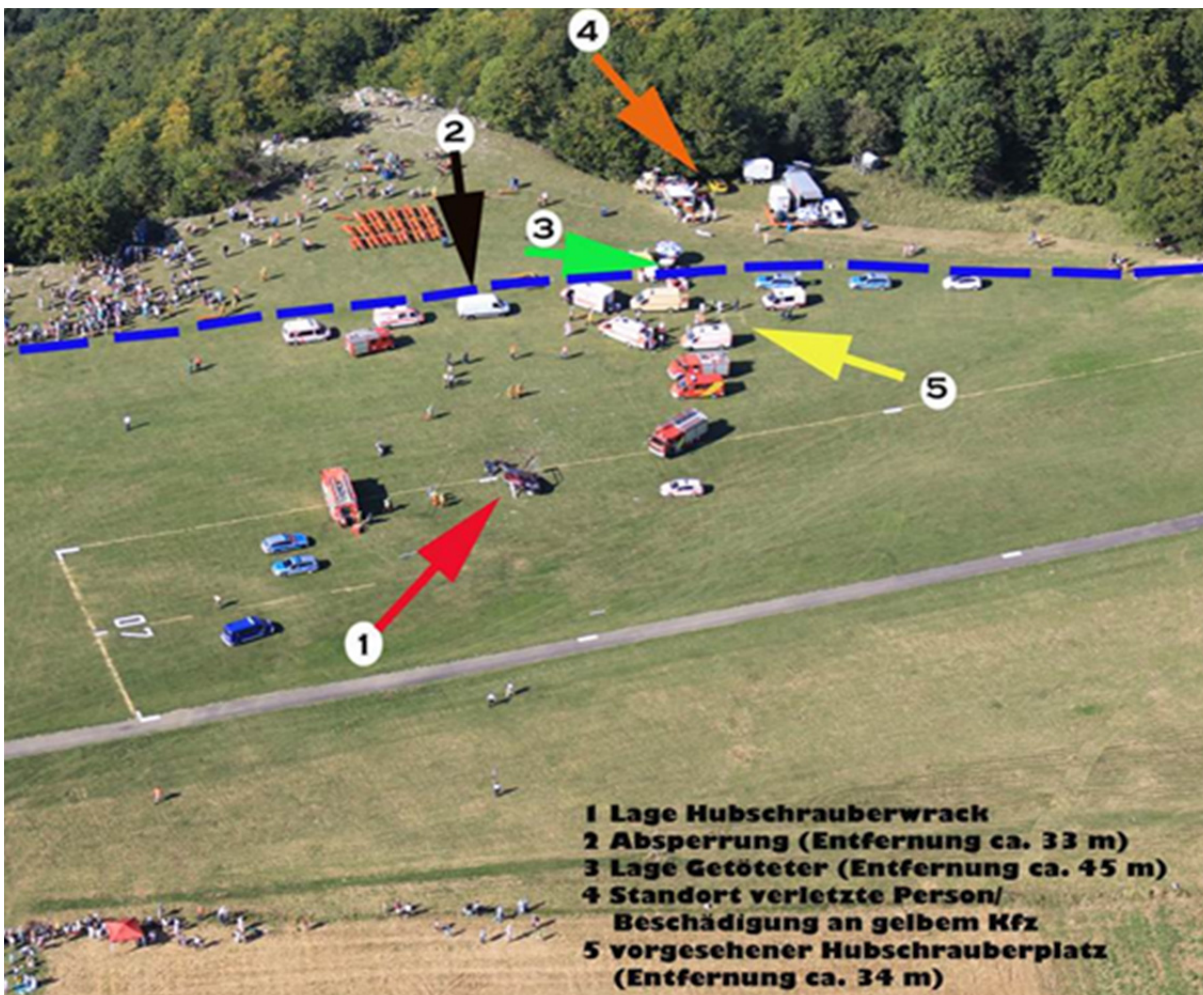
Roßfeld Glider Airfield is located on a hill about 2 km south-east of the village Metzingen in about 2,625 ft AMSL. It has one grass strip (main runway) with a length of 635 m, a width of 30 m, oriented 074° (254°). Runway 07 rises at the beginning of the runway from 2,553 ft AMSL to 2,625 ft AMSL and at the end of the runway declines to 2,616 ft AMSL. The area at the beginning of runway 07 declines toward the south. During the air show the runway was also marked with lines of wood shavings.

The Regierungspräsidium Tübingen (regional council) approved the airfield fair on 22 August 2012 and stated the landing area for helicopters used for sightseeing flights was to be at the north-eastern part, north of the beginning of runway 25. There the distance between helicopters and spectators should be more than 30 m (Appendix). This area was used by a helicopter of an operator. For any other helicopters the approval map of the area did not stipulate separate parking areas.

The approval further stipulated:

The minimum distance between the outer part of a taxiing aircraft and the spectators shall be at least 10 m, to hovering helicopters this distance shall be adequately increased.

The helicopter in question had received its own parking position marked by an "H" written with saw dust north of runway 07 in front of the spectator barrier (blue line in the photograph). The helicopter also used this landing area the day before (Saturday). According to police investigation, on Saturday, the responsible official of the Aviation Supervision Office at the Regierungspräsidium Tübingen being at the site, ordered that the next day the landing area for the helicopter was to be moved to the western end of the asphalt track due to the limited space and the short distance to the spectators and that generally a minimum distance of 30 m between spectators and helicopter has to be observed.



Overview airfield, accident site and area for the spectators

Photo: Police

Flight Recorder

The helicopter was not equipped with a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR). These recording devices were not mandatory.

The helicopter was equipped with a Vehicle and Engine Multifunction Display (VEMD) for engine monitoring. It stored operating hours, start-up cycles, error messages, threshold limit violations and performance data. The VEMD was read-out on site in the presence of the police and an examiner familiar with the helicopter type. It was determined that until the accident neither error messages nor threshold limit violations were stored. At the site, the accident flight could not be analysed because the system had not completed the flight. For further examination the VEMD was sent to the manufacturer.

The manufacturer could complete the accident flight in the VEMD on the test bench. Two recorded error messages were found which occurred after one minute and 26 seconds of operating time. The system had detected a difference between the engine data and the main rotor rpm. In addition, a threshold limit violation was recorded. The engine rpm (NF) was between 104% and 110% for 18 seconds and for two seconds above 110%.

The manufacturer was of the opinion that both error messages and the threshold limit violation were to be expected and understandable due to the fractured main drive shaft after the initial ground contact.

Wreckage and Impact Information

The accident site was located at the northern edge of runway 07 of Roßberg Glider Airfield, south of the so-called Olgafelsen.

The helicopter rested on the right side. The torn off tail boom was found next to the fuselage and was only attached to the fuselage via the push-pull-cables of the Fenestron. The mounting point of the aft crosstube of the skids was torn out of the fuselage. Two of the three main rotor blades were torn off the main rotor hub, the remaining blade was bent. The torn-off blades had fractured into many individual pieces. The main drive shaft between the engine and the main gear box had fractured. Witnesses stated that the engine was still running until it was shut off after the helicopter had come to rest on its side. Evidence that the controls had been impaired was not found. The control rods to the swash-plate and to the engine controller had a frictional connection.



Helicopter wreckage

Photo: BFU

The fire brigade removed about 150 litres of fuel from the fuel tank. In the area where the spectators stood, rotor blade pieces and weights from the main rotor blades were found. The side metal sheet of a car parked at the edge of the forest near the so-called Olgafelsen had been penetrated. Near the car a weight from one of the main rotor blades was found.

Medical and Pathological Information

There was no indication of any physiological or health problems on the part of the pilot. The blood alcohol level was negative.

Fire

There was no fire.

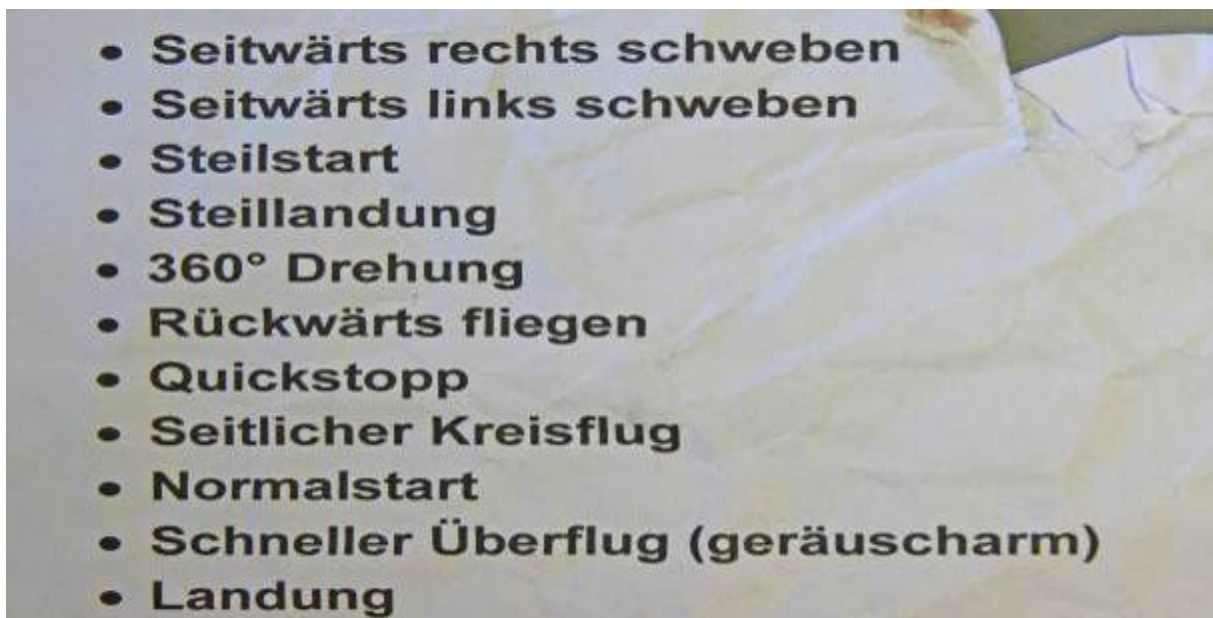
Survival Aspects

The spectator who was killed had been about 45 m away from the accident site when he was hit by several weights from the main rotor blades. The weights had a dimension of 12 x 9 x 9 mm and weighed about 40 g. Two of the weights were found directly in front of the body and several during the post-mortem examination inside the body.

Organisations and their Procedures

The Federal Aviation Act para 24 stipulates that public events involving aircraft require approval of the responsible regional civil aviation authority. On 14 June 2012 the organiser of the airfield fair submitted the appropriate application to the Regierungspräsidium Tübingen. On 22 August 2012 the event was approved with restrictions. The approval made stipulations for: Responsibilities of the organiser, emergency procedures, individual aerobatics, and minimum safety distances to the spectators, etc. Regarding the helicopter demonstrations it was stipulated that these should take place in the area of or above runway 07/25.

A piece of paper was found aboard the helicopter according to which the following program was to be flown:



Planned program which also had been conducted the previous day

Photo: BFU

Additional Information

Helicopter can roll over under certain conditions. One skid has to have ground contact and serve as pivot point and a rolling movement has to be present. This is a so-called static or dynamic rollover. As soon as the critical roll angle is exceeded, the pilot has, generally, no chance to prevent the helicopter from rolling over. The attempt to pull the helicopter into the air by using the pitch usually quickens the roll over; therefore, it is recommended to push the pitch down immediately.



Static and dynamic rollover

Photos (2): EHEST

Because this type of accident happens quite frequently already a number of documents including recommendations have been published. Examples are Federal Aviation Administration (FAA) 1986: Advisory Circular 90-87 "Helicopter Dynamic Rollover"

Flight Safety Foundation (FSF) 1989: Volume 14 No.1 "Preventing Dynamic Rollover"

European Helicopter Safety Team (EHEST) 2011: HE1 - Safety Considerations - "Static and Dynamic Rollover"

A BFU database query regarding personal injury on the ground in connection with the operation of helicopter showed a total of 28 occurrences by 966 stored incidents since 1973. In most cases the downwash during take-off or landing was responsible for the personal injury of third parties.

Analysis

The Regierungspräsidium Tübingen (regional council) had approved the airfield fair. The area for the spectators had been cordoned off with warning tape. According to the appendix of the approval runway 07/25 was intended for the fire fighting and the planned helicopter demonstration. The accident occurred in the area of the runway.

The pilot was properly licensed, medically fit to fly and had the type rating for the EC 120B. Since he had owned and flown the accident helicopter for years he was certainly familiar with its use and aware of potential peculiarities of the type. His flying experience was certainly sufficient for the planned flight manoeuvres, especially since he had flown the same program several times at airfield fairs.

The flight program contained only manoeuvres which are part of the flight training to acquire a pilot's licence and of the annual proficiency check. The manoeuvres are neither aerobatics nor do they place special demands on the pilot or the performance of the helicopter.

The helicopter was certified, equipped and maintained in accordance with existing regulations and approved procedures. Evidence that the controls had been impaired or a technical malfunction had occurred was not found. The analysis of the VEMD showed normal engine data, no error messages or threshold limit violations up until the accident. The video recordings did not show any sudden changes in flight attitude or altitude which could be expected had the engine failed or the controls been impaired. Based on the loading, configuration, rotor mast tilt and the Fenestron thrust the flight attitude in static hover was slightly tail heavy and tilted to the right.

Spectators were injured by main rotor blade parts flying around; one spectator was fatally injured. The design requirements for helicopters (JAR 27) valid at the time of the type certification of the EC 120B, specified strength requirements (limit loads and ultimate loads) for helicopter components during normal flight operations (JAR 27.301 ff). Additional safety factors had to be used to prevent premature fatigue or failure. There were no strength requirements for components such as the main rotor (JAR 27.574) in case of contact with obstacles. There only were requirements for emergency landing conditions (JAR 27.561 ff) for the protection of occupants in case of an accident which have probably contributed to the fact that the two occupants only suffered minor injuries. Injuries of third parties by helicopter parts flying through the air are rare according to the BFU accident statistics.

The weather was good; it was a warm, sunny and cloudless late summer day. There was a slight wind. It cannot be excluded that the pilot was blinded or impaired by the sun during the hover to the right, i.e. toward the west, while the fuselage simultaneously pointed to the south. It is highly likely that the pilot was looking to the front right or to the right during the hover. According to the shadow of the helicopter this would have been in the direction of the sun. During the flight the pilot was wearing sunglasses with progressive-addition lenses and a peaked cap.

The terrain at Roßfeld Glider Airfield is characterised by significant waviness in all directions. Not only is it an up-and-down terrain along the runway, it is also sloping crossways to the runway. This is aggravated by the fact that due to the waviness there is no constant horizontal horizon in every direction. In order to hover in the

same distance to the ground the terrain demands continuous control corrections and keeping the ground for the intended flight direction in sight.

The video recordings of the accident show a typical so-called dynamic rollover which resulted in the accident. After the sideways hover the left skid had ground contact which resulted in deceleration and caused the right skid to have ground contact, together with the tail skid it served as pivot point for the tilting helicopter.

Due to the high centre of gravity, because the main gear box and the engine being mounted so high up and the narrow skid width, dynamic rollovers are one of the most common accident causes for helicopters. Many publications describe the rollover of helicopters which are technically sound. Ultimately, the pilot has to avoid ground contact with the skids at all times during sideways flight manoeuvres. After a sideways ground contact, correction of the control inputs often occurs too late or is ineffective due to the severe rolling movement.

It is highly likely that the pilot was not aware of the marginal height above ground due to the sloping terrain.

It could not be determined why the passenger, who was also familiar with the helicopter and held a PPHL and the necessary type rating as well, did not notice the loss of altitude and made the pilot flying aware of it or took over the controls himself.

Conclusions

Due to the selected hover height being too low an inadvertent ground contact of the skids during sideways hover occurred as result of which the helicopter rolled over.

Investigator in charge:	Axel Rokohl
Field investigation:	Klaus Mehring, Harry Roland
Braunschweig,	4 September 2013

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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