Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accidents Investigation

Investigation Report

3X002-0/05
17 May 2006

Identification

Type of occurrence:	Accident
Date:	17 January 2005
Location:	Near Thalheim
Aircraft:	Helicopter
Manufacturer / Type:	PZL-Swidnik / W-3A
Injuries to persons:	Two fatally injured and three seriously injured persons
Damage:	Aircraft destroyed
Other damage:	Damage to forests
Information Source:	Investigation by BFU

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The investigation has been conducted in compliance with the law relating to the Investigation of Accidents and Incidents associated with the Operation of Civil Aircraft (Flugunfall-Untersuchungsgesetz - FlUUG) dated 26 August 1998.

According to the law the sole objective of the investigation shall be the prevention of future accidents and incidents. It is not the purpose of this activity to asign blame or liability or to establish claims.

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Abbreviations

BiV	Night Vision Goggles
FAR	Federal Aviation Regulation
FLIR	Forward Looking Infrared
JAR	Joint Aviation Regulation
LBA	Luftfahrt-Bundesamt
MSL	Mean Sea Level
MTOM	Maximum Take-off Mass
PIC	Pilot in Command
TRE	Type Rating Examiner
TRI	Type Rating Instructor

Synopsis

On 17 January 2005 at 11:40 hrs[1], the German Federal Bureau of Aircraft Accidents Investigation (BFU) was notified by phone of an accident to a police helicopter which had occurred near Thalheim (Saxony). A BFU field investigation team was dispatched to the accident site.

The investigation was conducted on the basis of the Flugunfalluntersuchungsgesetz (Law Relating to the Investigation into Accidents and Incidents Associated with the Operation of Civil Aircraft) (FlUUG) and the standards and recommendations of Annex 13 of the International Civil Aviation Organisation (ICAO). Representatives of the Republic of Poland as the State of the manufacturer participated in the investigation into the aircraft accident.

On a police mission flight, the helicopter became uncontrolled and crashed on a wooded slope.

The causes of the flight accident were:

Immediate causes:

- The mission order given did not sufficiently consider the pilot's qualification and experience level.
- In a low altitude the helicopter became uncontrolled because of control errors.

Systemic causes:

- The police helicopter squadron's procedures for pilots on the accident aircraft type were insufficient regarding their flights under supervision (including flight time and range of missions).
- The aeronautical regulations for operations of police helicopter squadrons were insufficient.

[1] Unless otherwise specified all times are indicated as local time.

1. Factual information

1.1 History of the flight

On the day of the accident at 09:51 hrs, the police helicopter squadron was requested to carry out an ad hoc mission because a person had gone missing in the area of Thalheim. The helicopter took off at 10:17 hrs from Dresden Airport for the flight to Thalheim. The pilot, a flight mechanic, a camera operator (thermal imaging) and one other police officer were aboard the helicopter. At 10:47 hrs, after a thirty minute flight, the helicopter landed west of Thalheim, where a female police officer familiar with the locality boarded the helicopter for support.

After a briefing the helicopter took off at 11:08 hrs. The helicopter climbed to approximately 2,000 ft MSL and started the search east of Thalheim. According to radar data, the initial flight direction was southeast across woodland. Cockpit Voice Recorder (CVR) data show that the camera operator had activated the digital thermal imager and the flight mechanic had also switched on his LCD display in the cockpit in order to view the thermal image as well. The flight mechanic suggested as search procedure that the pilot "jibe" between the town and a street running east of Thalheim starting in the western area on the edge of the forest. The flight mechanic arranged the procedure to be applied with the camera operator. It was agreed that a small strip at the time was to be searched and that the camera was to point into the 12 o'clock position and should have a large tilt angle. After having crossed the forest the helicopter flew to the right and then west toward the outskirts of Thalheim.

The camera operator said: "… for me this is going to fast here. The pilot answered "OK then we will a little slower …" The camera operator reported: " I have something down here at 12 o'clock …". The pilot answered: „... "… yes we will fly this stretch back …". After that pilot and flight mechanic agreed to turn around in a right hand turn.

After the turn the aircraft flew straight on with a heading of 128° – according to the flight data recorder (FDR) -41 seconds prior to impact (see attachment 1). The altitude was 2,070 ft MSL, the height 800 ft AGL. The indicated airspeed increased to approximately 40 kt. During straight flight the flight mechanic said: " … and now decrease speed down to 20 kt if possible." Afterwards until -21 s, the longitudinal pitch of the helicopter increased from 0° to +10° and the indicated airspeed decreased to 30 kt. During this time period the pedal movement was close to neutral. Between -21 s and -19 s of the straight flight (see attachment 2), the flight data recording shows an increase in engine torque to approximately 72 %. At the same time the right pedal was depressed. The helicopter flew with a heading of 123° at a height of 475 ft AGL. Between -19 s and -16 s the pedal movement (to the right) increased continuously to 33 mm. All other parameters including the torque values remained almost constant. During the same time the flight mechanic said to the camera operator: "… slower is not possible now".

After -16 s the collective pitch lever was pulled further with a corresponding increase of the torque values and a further increase of the pedal movement. At -15 s the helicopter started to yaw to the left. At -12 s the CVR recorded two dull sounds in quick succession. The yaw rate exceeded at this point 20°/s and increased further. At -10 s the flight mechanic asked: "What now? And the pilot answered: "I don't know".

At -13 s, the pedal movement started to decrease and at -10 s the pedal had reached the neutral position. During the same period the engine torque decreased to 55 %. The attitude initially decreased from +4° to 0° and within the following 2 seconds changed to -18°. The helicopter started to descent. Several intense load changes and abrupt, alternating control inputs were recorded until the impact.

Between -10 s and -7 s the right pedal was pushed down again by approximately 15 mm. The yaw rate increased less during this phase (see attachment 2). The pilot swore several times and the flight mechanic said " Easy, easy, easy …"

Witnesses observed the aircraft rotating about its vertical axis several times and crashing into the forest with a very steep pitch down attitude.

The survivors stated that the helicopter had been well above the trees at the beginning of the spin. The female police officer had the impression that the helicopter shook and droned during the spin. The camera operator did not notice any unusual sounds or vibrations.

1.2 Injuries to persons:

injuries	Crew	Passengers	Total	Others
Fatal	2		2	
Serious	3		3	
Minor				
None				---
Total	5		5	

1.3 Damage to aircraft

The helicopter was destroyed.

1.4 Other damage:

There was damage to the forest.

1.5 Personnel information

1.5.1 Pilot in command

The 35-year-old helicopter pilot held a commercial pilot's licence CPL(H), first issued on 20 January 2003 according to ICAO standards and valid until 15 January 2006. In the licence, type ratings as pilot in command (PIC) on Eurocopter EC125P/135T and on W-3 Sokol were entered. The helicopter pilot's medical certificate was valid until 15 January 2006.

His total flight experience amounted to approximately 445 hours, of which 31 hours were on the type W-3 Sokol. In the last ninety days prior to the accident the pilot had flown approximately 28 hours, of which approximately 13 hours (on 16 flights) were on the type W-3. His total flight time in the 30 days prior to the accident amounted to 15 hours and 54 minutes, of which 4 hours and 55 minutes were on the type.

His police helicopter squadron rating included VFR-Night / SX-16 flights with a crew pilot/pilot or under supervision.

In March 2001 the pilot had started flight training and attended the training course to acquire a commercial pilot's licence - helicopters – at a commercial flying school until July 2002. He acquired type

ratings for EC 120 and Bo 105. The practical training covered 160 flight hours. In February 2003 the pilot acquired the type rating for the helicopter EC 135. From 23 August to 20 September 2004, he attended the theoretical training course at the police helicopter squadron and from 20 to 30 September 2004 he completed the practical training (15 hrs and 9 minutes of flight time) and examination for the W-3 type rating. Until the end of the year 2004 he flew on the aircraft type W-3 under supervision.

The police helicopter squadron stated that until the day of the accident the pilot had conducted a total of 20 search missions with a total flight time of 35 hours and 3 minutes. Eight of those flights were conducted with the support of the video and/or digital thermal imager.

The two flights on the day of the accident were the first flights on the type conducted by the pilot with a crew pilot/flight mechanic.

On the day of the accident, the helicopter pilot was assigned shift duty as mission crew pilot and started work at 06:00 hrs. Prior to this duty period he had more than 48 hours off.

1.5.2 Flight mechanic

The 32-year-old flight mechanic held an open-ended licence for flight mechanics on helicopters with type ratings for Eurocopter EC135P/135T and for W-3 Sokol, issued on 5 November 1998. His medical certificate was valid until 29 April 2005. His total flight experience amounted to approximately 867 hours, of which 508 hours were on the type.

He held a rating of the squadron for external load flying, for roping, for air-ground location, VFR-Night / SX-16 flights, BIV operations and FLIR operations.

From May 1997 to November 1998 he completed the flight training with the Federal Police and acquired the licence for flight mechanics. From December 1998 until January 1999 he acquired the type rating for the type W-3 and from May 2001 until July 2001 for the type EC 135 at the police helicopter squadron.

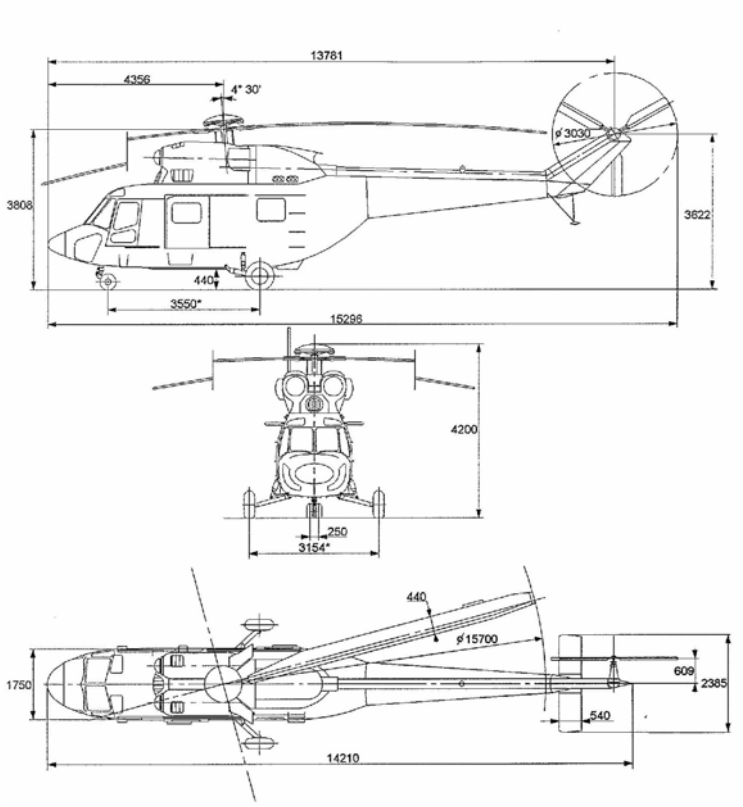
On the day of the accident, the flight mechanic was assigned shift duty as part of the mission crew and started work at 6:00 hrs. Vor Dienstbeginn hatte er mehr als 48 Stunden Freizeit.

1.5.3 Other crew members

Three other police officers were aboard the helicopter: the 33-year-camera operator, a 26-year-old police officer, undergoing the thermal imaging operator aptitude selection procedure, and a 30-year-old female police officer from the local police station.

1.6 Aircraft information

The PZL-Swidnik W-3A is a twin engine transport category helicopter with a fully articulated four blade main rotor turning clockwise and a three blade tail rotor. The airframe of the helicopter is manufactured in mixed construction. The aircraft has a fixed tricycle landing gear. The aircraft is certificated as a Category A and B rotorcraft under FAR Part 29. It is designed to carry up to 14 persons including the crew.



Three-way view (dimensions indicated in mm)

Minimum crew for flights under instrument flight rules (IFR): two pilots. Minimum crew for flights under visual flight rules (VFR): one pilot operating from the left-hand seat.

Manufacturer serial number (MSN):	370708
Year of manufacture:	1996
MTOM:	6,400 kg
Total operating hours:	2,455 hours
Engine manufacturer:	PZL
Engine type:	gas turbine
Engine type:	PZL-10W

The helicopter was registered and certificated and the last annual inspection took place on 21 July 2004. On 12 January 2005, a 25-hour inspection was performed.

Prior to departure in Dresden the helicopter had a fuel quantity of 1,500 litres on board. At the time of the accident the fuel quantity amounted to about 1,150 litres. The resulting gross weight of the helicopter amounted to approximately 5,817 kg. The centre of gravity was within limits.

The Rotorcraft Flight Manual states in section *Operational Limitations and Restrictions* that "360° turns in less than 18 seconds are prohibited".

1.7 Meteorological information

Witnesses stated that at the time of the accident the weather was sunny with good visibilities.

The expert opinion of Deutscher Wetterdienst (DWD; German Meteorological Service) stated:

At the time of the accident, a winterly high pressure weather prevailed without any significant meteorological phenomena. Visibility was between 10 km and 30 km.

The surface wind direction was approximately 230 to 250° with wind directions also from 250 to about 270° due to orographic conditions (channel effect caused by the Erzgebirge). The mean wind speed (10 minutes' average value) reached about 7 to 12 kt. Surface wind was slightly gusty. Gusts between 15 kt and 20 kt occurred.

In the lower air masses up to 5,000 ft MSL, the wind was blowing mostly from the west southwest (240 - 260°) with an average speed of 15 to 20 kt. At the ridge and summit area and on the lee side of the Erzgebirge, a local, slight turbulence occurred.

The cloud base (1 to 3/8 cumulus/stratus fractus) was between 3,500 ft MSL and 4,000 ft MSL. Above those clouds there were thin mid-level or high-level clouds (1 to 3/8) with bases above 10,000 ft MSL.

The air temperature was 4 °C to 5 °C, the dew point was between -1 °C and -2 °C.

At the time of the accident, visual meteorological conditions prevailed in the area of Thalheim.

1.8 Aids to navigation

Not applicable

1.9 Communication

Radio communications between the helicopter crew and air traffic control at Dresden Airport and the police radio communications between the helicopter crew and the ground radio stations were recorded and available to the BFU for evaluation. Radio communications did not reveal any information relevant to the accident.

1.10 Aerodrome information

Not applicable

1.11 Flight recorders

The helicopter was equipped with a flight data recorder and a cockpit voice recorder. Both recorders were recovered and transported to the BFU for evaluation.

Both recorders showed heavy traces of fire and slight mechanical damage.

The radar data of the flight from Dresden to Thalheim and of the accident flight were recorded by the Deutsche Flugsicherung GmbH (German Air Navigation Services) (DFS) and available to the BFU for evaluation.

1.11.1 Flight data recorder

Type: MLP-23, Serien-Nr. 80370; Aufzeichnungsmedium: ½“ Stahlband; Aufzeichnungsart: Digital; Datenformat: ARINC 573, 64 Datenworte je Subframe; Aufzeichnungskapazität: ca. 50 Stunden;

The flight data recorder could be opened without any difficulties. The steel tape did not show any damage caused by fire or by mechanical effects.

The flight data recorder had recorded 72 parameters.

During the whole flight, the FDR did not record any warnings e.g. chips, fire or vibrations.

1.11.2 Cockpit voice recorder

Type: MARS-BM, Serien-Nr. 354035; Aufzeichnungsmedium : ½“ Magnetband, 4 Spuren; Aufzeichnungsart: analog; Aufzeichnungskapazität: ca. 30 min;

The cockpit voice recorder had been subject to very high temperatures due to the fire. However, it could be opened without any difficulties. The exposed parts of the magnetic tape outside the reels showed deformations caused by heat. The initial about 2 mm of the tape windings on the metal reels were useless due to heat conduction via the hubs. In this area, the magnetic surface had separated in the most part and stuck to the back side of the adjacent tape winding. Thus, at both ends of the tape about 4 minutes of the recording were lost.

The tracks had recorded the Cockpit-Area-Microphone, radio communications and Intercom. A significant part of the communication during the accident flight and parts of the flight form Dresden to Thalheim was reconstructed and evaluated.

FDR and CVR recordings of the accident flight were correlated based on distinctive events of the flight.

1.12 Wreckage and impact information

The helicopter had crashed on the northwest slope of a wooded mountain range approximately 500 m southeast of Thalheim's railway station. The accident site was located at approximately 548 m (1,798 ft) MSL.

On an almost vertical flight path, the fuselage and the main rotor of the aircraft had initial contact with several trees, thereby cutting off several tree tops and trunks, then crashed to the ground, tilted to the right and caught fire. During impact the nose was severed and the airframe compressed particularly in the cockpit area. The cabin area had suffered minor mechanical damage during impact.

The wreckage pointed into approximately 240°. The four main rotor blades were severed in the area of the root attachments and had fragmented. Debris was found within a radius of up to 100 m around the main wreckage.

The rotors of both turbines turned freely.

At a distance of about three meters from the fuselage, the tail boom was bent. The rear part of the tail boom with the intermediate gear box and the tail rotor pointed forward into the direction of the aircraft fuselage. The three tail rotor blades were broken off. Debris of the tail rotor blades were found within a radius of about 25 m around the main wreckage.

Due to the high degree of destruction caused by the fire, investigation of the wreckage was possible to a limited degree only.

In the area of the fuselage, the directional controls were destroyed by the fire. The control cables in the tail boom were in place and undamaged. The tail rotor blade pitch control was operational.

The intermediate gear box did not show any mechanical damage. Caused by the impact, the tail rotor gear box was jammed by a piece of casing. Once the piece of casing was removed, the gear box turned freely.

The tail rotor drive shaft consisting of a total of six segments was broken and in several places damaged by the fire. No traces of torsion were found on the whole length of the drive shaft.

A detailed investigation of the main gear box was conducted at the manufacturer. The casing of the main gear box was partly damaged by the fire. The oilsump of the gear box was destroyed. On the inner surface of the gear box casing residues of burnt oil were found. The linkage of the tail rotor drive did not show any mechanical damage. The gears and shafts were not damaged mechanically. All gears rotated freely after the residues of the melted gear box casing were removed. The left free-wheel clutch was functioning, the right one showed traces of high temperatures. The shaft was jammed.

1.13 Medical and pathological information

Post mortem examinations were performed on the helicopter pilot and the flight mechanic. The autopsy revealed that both crew members had died as a result of the head injuries suffered during impact.

The analysis of blood specimen regarding the alcohol level produced negative results.

1.14 Fire

The helicopter caught fire during impact. According to statements of the surviving occupants and other witnesses, the fire had spread from the rear fuselage area forward. Until the arrival of the fire brigade, helpers had tried to fight the fire using hand fire extinguishers from police vehicles. The fuselage was destroyed by the fire except for the floor component.

1.15 Survival aspects

After the initial ground contact, the helicopter fell over onto the right side. Whereas the cockpit area was destroyed by impact forces, the cabin suffered only minor mechanical damage.

The camera operator stated that once the helicopter had come to a stop he could open the sliding door on the left-hand side of the fuselage without any problems. He noticed that the female police officer was alive and helped her to leave the helicopter. She was able to move away from the wreckage by herself. The police officer undergoing the thermal imaging operator aptitude selection procedure lay unconsciously in the helicopter. The camera operator pulled him out of the wreckage and put him on the ground some distance away from the helicopter. He then tried to rescue the cockpit crew from the

wreckage. He stated that he could not reach the flight mechanic. He climbed onto the left-hand side of the fuselage, opened the safety harness and tried to pull the pilot out of the cockpit but without success. At that time, the wreckage was burning in the area behind the engines. When the fire spread further the camera operator moved away from the wreckage.

Several persons had come to the accident site and tried to help the cockpit crew. They did not succeed in recovering the occupants from the wreckage.

1.16 Tests and research

Not applicable

1.17 Organizational and management information

1.17.1 Duties and organization of the police helicopter squadron

The police helicopter squadron's duties include e.g. searching missions, transportation, traffic monitoring, air support of fire fighters and aerial photography.

The squadron was divided into flight operations including the departments police executive service, training and advanced training, and engineering. The squadron management intended to change the organisational structure based on JAR-OPS 3 by establishing a department "Inspection organization/Quality assurance". At the time of the accident this change had not been implemented.

The police helicopter squadron had a fleet of three rotorcraft, two PZL-Swidnik W-3 A and one Eurocopter EC135. On the day of the accident, only one helicopter W-3 A was available because the other W-3 A was undergoing an extensive general overhaul and on the EC135 maintenance action of several days' duration was conducted.

The flying personnel of the squadron consisted of 10 helicopter pilots, 9 flight mechanics and 2 camera operators. Two of the squadron helicopter pilots were LBA approved experts TRE and TRI for the type W-3A.

Two additional police officers were undergoing the thermal imaging operator aptitude selection procedure. The squadron management stated that they not part of to the police helicopter squadron's flying personnel at that time.

A police helicopter's standard flight crew consisted of one pilot and one flight mechanic.

In addition to the regular operation of the squadron, one helicopter crew was on duty in order to handle ad hoc missions. Whenever ad hoc missions were required the procedure "Soforteinsatzflug" was applied. The report form "Soforteinsatzflug" contained details on the mission, cause of the flight, the crew and/or other personnel involved and the squadron management's decision regarding the flight's feasibility. On the day of the accident it was decided that the mission crew should conduct the flight and that additionally the camera operator, the police officer undergoing the thermal imaging operator aptitude selection procedure and a female police officer of the local police station and familiar with the locality should attend the mission.

1.17.2 Flight operational procedures of the police helicopter squadron

Flight operations of the squadron were regulated in 12 operational directives. Additionally, 28 temporary provisions regarding flight operations were in effect.

In addition to the flight operational directives, an advanced training schedule regulated kind and scope of the advanced training for the flying personnel. The advanced training schedule aimed at the standardization of all crew members' training level on a uniformly high level, the use of new options for the continuously broadening range of police duties, the increase in efficiency and the success rate of police missions and to permanently ensure flight safety. The squadron management stated that eight chapters of the advanced training schedule were on a par with a flight operational directive.

It was established in the *flight operational directive TV/FLIR Operations* that such flights were to be conducted only by crews holding the appropriate ratings.

The following kinds of operation were described in the directive:

- TV/FLIR operations VFR,
- FLIR operations, VFR-Night
- FLIR operations, VFR-Night (BiV).

The flight operational directive contained specifications relating to weather minima, cooperation within the crew and the distribution of tasks for the different kinds of operation. The directive stated that on such flights the numerous individual tasks of the crew members result in a high work load for the whole crew. According to the basic distribution of tasks in FLIR operations the pilot was responsible for the controls and ATC radio communications, the flight mechanic for navigation, police radio communications, operation of the NAV/COM and the searchlight SX-16. The operator is responsible for the FLIR and the SX-16 slaving unit. For VFR operations with the crew composition pilot / flight mechanic the pilot is also responsible for the navigation and the flight mechanic for the FLIR system.

The police helicopter squadron's advanced training schedule included also specifications for tactical flight procedures. The flight procedure *Suchflüge nach Personen oder Sachen* (flights to search for persons or objects) stated that the helicopter pilot was responsible for the aircraft and the safe conduct of the flight and the flight mechanic and the accompanying observer were responsible for the search. Dependant on the conditions of the terrain to be searched, search flights were normally to be conducted at heights between 500 ft and 1,000 ft AGL. According to Chapter 10 *FLIR* of the advanced training schedule, VFR flight training by night and a completed familiarization with police flight operations was required of pilots to become eligible for FLIR training.

One of the specified search procedures is referred to as "to meander". This will be used with large search areas or when only vague information is available and an evenly spread area coverage is to be achieved. For better navigation a crew should determine the boundaries of the area to be searched on natural conditions. The area is then searched in a meander like fashion i.e. parallel running search strips and a 180° turn at each end. This procedure was intended for the search for persons or objects without the digital thermal imager and during TV/FLIR operations. During FLIR operations the camera has to point into the 12 o'clock position during the whole search.

The squadron management stated that usually on visual search missions during the day police officers familiar with a place accompanied the crew and additional help was provided by using binoculars, a video camera or digital thermal imager.

1.17.3 Oversight authorities

The police helicopter squadron was part of the department 5 of the Landespolizeidirektion central services. The Landespolizeidirektion was the responsible organisation for oversight activities of all police-related matters.

The police helicopter squadron was approved and supervised as a maintenance organisation for the squadron's rotorcraft by the Luftfahrt-Bundesamt (German Civil Aviation Authority).

The police helicopter squadron's flight operation was not subject to any oversight activities by a civil aviation authority. The Luftfahrt-Bundesamt was responsible for approval and supervision of commercial operators operating under instrument flight rules. Operators conducting flight operations under visual flight rules only were supervised by the aviation authority of the respective Land.

1.18 Additional information

1.18.1 Basic flight training of police helicopter crews

The basic flight training of pilots and flight mechanics was conducted either at the flight training school of the Federal Police or at a commercial flight training organization. At a commercial flight training organization, the training for pilots of about 14 months included the officially required programme for acquirement of the CPL(H). Approximately 160 flight hours were completed in the course of the practical training. During the pilot training of about 16 months at the flight training school of the Federal Police, a student pilot received intensive mission-related flight training in addition to the officially required training programme for acquirement of the CPL(H). Pilots left flight training school with a total flight experience of approximately 250 - 280 hours.

1.18.2 Advanced flight training

After finishing the basic flight training and having acquired the commercial pilot’s licence – helicopter - or the flight mechanic’s licence, the personnel received theoretical and practical familiarization with police flight operations and obtained additional flight qualifications in the police helicopter squadron. Practical familiarization for pilots included approximately 35 flight hours on EC 135, of which 5 flight hours were on flight familiarization including police radio communications and tactical police flight manoeuvres and a mission training of 30 hours including a search exercise. For the aircraft type W-3A, an additional familiarization with police flight operations of another 2 hours of police flight manoeuvres was required.

The additional qualifications acquired by the pilots and flight mechanics for external load flying, winch/rope, airborne operation, air reconnaissance, VFR-Night/SX-16, BiV and FLIR operations were entered into the police helicopter squadron's *Berechtigung zur Durchführung von Flügen mit Hubschraubern der Polizeihubschrauberstaffel* (ratings for the conduct of flights with the police squadron's helicopters). According to this rating a pilot or flight mechanic was eligible to conduct flights according to administrative provision VwV PHSt Pkt. 3. It was noted that in principle the orders of the respective report form applied. Furthermore, the squadron's flight operational directives were to be adhered to. The police helicopter squadron kept their ratings for each pilot and flight mechanic up to date on a monthly basis.

1.18.3 Acquiring type rating W-3A

Until the year 2003, the training of pilots was regulated by the *Verordnung über Luftfahrtpersonal (Personnel Licensing Order) (LuftPersV)*. According to *LuftPersV para 68 (5)* the following requirement had to be met in order to acquire a type rating:

> *Helicopter pilots wanting to acquire a type rating for a transport category helicopter for the first time must account for a total flight time of 900 hours as a helicopter pilot.*

As the helicopter W-3 A was certificated as a transport category helicopter this requirement was applicable also to the pilots of the police helicopter squadron. The squadron management stated that compliance with this requirement would demand approximately 6 years.

Since 1996 the two LBA approved experts TRE and TRI of the police helicopter squadron had conducted training courses for four pilots for acquirement of W-3A type ratings.

With the coming into force of JAR-FCL 2 and the publication of the *Verordnung zur Änderung luftrechtlicher Vorschriften über Anforderungen an Flugbesatzungen vom 10.02.2003 (Regulation for the Amendment of Regulations Relating to the Requirements for Flight Crew dated February 10th, 2003)* this requirement was no longer valid. Since then, training of helicopter crews had been conducted on the basis of the *Bekanntmachung der Bestimmungen über die Lizenzierung von Piloten (Hubschrauber) JAR FCL 2 (deutsch) (JAR-FCL German)* dated 29 April 2003. JAR-FCL 2 prescribed that training had to be conducted in approved Flying Training Organizations/Type Rating Training Organizations (FTO/TRTO). The police helicopter squadron was no LBA approved training organization in terms of JAR-FCL. In April 2004, the LBA had granted the police helicopter squadron a certificate of exemption for the conduct of a training course outside an FTO/TRTO. The programme of the course was coordinated with the manufacturer of the helicopter type and was approved by the LBA. The accident pilot and one other pilot had undergone this course.

It was specified that a pilot having successfully completed the type rating training was to fly initially with the crew composition pilot/pilot. The date when a pilot may be assigned the position of pilot-in-command was to be determined individually by the two experts depending on the training level of the pilot. On 15 December 2004, the squadron management determined that the pilot was to conduct VFR flights on the aircraft type W-3A as of 1 January 2005 with the crew composition pilot/flight mechanic.

1.19 Useful or effective investigation techniques

For a better assessment of the yaw movement's characteristics, the yaw rate was calculated on the basis of the helicopter’s heading recorded by the FDR.

The FDR records the heading it received from the Slaved Gyrocompass System KCS 305 twice per second. This parameter showed a good firmness and did not jitter. In order to achieve consecutive values even at 360° the presentation of 0° – 360°must be converted. The heading was differentiated using a slight smoothing algorithm. The result was the yaw rate in degrees per second.

2. Analysis

2.1 Aircraft

As a result of the torque transmission to the main rotor, single main rotor helicopters generally develop a torque which affects the fuselage and is opposite to the main rotor's sense of rotation. This torque is counteracted by the thrust generated by the tail rotor. Thrust demand on the main rotor requires a thrust demand on the tail rotor through pedal movement in order to counteract torque.

On focal point of the investigation was the functioning of the tail rotor based on the determined course of flight.

The investigation of the entire power transmission from the main gear box to the tail rotor did not indicate any mechanical damage or other technical malfunction. FDR data showed no in-flight warnings about any malfunctions.

FDR data show that tail rotor pitch rod positions corresponded to the pilot’s control inputs. The investigation of the control cables and the tail rotor pitch control did not indicate any technical malfunctions. The right pedal movement recorded between -10 s and -7 s, which resulted in a momentary decrease of the yaw rate, indicates that the tail rotor controls were functioning.

Damage to tail rotor blades results in imbalance and is indicated by sudden, intense vibrations. FDR data show, however, that no unusual vibrations occurred. Witnesses stated that there was no collision with obstacles prior to the yaw movement. In addition, all three tail rotor blades were found close to the helicopter wreckage.

2.2 History of the Flight

The conversation recorded by the CVR indicates that the digital thermal imager was activated shortly after take off and its use was closely arranged between flight mechanic and camera operator. The search procedure "meander" suggested by the flight mechanic was applied. Based on the information given by the flight mechanic speed was reduced significantly during straight flight.

Until -23 s prior to impact, the data recorded by the FDR do not show any anomalies. At -22 s, engine torque increased within 4 s from approximately 52% to approximately 72%. From -19 s to -16 s, torque remained nearly constant whereas the pedal movement (to the right) increased continuously and considerably. During this period of time, the heading remained almost constant. This indicates that during this phase tail rotor effectiveness decreased and that the pilot had to depress the right pedal for compensation. However, the pilot succeeded in maintaining a yaw rate close to zero.

From -16 s the pilot pulled the collective pitch lever so that torque increased accordingly. In this phase the helicopter followed the rising terrain at a nearly constant height. Simultaneously with the torque increase, the pilot depressed the right pedal even farther. The pedal movement reached a value of approximately half the maximum pedal range. In this phase, the yaw movement set in and longitudinal pitch changed from approximately +9° to approximately +3° Indicated airspeed reached 50 kt.

At -15 s the helicopter started to yaw to the left. However, the pilot did not depress the right pedal farther but released it from -13 s on until it reached neutral.

The source of the two dull sounds recorded by the CVR at -12 s could not be determined. However, there were no indications of technical failures at that time. The flight mechanic's surprised expression "What now?" and the pilot's answer "I don't know" refers in all probability to the yaw rate which had at that point increased to more than 20°/s and kept on increasing. Indicated airspeed dropped to a very low value.

The parameters recorded in the further course of events show an uncontrolled flight until impact.

2.3 Specific conditions at the time of the accident

The helicopter flew at approximately 475 ft AGL, had a heading of approximately 125° and an indicated airspeed of 30 knots. According to the DWD's expert opinion wind velocity was approximately 250°, 20 knots. In relation to the aircraft's longitudinal axis there was a tail wind from the right.

Considering the mission profile flown (low forward speed, low height) and the terrain (hilly woodland) - the crew had little time to notice an emergency situation and to take appropriate remedial action.

The pilot had flown merely 7% of his total flight time on the accident type. Whereas the aircraft type W-3A is flown from the left pilot seat, the other types the pilot had flown are piloted from the right seat. The resulting different perspective relative to the aircraft longitudinal axis and the seats' different installation heights may lead to spatial misinterpretation - in critical situations and with pilots having little flight experience.

A pilot with less type experience has to concentrate harder to control the helicopter than a pilot with more type experience. A search mission in low altitude and low speed and precise flying requires also a high level of concentration from a pilot. During this mission the pilot had to accomplish both tasks. However, the danger existed that the more he attended to one of the tasks he would neglect the other. The pilot's exclamation, the flight mechanic's verbal reaction and the inappropriate control inputs as the helicopter started to yawn indicate that the pilot was overwhelmed.

The conversations recorded on the CVR indicate that the flight mechanic was very familiar with the type W-3A, the search technique and the digital thermal imager.

2.4 Defences

Defences are measures undertaken by an organization to ensure safe operations. Preventive defences, for instance, are procedures, training standards, definition of duties, etc. Last-line defences, for instance, are emergency procedures to recover from uncontrolled flight attitudes.

The flight crew's experience and training level is one of the preventive defences to avoid errors in flight operations. The pilot is solely responsible for the control of the helicopter. The flight mechanic will support the pilot only with non-piloting tasks. After acquiring the type rating, a pilot of the police helicopter squadron will - for a certain time – fly in the crew composition pilot/pilot and not the standard composition pilot/flight mechanic. During this time under supervision, the pilot will gain type and mission experience in order to become eligible to fly the helicopter as pilot in command at a later date.

The pilot had little experience on this aircraft type and flew the aircraft for the first time in the crew composition pilot/flight mechanic on the day of the accident.

To prevent the uncontrolled yaw movement, the appropriate emergency reaction would have been to initiate autorotation by immediately minimizing collective pitch and to increase forward speed. Both actions would have resulted in an extreme increase in the rate of descent. A successful autorotation landing would have been difficult even for an experienced helicopter pilot because of the low altitude left.

2.5 Organizational environment

2.5.1 Helicopter squadron

At the time of the accident, the helicopter squadron had no *Safety Management System.* One of the functions of a Safety Management System is the identification of potential intra-organizational flight safety risks resulting from operations, procedures or equipment. In the BFU's opinion, the elimination of the legal requirement for a minimum 900-hour flight experience to acquire the type rating for the helicopter W-3A represents a significant change of the former training process. This change has brought about operational advantages concerning the mission schedule. This resulted in a considerably shorter period of time after which a pilot could fly both helicopter types of the squadron without restrictions. The police helicopter squadron had not specified prerequisites to be met by pilots to become eligible for training on the W-3A type.

It is the BFU's opinion that the squadron's decision to assign the pilot to the position of PIC as of 1 January 2005 when he had merely about 15 hours VFR flights under supervision, did not sufficiently take into account that the pilot had only half the total helicopter flight experience previously trained helicopter pilots had been required to have. A Safety Management System would have provided for a risk assessment of the new training requirements prior to their becoming effective. There was no regulation requiring the police helicopter squadron to establish such a system.

It is the opinion of the BFU that the police helicopter squadron's established flight operation standards on the one hand and the practice applied on the day of the accident on the other hand were inconsistent. The flight operational directive requires that the applicable training be completed and be entered in the individual qualification record as a prerequisite to be met to perform FLIR operations. According to the report form the mission was defined as search mission with FLIR and the pilot was assigned although he did not have a FLIR rating. The digital thermal imager was used during the search operation. The squadron's procedures for flights to search for persons or objects include guidelines based on a visual search of the crew or other personnel aboard the aircraft without support of any technical surveillance system (TV/FLIR camera). FLIR operations procedures contain guidelines for search missions conducted exclusively with TV/FLIR cameras. The different kinds of FLIR operation such as VFR, VFR-Night and VFR-Night (BiV) are differentiated and procedures for effective and ideal use of the technical equipment are described. No procedures were developed for visual search with the help of the digital thermal imager. Nor were there guidelines for the use of the digital thermal imager outside of FLIR operations or the required qualifications of crew members.

On the day of the accident, type EC-135, which the pilot was more familiar with, was not available due to maintenance action. No use was made of the possibility to support the pilot by a more experienced pilot or to have the mission conducted by another pilot.

2.5.2 Aeronautical regulation setting

Helicopter air carriers are subject to JAR-OPS 3. According to the latter, the establishment of a quality management system with a quality assurance programme is required. The operator shall specify - in the flight operations manual - the flight crew members' qualification and experience requisite for retraining and the minimum experience for a pilot to be eligible for a commander position within the organisation. The requirements of JAR–OPS 3, however, explicitly do not apply to helicopters when used in military, customs and police services. There are no specific aeronautical regulations for flight operations of police helicopter squadrons.

European Parliament Council Regulation (EC) No 1592/2002 dated 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency does not apply to military, customs and police operations. However, the regulation includes the requirement for the Member States to ensure that such services have due regard as far as practicable to the objectives of this regulation. The

main intention of the regulation is to achieve and to maintain a uniform and high level of flight safety in Europe.

In the BFU's opinion, the continuously broadening range of police helicopter squadron duties, the increasingly sophisticated technology of helicopters and the obligation to ensure a high level of flight safety mandates an ever higher degree both of the police helicopter squadron's organisation and the flight crew's qualification. Currently, individual police helicopter squadrons differ considerably in size and organisational structure.

At present, there is no legal basis for support and/or supervision of police helicopter squadrons by aviation authorities regarding flight operational aspects, such as organisational structure or safety architecture comparable to commercial operators.

3. Conclusions

3.1 Findings

- Pilot and flight mechanic held licences and ratings required by the civil aviation authority.
- The helicopter was certificated, equipped and maintained in accordance with the existing regulations.
- Mass and centre of gravity of the helicopter were within the prescribed limits.
- According to the report form "Soforteinsatzflug" the crew had the order to conduct a search mission with FLIR although the pilot did not have the rating required by the squadron.
- The course of flight adapted to the use of the digital thermal imager displayed significant characteristics of FLIR operation.
- The pilot in command had little flight experience on the aircraft type.
- Based on the autopsy and toxicology, there was no evidence to indicate that the pilot's and flight mechanic's performance was degraded by physiological factors.
- There was no evidence of tail rotor drive malfunction or tail rotor control failure.
- The investigation revealed that the pilot lost control of the helicopter because of a control error which induced a yaw movement.
- The maximum yaw rate specified in the Rotorcraft Flight Manual was exceeded.
- FDR and CVR recordings provided vital insights about actual flight status, accident related communication and the crew's actions.
- The accident was not survivable for pilot and flight mechanic due to the severity of the injuries sustained by the impact.
- The helicopter was destroyed by impact forces and a post-impact fire.
- The pilot's training level was not sufficiently taken into account when making a decision concerning the formation of the crew for this particular mission.

- The provision of Regulation (EC) No 1592/2002 to achieve and maintain a uniform and high level of flight safety in Europe has not been implemented by adequate regulations in the Federal Republic of Germany in the area of flight operations of police helicopter squadrons as yet.

3.2 Causes

The causes of the flight accident were:

Immediate causes:

- The mission order given did not sufficiently consider the pilot's qualification and experience level.
- In a low altitude the helicopter became uncontrolled because of control errors.

Systemic causes:

- The police helicopter squadron's procedures for pilots on the accident aircraft type were insufficient regarding their flights under supervision (including flight time and range of missions).
- The aeronautical regulations for operations of police helicopter squadrons were insufficient.

4. Safety Recommendation

4.1 Squadron management's actions

The police helicopter squadron's management has implemented a flight operation directive on 25 April 2005 regulating the acquirement of the type rating and the composition of crews for the aircraft type W-3A.

The latter includes that prior to the acquirement of the W-3A type rating a minimum of 900 flight hours on rotorcraft is required. After acquiring the type rating, a minimum of 300 flight hours on the type under supervision of a "qualified pilot" are required prior to the pilot being eligible to fly in the crew composition pilot/flight mechanic.

"Qualified pilots" are TRI/TRE on the aircraft type W-3A or pilots with a minimum of 1,700 hours of total flight experience on helicopters, of which at least 500 flight hours were on the type. The flight operations manager determines the supervising pilot.

In order to stay current it was established that each pilot must have at least 40 flight hours per calendar year and at least one training flight or mission flight within the last 30 days.

Based on these actions of the squadron management, the BFU has abstained from a safety recommendation concerning this matter.

4.2 Safety recommendation

The BFU has issued the following safety recommendations in order to prevent future accidents:

Recommendation No 01/2006

To ensure a high level of flight safety the Federal Ministry of Transport, Building and Urban Affairs should agree with the Federal and Land authorities responsible for the police on establishing aviation regulations for the operation of police helicopter squadrons such that the specific requirements of police missions are met and a safety level similar to that ruling the commercial use of civil helicopters is ensured (ref. JAR-OPS 3).

Recommendation No 02/2006

The Saxon State Ministry of the Interior should ensure that the police helicopter squadron Saxony establishes an effectively working Safety Management System.

This system should especially ensure that:

- Latent risks in established procedures are discovered and corrected at an early stage.
- through implementation of new systems or procedures safety losses are prevented.

Braunschweig, 17 May 2006

German Federal Bureau of Aircraft Accidents Investigation

For the BFU

Friedemann

Investigator in charge

The following BFU staff members have participated in the investigation

Klaus Büttner	Technical issues
Uwe Berndt	Field investigation, documentation
Joachim Schütte	Field investigation, flight operations
Karsten Severin	Human Factors
Axel Thiel	Flight data recorder, cockpit voice recorder
Dieter Ritschel	Flight data recorder, cockpit voice recorder
Uwe Pitz	Reconstruction of the flight path

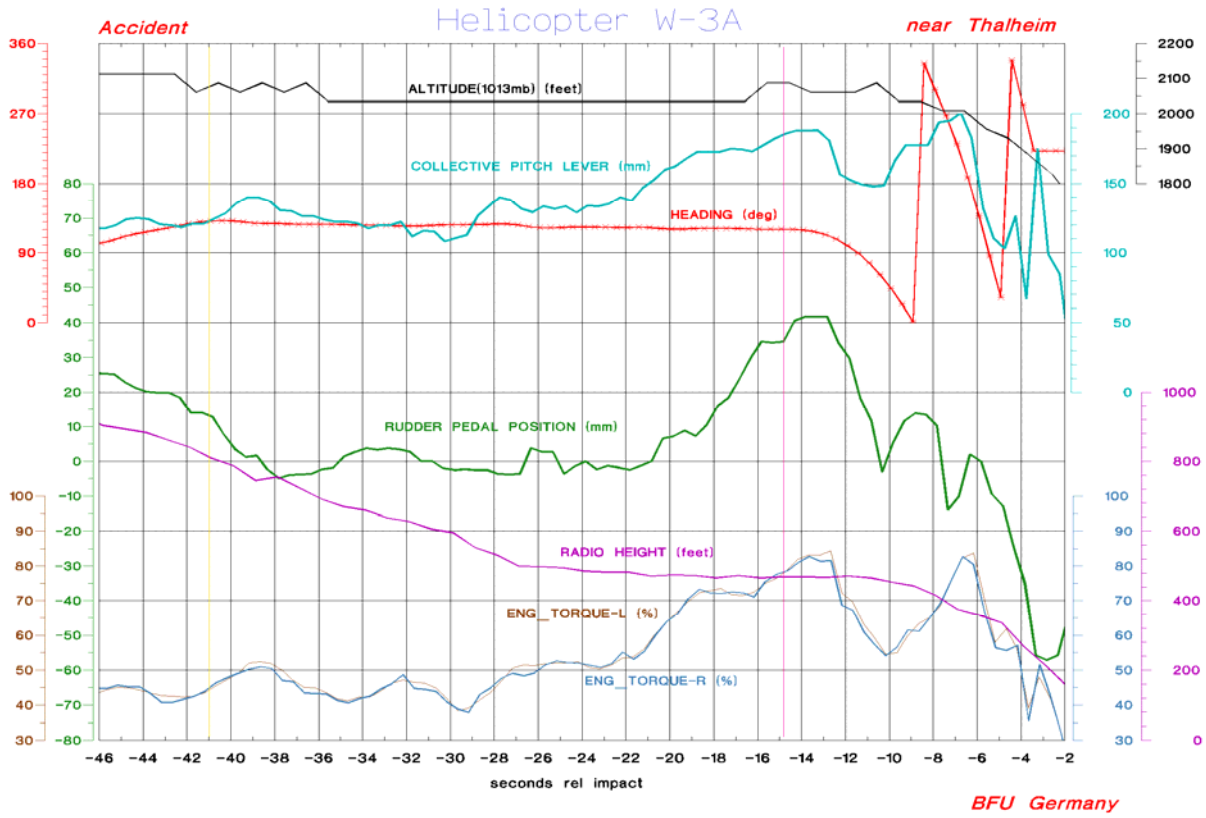
5. Appendices

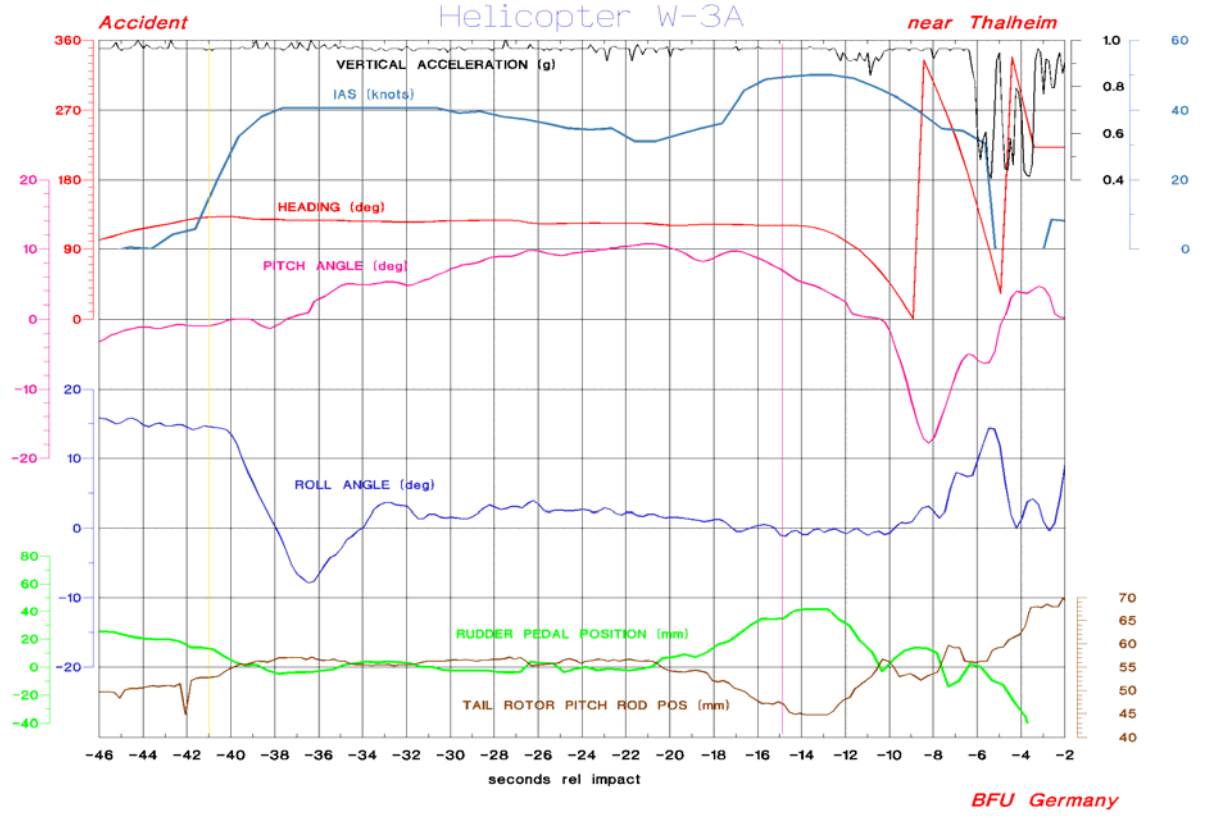
Attachment 1 Recordings of the flight data recorder, the last 44 seconds

Attachment 2 Recordings of the flight data recorder, the last 22 seconds with the calculated yaw rate

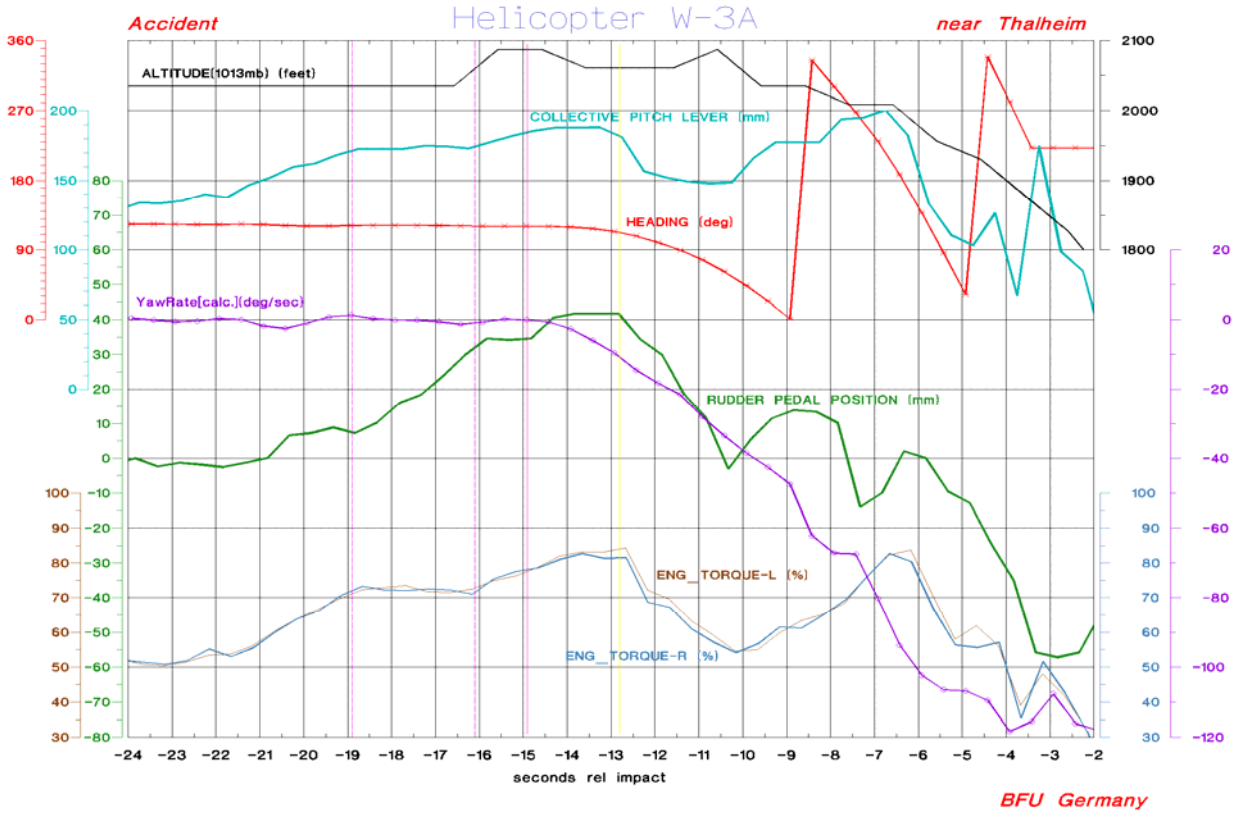
Attachment 3 Reconstruction of the flight path

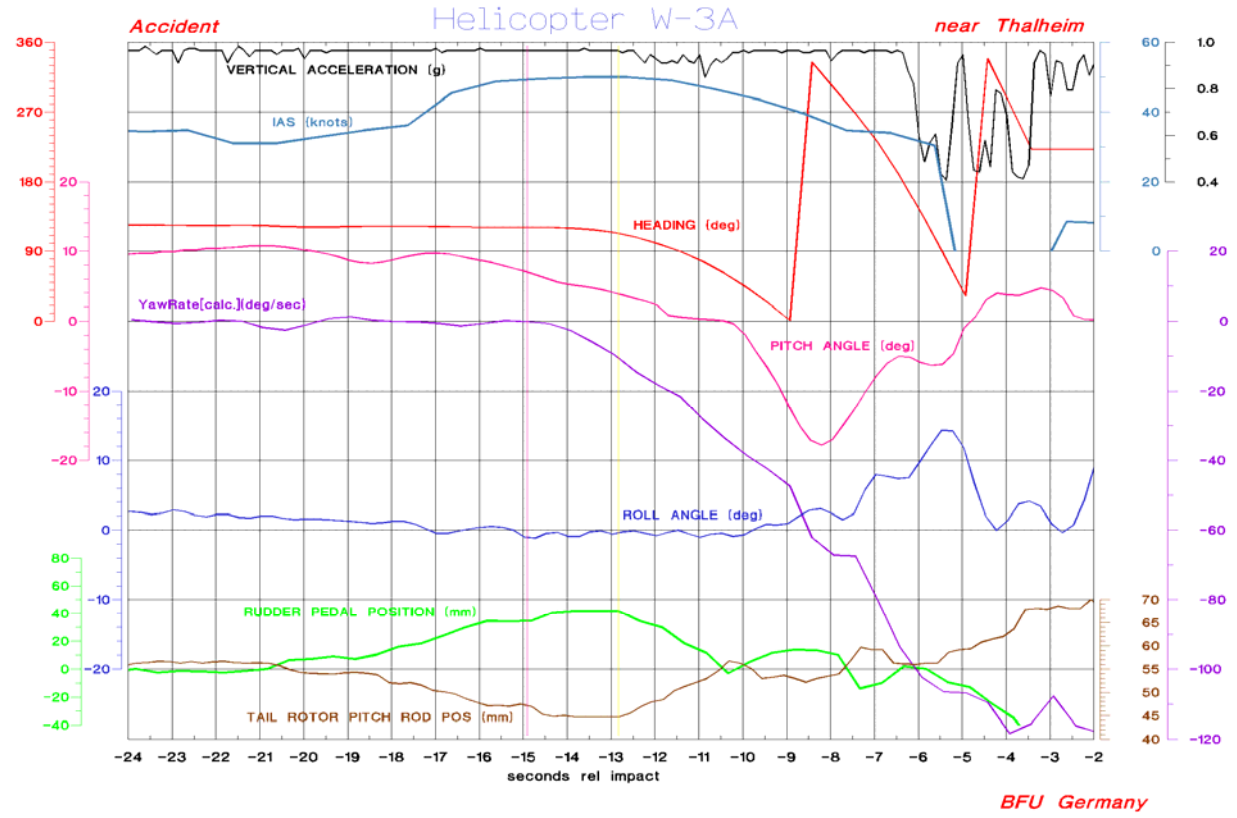
Attachment 1 Recordings of the flight data recorder, the last 44 seconds





Attachment 2 Recordings of the flight data recorder, the last 22 seconds with the calculated yaw rate





Attachment 3 Reconstruction of the flight path based on radar data