

Interim Report

Identification

Type of Occurrence:	Accident
Date:	5 December 2012
Location:	Neustädter Bucht
Aircraft:	Helicopter
Manufacturer / Model:	Eurocopter / AS 350BA
Injuries to Persons:	Pilot and system operator fatally injured
Damage:	Aircraft severely damaged
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU CX024-12
Published:	February 2013

Factual Information

During a ferry flight with an AS 350BA helicopter from Germany to Sweden radar and radio contact was lost in the area of the Lübecker Bucht (Lübeck Bay). After a search lasting for several days the helicopter and the two missing persons were found in the area of the Neustädter Bucht (Neustädt Bay) and subsequently recovered.

History of the Flight

Since February 2012, the Norwegian operator conducted Laser-Scan measuring flights with AS 350 helicopters in Norway, Sweden, Denmark and Germany for a Swedish contractor. On 16 November 2012 the measuring flights in Germany began. Due to several flight cancellations caused by the weather, the measuring flights in Germany should be stopped for 2012 and the helicopter was to be flown back to Norway.

On the day of the accident at about 1345 hrs¹ the pilot took off from Lübeck Airport (EDHL) with Halmstad (ESMT), Sweden, as his destination. He was accompanied by a system operator. In Halmstad the additional mission equipment was to be removed and periodic maintenance work on the helicopter was to be conducted before continuing the ferry flight to Norway.

For the flight to Sweden the pilot had filed a flight plan. It stated a cruising speed of 100 kt and Visual Flight Rules (VFR) as altitude without any explicit route. Flight time to Halmstad (ESMT) was given as two hours. The flight time to the border to Denmark was given as 10 minutes and to Sweden as one hour and 40 minutes. The flight plan listed three hours as maximum flight time.

After he had left the control zone the helicopter flew with a northern heading toward the western coast of the Neustädter Bucht. According to the radio transcript the pilot established radio contact with Bremen Information (125.10 MHz) at 1352 hrs. His attention was called to a temporary restricted area in the area of Sierksdorf Special Airfield (EDXT) straight ahead. The flight information service recommended to pass it either to the right or left. The pilot suggested to fly east toward Fehmarn. At that time a transponder signal of the helicopter was no longer recorded and the flight information service called the pilot's attention to the fact that he could only see a primary signal on his radar screen. The pilot said he would turn the transponder off and on again. He once again asked for the extent of the restricted area and how far east he would have to fly round it. The flight information service recommended to fly across the Lübecker Bucht toward the town Grömitz. The pilot acknowledged it and turned east after he had once again received the information that the restricted area was directly ahead of him. At 1357 hrs the flight information service informed the pilot that now not even a primary signal was visible on the radar screen and he could no

¹ All times local, unless otherwise stated.

longer provide any traffic information. At 1357:30 hrs the pilot transmitted an unintelligible sentence with an excited voice and then radio contact ceased.

Radar equipment of the Bundeswehr (German armed forces) recorded the last primary signal of the helicopter at 1357:47 hrs coming from approximately the middle of the Neustädter Bucht (54°02'44"N 010°50'45"E) with a heading of 084°.

After radio contact had ceased the flight information service tried several times to re-establish contact directly or by asking other aircraft to serve as substations. Once it became clear that these attempts were futile and it was suspected that an accident had occurred, the search and rescue service was notified at about 1431 hrs. The search for the helicopter and the two persons began.

On 13 December 2012 the helicopter and the two persons were found in a depth of about 20 m on the seabed of the Neustädter Bucht. The two persons were found about 50 m and 70 m, respectively, away from the helicopter.

On 14 and 15 December the helicopter and the two persons were recovered after the underwater wreckage situation had been documented.

Personnel Information

The 27-year-old pilot held a Norwegian Commercial Helicopter Pilot's License issued in accordance with JAR-FCL 2. It was initially issued on 27 May 2007 and valid until 2 February 2016. The license contained the type ratings as Pilot in Command (PIC) for AS350/B3/EC130B4. He held a class 1 medical certificate issued in accordance with JAR-FCL 3, with the restriction to wear glasses (VDL and RXO); it was valid until 1 December 2013.

He had become an employee of the Norwegian operator in April 2008. Initially he worked as load master during fire fighting missions with helicopters. In addition, he flew as PIC Under Supervision (PICUS) for about 390 hours. Since February 2012 the operator deployed him as PIC.

The Norwegian operator stated his total flying experience was about 530 hours; since May 2007 most of them on AS 350 helicopters.

The system operator was 32 years old. He was an employee of the Swedish contractor. During the entire time of the measuring flights in Germany he had been deployed together with the pilot.

Aircraft Information

The single-engine helicopter AS 350B manufactured by Eurocopter (formerly Aerospatiale) is a lightweight multi-purpose helicopter for up to six occupants. It was certified according to FAR/JAR Part 27 in 1977. The model AS 350BA was certified in 1991. It is equipped with a Turbomeca Arriel 1B engine, a Star-Flex three-blade main rotor, landing skids and a tail rotor for anti-torque. The tank has a volume of 540 litres. Maximum take-off mass of the model AS 350BA is 2,100 kg. The manufacturer stated that until the end of 2011 3,931 AS 350 helicopters were produced. Together they had been operated for a total of about 18,880,000 hours.

In normal operation at 394 revolutions per minute (rpm) on the main rotor the tail rotor has about 2,086 rpm. It is powered by a two-part tail rotor drive shaft. The drive shaft consists of a forward, short steel shaft and a rear longer multiple mounted aluminium alloy shaft. The two drive shafts are connected to each other by means of flexible couplings and a splined end fitting for length compensation. In normal operation and during autorotation the drive shaft rotates with about 6,125 rpm. The tail rotor drive shaft runs above the tail boom to the tail rotor gear box. It is covered by a fairing consisting of several segments.

The helicopter was built in 1978 as a B version and had the manufacturer's serial number 1017. It was transformed 1995 in a BA version. The empty weight was about 1,275 kg. The last airworthiness inspection was conducted and the Airworthiness Review Certificate (ARC) issued on 20 September 2012. On 8 November 2012 at a total of 12,941 operating hours the last release to service was issued after a maintenance check (W.O. 9) including a prescribed periodic visual inspection of the engine. At the time of the accident, the helicopter had a total of approximately 12,970 operating hours. The helicopter was registered in Norway and operated by a Norwegian operator.

The helicopter was equipped with a so-called Saab TopEye™. It consisted of a cargo container below the fuselage between the skids and a computer rack in the rear cabin. The Swedish Modification Certificate No. *M1/95, Rev.5* was issued for the additional mission equipment. According to the owner of the additional equipment it weighed about 220 kg. The flight manual supplement for flights with installed TopEye™ (Supplement TopEye™, No. 8081 001-102 and -103) stipulated a maximum airspeed (VNE) of 105 KIAS. The airspeed in normal cruise is reduced by

about 30 KIAS due to the higher aerodynamic drag. The rate of descent during an autorotation is therefore higher by approximately 150 ft/min.

The following items were found on board of the helicopter: Personal effects of the pilot and the system operator (roughly 30 kg), a crate filled with oil cans (15 kg), a battery charger (6 kg), an external power cable (3 kg), a portable external power battery (26 kg), transport wheels for the helicopter (attachable to the skids) (44 kg), rotor blade socks and engine cover (3 kg), a toolbox (5 kg), a bag with ropes for external loads (9 kg), a fuel pump including pipes and filters (26 kg), several cases for storage mediums and other additional equipment for the mission (11 kg). Further, the helicopter was equipped with a set of mirrors for external load transport and the skids were fitted with so-called bear paws.

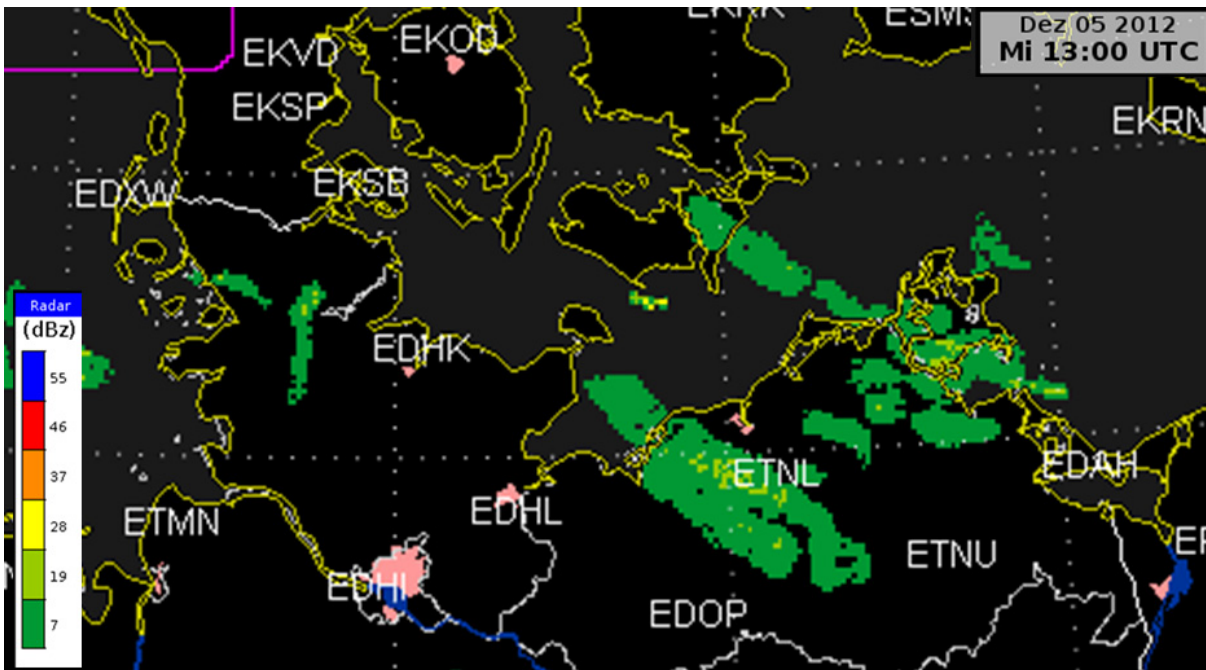
According to the aircraft logbook the helicopter was completely filled with fuel on 3 December 2012 for the flight from Braunschweig to Lübeck. The flight time was one hour. On the day of the accident the helicopter was refuelled at Lübeck Airport with 191 litres Jet A-1 fuel and prior to take-off the rotor blades had been de-iced with 63 litres de-icing fluid.

The helicopter was not equipped with emergency floats. Life vests were not found in the helicopter.

Meteorological Information

According to the Meteorological Aviation Report (METAR) of Lübeck Airport (EDHL), at the time of the accident there was a visibility of more than 10 km, no clouds below 5,000 ft (CAVOK), wind from 280° with 8 kt, and a temperature of -2°C with a dewpoint of -6°C. Air pressure (QNH) was 1,001 hPa.

The radar precipitation pattern of the Deutsche Wetterdienst (German meteorological service provider, DWD) did not show any precipitation in the area of the Neustädter Bucht. The precipitation east of the Lübecker Bucht moved toward the south-east.



Radar image at the time of the accident

Image: DWD

The Bundesamt für Seeschifffahrt und Hydrographie (BSH) (Federal Maritime and Hydrographic Agency) stated the water temperature at the day of the accident was about 4°C.

In Neustadt, Holstein, sunset was at about 1555 hrs; in Halmstad, Sweden, the destination airport, at about 1532 hrs.

Aids to Navigation

The operator had provided an iPad including mounting for pre-flight preparation and navigational support which was aboard the helicopter.

Communication

Radio communications between pilot and Lübeck Tower on 3 December 2012 and on 5 December 2012 and with Bremen Information on 5 December 2012 have been made available to the BFU for evaluation purposes as transcripts and as recording, respectively.

According to the transcript of Lübeck Tower (128.70 MHz) there was no transponder signal from the helicopter between take-off and leaving the control zone. At 1351:32 hrs, after the pilot had passed reporting point November in 500 ft and

requested to leave the frequency a signal was received for a short time and the pilot was informed accordingly.

The Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (French civil aviation safety investigation authority, BEA) as well as the BFU conducted a spectral analysis of the background noise recorded during radio communications between the pilot and Bremen Information which did not reveal any clear indication regarding an engine failure or any other technical defect.

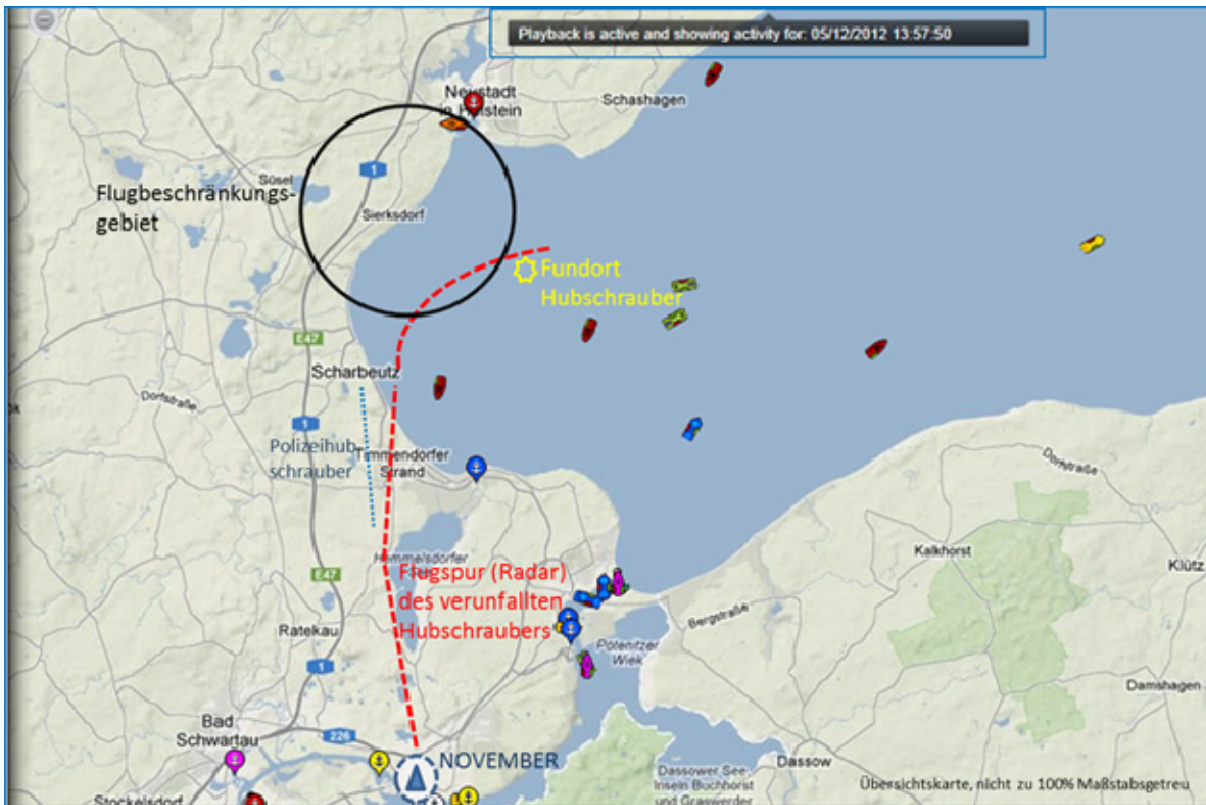
Several persons tried to interpret the last radio communication of the pilot. Contradictory interpretations were the result. Subsequently, the BFU asked the Institut für Nachrichtentechnik (Institute for Communications Technology) of the Technische Universität Braunschweig for support. Their analysis of the last radio communication did not offer an unambiguous result either. The following analyses / interpretations were heard or a technological result: *I hope we have a great xxx*, or *xxx xxx we are going stuck*, or *xxx xxx we are going south*. The investigator in charge heard: *I hope we have a break shaft*; investigators of the French and Norwegian accident investigation authorities heard: *we are going down*.

Information on the Aerodrome of Departure, the Temporary Restricted Area and the Location of the Wreckage

According to the statements of the operator and the analysis of the radio communications, the helicopter landed at Lübeck Airport on 3 December 2012 due to worsening weather conditions along the flight path for the ferry flight. Until 5 December 2012 the helicopter was parked on the apron in front of Hangar B. Lübeck Airport has a control zone with the exit point November in northern direction.

The Aeronautical Information Publication (AIP) SUB VFR 18 (ENR) of 29 November 2012 stated that in the area around Sierksdorf a temporary restricted area will be established between 4 December 2012 and 6 December 2012 (NFL I-294-12). It had a radius of two Nautical Miles (NM) around the coordinates N 54 04 25 E 010 46 40 and extended from the ground up to Flight Level (FL) 100.

The so-called Neustädter Bucht is the north-west part of the Lübecker Bucht. This area of the Baltic Sea is often used by the Bundesmarine (German navy) for military training. Water depth can reach up to 20 m. The distance to cross the Neustädter Bucht from the town Niendorf in the south to the Lighthouse Neustadt in the north is about 6.5 NM. Here the maximum distance to shore is about 3.6 NM.



Overview of the Neustädter Bucht

Photo: Google Maps TM / Shipfinder / BFU

Flight Recorder

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.

Several video cameras at Lübeck Airport have recorded the loading, refuelling, de-icing and the engine start-up until lift-off for taxi of the helicopter. The video data was made available to the BFU for evaluation purposes. The recordings show that the helicopter had been covered with a layer of frozen and crusted snow which could not simply be brushed off. The pockets of the rotor blade socks were frozen to the blades. The pilot needed several minutes to free each rotor blade from its blade sock. After the luggage had been stored the upper surface of each rotor blade was brushed off by hand and afterwards de-iced. Prior to engine start-up the pilot walked around the helicopter and also removed the cover of the engine air intake. Additional opening of maintenance compartment doors and the engine cowling could not be determined.

The iPad found in the helicopter is at the BFU.

Wreckage and Impact Information

The accident occurred in the area of the Neustädter Bucht. The helicopter was found at coordinates 54°02'39"N 010°50'33"O. The last radar recording occurred about 253 m north-east of these coordinates. The location of the helicopter wreckage was more than 4,600 m from the closest shore. The two persons were found 50 m and 67 m, respectively east of the helicopter.

The helicopter was lying on the seabed of the Neustädter Bucht on its main rotor hub, tilted right toward the left fuselage side. The tail boom had been severed and was found next to the fuselage beneath the skid cross beam opposite to the fuselage direction with the horizontal stabiliser horizontally on the ground and the tail skid pointing upward. One of the main rotor blades jutted out and pressed down on the tail boom prior to the vertical fin with its trailing edge. In this area the trim edge of the rotor blade was damaged. The right cabin door, the safety belts on the seats front right and rear right were open. On the left front seat one of the two transport wheels for the helicopter was fastened with the seat belt.



Fuselage lying on its side with open cabin door and tail boom



Photos (2): Navy / Police

Fuselage and tail boom were recovered individually of each other. After the fuselage had been recovered it was determined that all maintenance compartment doors and fairings were closed and secured. The cabin's front windows and the window panes on the right side and the door were intact. The window panes of the left side were pushed inside the fuselage. The left bottom window pane was missing. The left lower fuselage side and the area of the front skid cross tube were pushed in. The front part of the TopEye™ cargo container was pushed in and torn open.



Fuselage after recovery



Photos (2): BFU

The main gear box, the engine, the control units and the hydraulic system did not show any apparent damages after the mud had been washed off. The fuel control lever was locked in position "flight". Of the three main rotor blades only the "yellow" showed slight damages in the area of the trim edge and the "red" blade had a bent wing tip at the end of the blade. On the rotor head the Star-Flex to all three blade grips was torn off. The power transmission from the turbine to the drive shaft, main gear box and main rotor shaft was connected. The free-wheeling unit opened and locked as designed. The forward tail rotor drive shaft protruded from the aft fuselage section. The sheet metal of the fracture area on the aft fuselage section where the tail boom had been torn off was dented on the underside, the right side was warped and the left stretched.



Damages on the aft fuselage and the Star-Flex



Photos (2): BFU

The forward flexible coupling of the tail rotor drive shaft on the engine's backside was torn. The fairing in this area and the two half shells surrounding the beginning of the drive shaft showed rotation tracks, were torn out of their mountings and damaged.



Damages on the forward coupling of the tail rotor drive shaft

Photos (2): BFU

On the rear end of the tail rotor drive shaft the flexible coupling was pushed in, the flanks of the flanges were bent and one flange was torn off. On the outer side of the splined flange rotation tracks were found. The securing nuts were deformed and the washers were partially jaggedly pushed in.

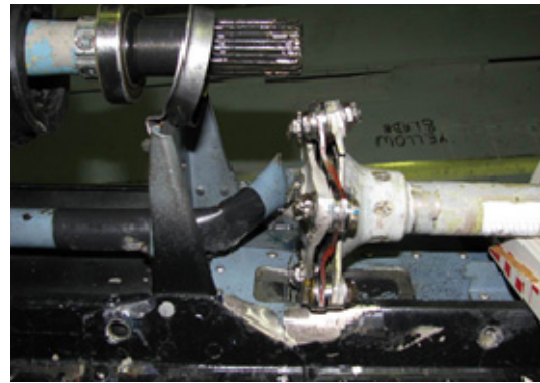


Damages on the rear coupling

Photos (3): BFU

After the tail boom was recovered it was determined that the tail rotor was undamaged. Soot and combustion residue had not been washed off the tail rotor. One of the two pitch links was slightly bent. Except for the most forward tail rotor drive shaft fairing all segments of the fairing were intact. The rear tail rotor drive shaft could be turned soundlessly and without resistance. The tail rotor gear box transmitted the rotation and the tail rotor turned. The chip detector of the tail rotor gear box was free of chips. The tail rotor gear box was filled with water. The foremost segment of the tail rotor shaft fairing was milled from the inside out in the area of the

flexible coupling. The foremost three quick release fastener on the left side were torn out. The inside of the fairing showed straight scratch marks stretching from the milling groove to the forward fairing opening.



Damages on the forward tail rotor drive shaft fairing and coupling

Photos (3): BFU

After the helicopter was recovered it was brought to Neustadt, Holstein. The BFU examination of the helicopter was supported by representatives of the French civil aviation safety investigation authority (BEA), the helicopter manufacturer Eurocopter, and the engine manufacturer Turbomeca. Among other things, the engine was examined by borescopy and the Fuel Control Unit (FCU) removed for further examination at the manufacturer. While dismantling the FCU a contaminated FCU fuel inlet strainer was found (particles and some kind of jelly). The engine was examined on site and no indications for mechanical damage or an operations failure were found.

The helicopter was transported to Braunschweig and there the airframe fuel filter in the fuselage was examined. It was determined that no filter element was installed in the fuel filter housing. The last documented maintenance and check of the fuel filter occurred in February 2012; about 227 operating hours ago. A visual inspection of the fuel sump of the helicopter did not show any indication of contamination.

On 8 January 2013 the FCU was examined at Turbomeca facilities in the presence of BEA representatives. It was determined that the contaminated FCU fuel inlet strainer did not impair fuel regulation in comparison with a new fuel inlet strainer. The FCU functioned in accordance with the manufacturer information. The FCU was subject to a maximum life cycle of 10 years (calendric). The last overhaul of the FCU had occurred on 13 May 2002 and had been documented in the respective log card.

1.13 Medical and Pathological Information

A post-mortem examination was performed on both persons. It was determined that the cause of death was hypothermia in combination with drowning. There were no injuries due to the emergency landing on the water.

Fire

There was no fire.

Survival Aspects

Search Process for Survivors and the Helicopter

About 34 minutes after radio contact with the helicopter had ceased the Search and Rescue Centre Glückburg (SAR) was notified. The SAR Glückburg requested the filed flight plan and called each airport along the suspected flight route asking for the missing helicopter. An emergency locator transmitter signal of the helicopter was not intercepted. At 1455 hrs it was confirmed that RCC Copenhagen did not have any contact with the helicopter. At 1647 hrs the SAR helicopter in Warnemünde was notified. At 1735 hrs two helicopters (Bundeswehr (German armed forces) and Bundespolizei (German federal police)) reached the search area. At about 2115 hrs the search was aborted due to worsening weather conditions.

In the following days several ships and aircraft participated in the search for survivors and wreckage parts. On 6 December 2012 a backpack was found on the beach of the northern shore of the Neustädter Bucht. It could be clearly identified as property of one of the occupants of the helicopter. Other pieces of luggage or parts of the helicopter were not found. On 7 December 2012 the search was abandoned to discuss other options. On 10 December 2012 the Bundesmarine (German navy) made available for the underwater search: the minesweeper "Passau" equipped with

a sonar and one autonomous submarine of the REMUS family with side scan sonar and mine diver. From 11 December 2012 on two BFU staff members were aboard the "Passau" supporting the crew in the interpretation of the information regarding the course of the flight and the determination of the search area. In addition, the crew received extended information including explanation regarding the helicopter so that the interpretation of the sonar images could be improved.

After the helicopter had been located, an area of 500 x 500 m surrounding the site was searched with the submarine. The two occupants were found about 50 m and 70 m, respectively, away from the wreckage on the seabed. The two BFU staff members switched to the multi-purpose vessel "Scharhörn". On 14 December 2012 and 15 December 2012 the BFU staff members supported the "Scharhörn" crew and the police divers in the preparation and execution of the recovery of the persons and the helicopter. Immediately after the recovery of the helicopter it was cleaned with fresh water. Subsequently, the BFU staff members conducted an initial examination of the helicopter. On the evening of 15 December 2012 recovery work was completed.

Survival in Cold Water

A study of the United States Search and Rescue Task Force states that one has approximately 10 to 15 minutes until exhaustion or loss of consciousness occurs in cold water of 0 - 4°C without protective clothing and depending on the physical condition. Overall survival time is given with 30 - 90 minutes.

The study of the Institute of Naval Medicine, University Portsmouth (Golden and Henry 1981), states that there are different stages during a plunge into cold water with a temperature of less than 15°C. Stage 1 is the plunge reflex and cold shock. Within the first 3 - 5 minutes danger of drowning is imminent due to reflexive breathing under water, reduced ability to hold one's breath and uncontrolled quick breathing. Stage 2 is the incapability to swim due to hypothermia of the muscles and nerves close to the skin. Within 3 - 30 minutes drowning due to failure of the muscular power and skill is possible. Stage 3 is hypothermia. Hypothermia of the body results in drowning due to loss of consciousness or cardiovascular failure.

Protective clothing was neither found aboard the helicopter nor were the recovered persons wearing them.

The operator stated that three life vests should have been aboard the helicopter.

Organisations and their Procedures

The operator of the helicopter was certified in Norway in accordance with JAR OPS 3. The operator stated the company is the largest inland Norwegian helicopter operator. The company headquarters is located in Trondheim, Norway. The company has additional offices in Norway. The company operates a total of 23 helicopters, several of which are AS 350 helicopters. It has its own maintenance organisation certified in accordance with EASA, Part 145 and in general it conducted all maintenance work.

From the company's perspective the flights in Germany including all ferry flights were so-called aerial work.

The Luftfahrt-Bundesamt (German civil aviation authority, LBA) issued an entry permit valid from 5 November 2012 to 31 December 2012 for the flights in Germany.

Aeronautical Regulations

JAR-OPS 3 regulates commercial flight operations with helicopters Europe-wide. JAR-OPS 3,540 ff stipulates for single-engined helicopters (flight performance class 3) that the conduct of the flight is to be planned and conducted in a way that an emergency landing in case of engine failure is possible at all times. According to JAR OPS 3.825 *An operator shall not operate a helicopter for any operations on water or on a flight over water: (1) When operating in Performance Class 3 beyond autorotational distance from land. According to JAR OPS 3.825 (2) ... is equipped with life jackets equipped with a survivor locator light, for each person on board, ...* According to JAR OPS 3.827 (b) *An operator shall not operate a helicopter in Performance Class 3 on a flight over water beyond autorotational or safe forced landing distance from land when the weather report or forecasts available to the commander indicate that the sea temperature will be less than plus 10°C during the flight, unless each member of the crew is wearing a survival suit.* According to JAR OPS 3.830 (1) *In the case of a helicopter carrying less than 12 persons, a minimum of one liferaft with a rated capacity of not less than the maximum number of persons on board; JAR OPS 3.843 states (d) An operator shall not operate a helicopter in Performance Class 3 on a flight over water beyond safe forced landing distance from land unless that helicopter is; so designed for landing on water; or is certificated in accordance with ditching provisions; or is fitted with emergency flotation equipment.*

In Germany there are similar regulations in the Third Executive Order for the Regulation on Operation of Aircraft (3. DV LuftBO) para 22 and para 23 also for so-called aerial work and non-commercially operated helicopters over water.

The Norwegian civil aviation authority published the Aeronautical Information Circular (AIC-N) 30/10 on 2 November 2010 regarding "Flights with helicopters over water". It included all aviation regulation valid in Norway (JAR OPS 3 and BSL D2-2) for commercial passenger transport and aerial work with helicopters over water.

Additional Information

On the flight to Halmstad the Fehmarnbelt would have to be crossed. Between the island Fehmarn and the island Lolland the Fehmarnbelt is about 11 NM wide (at the narrowest part). Between Denmark and Sweden several short flights over water would have been necessary to reach Halmstad.

Investigator in charge: Axel Rokohl

Field Investigation: Thomas Kostrzewa, Axel Rokohl

This investigation is 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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