

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	28 February 2014
Location:	Baltic Sea, about 3 NM north of Prerow
Aircraft:	Helicopter
Manufacturer / Model:	Airbus Helicopters Deutschland GmbH / BK117 C-1
Injuries to Persons:	Three persons fatally injured, one person suffered minor injuries
Damage:	Aircraft severely damaged
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU 3X006-14

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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Abbreviations

AAIB	(UK) Air Accidents Investigation Branch
AFCS	Automatic Flight Control System
ALT	Altitude
AMC	Acceptable Means of Compliance
AOB	Angle Of Bank
AOC	Air Operator Certificate
AP	Autopilot
ARC	Airworthiness Review Certificate
ATPL(H)	Airline Transport Pilot Licence (Helicopter)
ATT	Attitude Mode
BKN	Broken
CAT (A)	Category (A)
CFIT	Controlled Flight Into Terrain
CM	Crew Member
CIAIAC	Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (Spanish Safety Investigation Authority)
COP	Co-pilot
CPL	Commercial Pilot Licence
CRD	Comment Response Document
CVR	Cockpit Voice Recorder
DAFCS	Digital Automatic Flight Control System
DFS	Deutsche Flugsicherung (German air traffic service provider)
EASA	European Aviation Safety Agency
ELT	Emergency Locator Transmitter
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation

FCL	Flight Crew Licensing
FD	Flight Director
FDM	Flight Data Monitoring
FDR	Flight Data Recorder
FMS	Flight Manual Supplement
GA	Go-Around
HDG	Heading
HCM	HEMS Crew Member
HEED	Helicopter Emergency Egress Device
HEMS	Helicopter Emergency Medical Services
HFDM	Helicopter Flight Data Monitoring
HHO	Helicopter Hoist Operation
Hi-Line	A weighted line to haul in the winchman
HOGE	Hover Out of Ground Effect
HUET	Helicopter Underwater Escape Training
HUMS	Health and Usage Monitoring System
IAS	Indicated Airspeed
IFR	Instrument Flight Rules
IHST	International Helicopter Safety Team
ILS	Instrument Landing System
JAR	Joint Aviation Regulation
LBA	Luffahrt-Bundesamt (German civil aviation authority)
LDP / DPBL	Landing Decision Point / Defined Point Before Landing
MCC	Multi Crew Concept
METAR	Meteorological Aerodrome Report
MRCC	Maritime Rescue Coordination Centre

NM	Nautical Mile
NPA	Notice of Proposed Amendment
OEI	One Engine Inoperative
OM	Operation Manual
OPM	Operation Manual Manufacturer (helicopter)
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Non Flying
QNH	Barometric air pressure
SAR	Search and Rescue
SAS	Stability Augmentation System
SCT	Scattered
SMS	Safety Management System
SOP	Standard Operating Procedure
STP	Sea Training Programme
TC	Type Certificate
TCAS	Traffic Alert and Collision Avoidance System
TCDS	Type Certificate Data Sheet
TDP / DPATO	Take-off Decision Point / Defined Point After Take-off
TRE	Type Rating Examiner
TRI	Type Rating Instructor
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VS	Vertical Speed
WEA	Windenergieanlage (wind energy plant)

Synopsis

The helicopter BK117 C-1 approached a ship for hoist training at night at sea. It collided with the surface of the water and sank. During the accident three of the four crew members drowned.

The accident was due to unintentional Controlled Flight Into Terrain/Water (CFIT/W) at night.

Immediate Causes:

- Little experience of the crew regarding the applicable procedures at night over sea
- The approach deviated from the described approach procedure
- In regard to the altitude, the airspeed, and the rate of descent the approach was not stabilised
- The descent was commenced prior to being on final approach and without visual contact with the ship
- Insufficient monitoring of the flight instruments
- Loss of situational awareness in combination with loss of control
- Non-reaction to visual and audio altitude warnings of the radio altimeter

Systemic Causes:

- Insufficient descriptions of tasks and procedures regarding the flight-safety improving crew cooperation particularly for the offshore scenario
- Insufficient company specifications for the use of the flight attitude stabilising functions of the autopilot system during approaches and departures and in traffic circuits above sea
- Lack of go-around criteria for a non-stabilised approach
- Lack of aviation regulations for offshore helicopter flight operations in Germany
- Insufficient assessment of the operator's procedures by the responsible supervising authority
- Insufficient understanding for the characteristics of offshore helicopter operations by the responsible supervising authority

1. Factual Information

1.1 History of the Flight

The crew of four, Pilot in Command (PIC), co-pilot, one winch operator or Helicopter Hoist Operation Crew Member (HHO-CM), who was also paramedic, and an emergency physician, intended to conduct helicopter hoist training above a sea rescue vessel over sea at night. A night-VFR flight plan had been filed. The sea rescue vessel was based at Darßer Ort. In preparation of the mission, arrangements were made with the crew regarding the training procedure and the meeting point at sea.

According to the radar data and the recording of the Cockpit Voice Recorder (CVR) the helicopter took off at 1752 hours¹ from Rügen Airfield (EDCG). After take-off the crew received VFR night clearance in accordance with the flight plan filed from Bremen Radar. At this time the PIC in the right-hand seat was the pilot flying. Initially, the flight was conducted with autopilot and Flight Director (FD) in about 1,100 ft AMSL on direct course to the offshore wind park "Baltic 1". There the course was changed to south-south-west for the arranged meeting point with the sea rescue vessel. After radio contact had been established with the sea rescue vessel a direct approach was conducted and the altitude reduced to about 500 ft AMSL. Then the airspeed was reduced, the FD deactivated, and the autopilot selected to SAS (Stability Augmentation System) mode. The co-pilot became pilot flying. Despite using the weather radar it was difficult to determine the position of the ship and therefore the first approach was aborted and repeated with a left-hand traffic pattern. The final to the sea rescue vessel was flown with a heading of about 090°. The sea rescue vessel crew stated that the ship moved backward with about 5 kt toward approximately 060°.

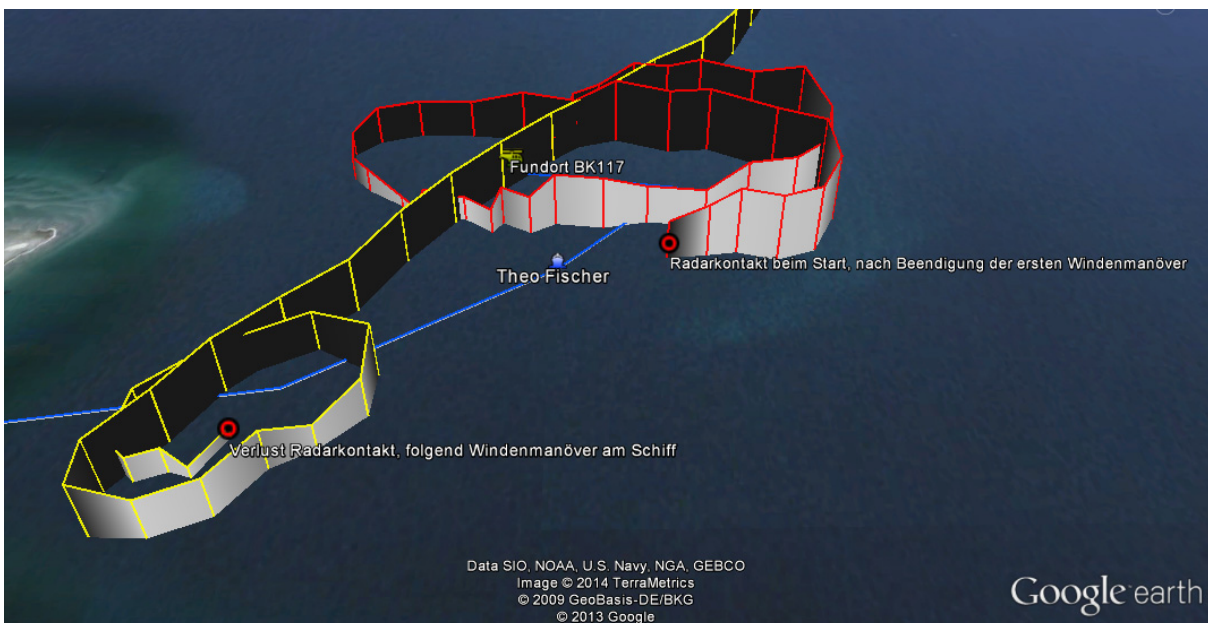
¹ All times local, unless otherwise stated.



Flight path

Source: BFU / Google earth™

Hovering above the bow of the sea rescue vessel the so-called Hi-Line was lowered to the ship. Three hoist manoeuvres were conducted. Each time the emergency physician was lowered to the deck and lifted into the helicopter again.



Approaches based on the radar data

Source: BFU / Google earth™

After the hoist manoeuvres had been completed the Hi-Line was pulled back into the helicopter. After the HHO-CM had reported the cabin "clear", the co-pilot conducted the take-off towards the east. The left cabin door remained open and latched and the

hoist boom slightly rotated outward. The emergency physician, wearing a security belt for rescuers, and the HHO-CM, wearing an operator harness with connection belt, were connected with the cabin as safety measure preventing them from falling out the open door. At the beginning of the climb, the HHO-CM advised to not fly faster than 60 KIAS. The PIC supported the co-pilot during the take-off by calling out engine torque, the rate of climb, altitude and speed. In about 300 ft AMSL the PIC took over controls. During the approach the crew talked about the conducted hoist manoeuvres and the determined problems of the sea rescue vessel crew with the Hi-Line and answered the repeated radio communications of Bremen Radar. Then the PIC turned left and asked the HHO-CM about the position of the ship. Due to the conversations about the hoist manoeuvres and the problems with the Hi-Line the HHO-CM had no longer kept track of the ship and subsequently lost sight of it. After a short discussion whether other ships were in the area, the co-pilot and the HHO-CM identified the sea rescue vessel and the PIC began the approach to the ship without visual contact, turned left and reduced the altitude to about 150 ft AMSL (see Appendix). Once he had visual contact with the sea rescue vessel the helicopter had inadvertently climbed back to about 500 ft AMSL. In the opinion of the PIC the helicopter was too high and therefore he aborted the approach and began again by flying a left-hand traffic pattern. Now the HHO-CM called out the ship's position left of the helicopter in accordance with clock positions. On the downwind leg the helicopter had an altitude of approximately 500 ft AMSL. The co-pilot pointed out to the PIC that he shouldn't fly out too far and turn 15° left. Then the HHO-CM reported the vessel abeam. The co-pilot pointed out to the PIC that he could turn now and a little later during the turn into the base leg he switched on the searchlight in addition to the already switched-on landing light and asked the PIC if the searchlight were interfering. A few seconds later the PIC answered in the negative. As far as the memory of the co-pilot serves the searchlight pointed to the front and left. Approximately 20 seconds prior to the accident the co-pilot said to the PIC "langsamer (slower)" and "wir müssen runter [...] (we must go down [...])". According to the FDR data at that time the helicopter flew with approximately 45 KIAS in about 200 ft AMSL. Approximately 12 seconds prior to the accident the PIC stated the course with "170" and the co-pilot said "jetzt einkurven (now turn)". At that time the helicopter had a speed of approximately 35 KIAS and was in approximately 150 ft AMSL. The PIC said "150" and at the same time the radio altimeter sounded "Decision Height". The co-pilot acknowledged four seconds prior to the accident

“150” and the PIC reported three seconds prior to the accident “100”. This was followed by the HHO-CM’s “Ey, ey, ey” which was also the last voice recording. At about 1837 hrs the helicopter impacted the surface of the water.

The sea rescue vessel crew had observed the helicopter’s lights during their approach. The crew had the impression that the helicopter had turned in their direction from approximately 1 Nautical Mile (NM) away and had rapidly lost height until contact with the surface of the water.

The co-pilot said to the BFU that up until the accident the flight had occurred without incident.

1.2 Injuries to Persons

The two pilots were able to leave the helicopter. The co-pilot had suffered minor injuries. The PIC had been lifeless when the sea rescue vessel crew rescued the two pilots. Immediately commencing resuscitation was not successful. The HHO-CM and the emergency physician sank with the helicopter and divers later recovered their bodies.

Injuries	Crew	Passengers	Third Party
Fatal	3		
Serious			
Minor / None	1		

1.3 Damage to Aircraft

Due to the minor fuselage damage inflicted by the collision with the surface of the water and the subsequent recovery, the BFU classified the helicopter as severely damaged.

The manufacturer classified the helicopter as destroyed due to the salt-water contamination and subsequent corrosion.

1.4 Other damage

None

1.5 Personnel Information

1.5.1 Pilot in Command

The 53-year-old pilot in command, in the right-hand seat, held an Airline Transport Helicopter Pilot Licence (ATPL(H)) issued by the Luftfahrt-Bundesamt (LBA, German Civil Aviation Authority) in accordance with Part FCL. He had the ratings for BK117 and EC135/635 as pilot in command and for flights in accordance with Instrument Flight Rules (IFR). In addition, he held the Type Rating Instructor (TRI) rating for the BK117 and the EC135/635 and the LBA had certified him as Type Rating Examiner (TRE) for these type ratings. His class 1 medical certificate without restrictions issued in accordance with Part-Med was valid until 23 March 2014.

According to flight operations and training records of the operator, the PIC had a total flying experience of approximately 7,000 hours. Between 2001 and 2005 he had flown Learjet 35 airplanes for the operator involved and accumulated approximately 1,735 IFR flight hours.

Between May 2013 and the day of the accident he had flown 44:51 hours and conducted 268 hoist manoeuvres during training and stand-by for medical emergency services for offshore wind park companies. Of these he had flown 7:36 hours and conducted 56 hoist manoeuvres at night over sea. He had a total night flying experience of approximately 236 hours and a total helicopter IFR flying experience of approximately 215 hours.

Between April and July 2013 he completed the company basic training for offshore flight operations, hoist manoeuvres, and the sea survival training.

On 22 February 2014 the pilot had arrived at the rescue station for his seven-day on-call service.

1.5.2 Co-pilot

The 47-year-old co-pilot, in the left-hand seat, held an Airline Transport Helicopter Pilot Licence (ATPL(H)) issued by the LBA in accordance with Part FCL. He had the

ratings for BK117 as pilot in command and for IFR flights. In addition, he held the TRI rating for the BK117 and the Flight Instructor (FI) rating for private and commercial pilots and night flights (FI(H) PPL, CPL, SEP, SP, night). The LBA had certified him as TRE for the type ratings BK117, EC145 (BK117) and HU269. His class 1 medical certificate without restrictions issued in accordance with Part-Med was valid until 29 May 2014.

According to the operator's records he had a total flying experience of approximately 9,500 hours. Between September 2013 and the day of the accident he had flown 22:38 hours and conducted 136 hoist manoeuvres during training and stand-by for medical emergency services for offshore wind park companies. Of these he had flown 04:48 hours and conducted 44 hoist manoeuvres at night over sea. Since beginning his flying career in 1982 he had accumulated approximately 434 night flying hours and an IFR experience of approximately 107 hours.

Between September and October 2013 he completed the company basic training for offshore flight operations, hoist manoeuvres, and the sea survival training.

On 23/02/2014 the pilot had arrived at the rescue station for his seven-day on-call service.

1.5.3 Helicopter Hoist Operation Crew Member

The helicopter hoist operator was 45 years old and also paramedic. He was employed at the operator. The operator stated that he had completed the sea survival training in March 2013 and between May and September 2013 the company training for hoist manoeuvres land and sea, and at wind energy plants.

1.5.4 Emergency Physician

The emergency physician was 47 years old. The operator stated he had received his sea survival training the beginning of July 2013. Mid-September 2013 he had completed the company training for offshore emergency physicians and hoist manoeuvres.

1.6 Aircraft Information

According to the Type Certificate Data Sheet (TCDS) No. R.010 of the European Aviation Safety Agency (EASA), the twin engine helicopter BK117 C-1 manufactured

by Airbus Helicopters Deutschland GmbH is a multi-purpose helicopter for up to 8 occupants (11 if FMS 10 - 8 is adhered to). The helicopter is equipped with two Turbomeca Arriel 1E2 engines, a hingeless four-blade main rotor, a fuselage in semi-monocoque construction and skids. Maximum take-off mass is 3,350 kg. In 1992 the helicopter type was certified in accordance with FAR 29 (LBA TC No. 3049). As minimum crew one pilot in the right seat is required. Assumable mean fuel consumption per flight hour is about 240 kg.

The optional rescue hoist is mounted to the left-hand fuselage side. The rescue hoist has to be rotated outward by a hoist boom assembly so that the hoist load can pass the skid when lowered or lifted.

According to the Flight Manual Supplement FMS 11-3 of the helicopter manufacturer it is recommended to limit airspeed to a maximum of 60 KIAS when opening or closing the cabin door in flight. If doors are open CAT-A operations are prohibited.

According to the Flight Manual Supplement FMS 10-35 airspeed limitation is 60 KIAS and maximum gross mass during rescue hoist operation, including hoist load is limited to 3,200 kg, if hoist boom is rotated outward. An installed rescue hoist system reduces maximum gross mass for CAT-A Clear Heliport procedures by 85 kg, climb performance of the helicopter by 75 ft/min (gross mass > 2,800 kg) and by 85 ft/min (gross mass < 2,800 kg) and altitude gain by 2 ft / 100 ft.

According to the Flight Manual Supplement FMS 10-47 installed emergency floats reduce the maximum gross mass by 20 kg for CAT-A Clear Heliport procedures, the climb performance of the helicopter by 20 ft/min, and the altitude gain by 1.5 ft / 100 ft.

The helicopter can be equipped with a Sperry / Honeywell SPZ 7100 Digital Automatic Flight Control System (DAFCS). This system consists of an autopilot function for attitude stabilisation (SAS or ATT modes), and a flight director function for roll and yaw control (ALT, IAS, VS, HDG, Nav or ILS modes). During automatic flight control one or several flight director modes are coupled with the autopilot in ATT mode. According to the Flight Manual Supplement Use of the Flight Director (FMS 10-48) the DAFCS had the following limitations:

Minimum airspeed with FD coupled in IAS mode: 45 kt,

*Minimum airspeed with FD coupled in ALT (while in a captured condition), VS, ILS or GA mode: 70 kt**

*NOTE * Below 80 kt the airspeed indicator shall be monitored closely*

[...] Minimum height with FD coupled in ILS or GA mode: 200 ft.

Minimum height with FD coupled in ALT (while captured), VS or IAS mode: 500 ft. During rescue hoist activities operation of the DAFCS is limited to SAS mode only.

The helicopter in question, year of manufacture 2002, manufacturer's serial number 7540, had a certificate of registration issued by the Luftfahrt-Bundesamt. According to the weight report of 27 September 2013 the empty mass was about 2,356 kg. According to the weight and balance Excel calculation of the rescue station, take-off mass at the day of the accident was 3,309.2 kg and included: 470 kg fuel, four persons on board, and the offshore HEMS equipment. The centre of gravity with length of lever arm 4,459 mm was within prescribed limits. The last Airworthiness Review Certificate (ARC) was issued on 29 August 2013. On 30 January 2014 the last 50-hour check including the release to service were conducted and issued at a total operating time of 2,944 hours. At the time of the accident, the helicopter had a total operating time of about 2,954 hours.

The helicopter had been certified for offshore rescue missions in the Air Operator Certificate (AOC, Appendix 1 dated 20 September 2013). The helicopter was especially equipped for offshore missions: medical equipment, autopilot, radio altimeter with audio and visual warnings in the right instrument panel, weather radar, Traffic Collision Avoidance System (TCAS), Health and Usage Monitoring System (HUMS), rescue hoist, and emergency floats on the skids, among other things. In addition a packed life raft for up to six persons, a one-man rescue boat, and an Emergency Locator Transmitter (ELT) were on board.

1.7 Meteorological Information

The aviation routine weather report (METAR) of Rostock-Laage military airport (ETNL) of 1820 hrs reported: ground visibility 6,000 m, slight rain, scattered clouds (SCT) in 2,300 ft, broken clouds (BKN) in 3,600 ft, wind 140° with 2 kt, temperature 7°C, and dewpoint 4°C. Barometric air pressure (QNH) was 1,004 hPa.

According to CVR recordings and the statements of the sea rescue vessel crew wind came from the east with about 2 kt. The sea had been almost waveless. During the hoist manoeuvres at the sea rescue vessel it had been raining slightly.

The co-pilot said it had been hazy. But visibility had been better than predicted.

The Bundesamt für Seeschifffahrt und Hydrographie (BSH) (Federal Maritime and Hydrographic Agency) stated the water temperature in the southern Baltic Sea close to the shore at the day of the accident had been about 4°C.

Sunset at Rostock-Laage had been at about 1745 hrs. The moon was at the end of the last quarter. One day after the accident it was new moon.

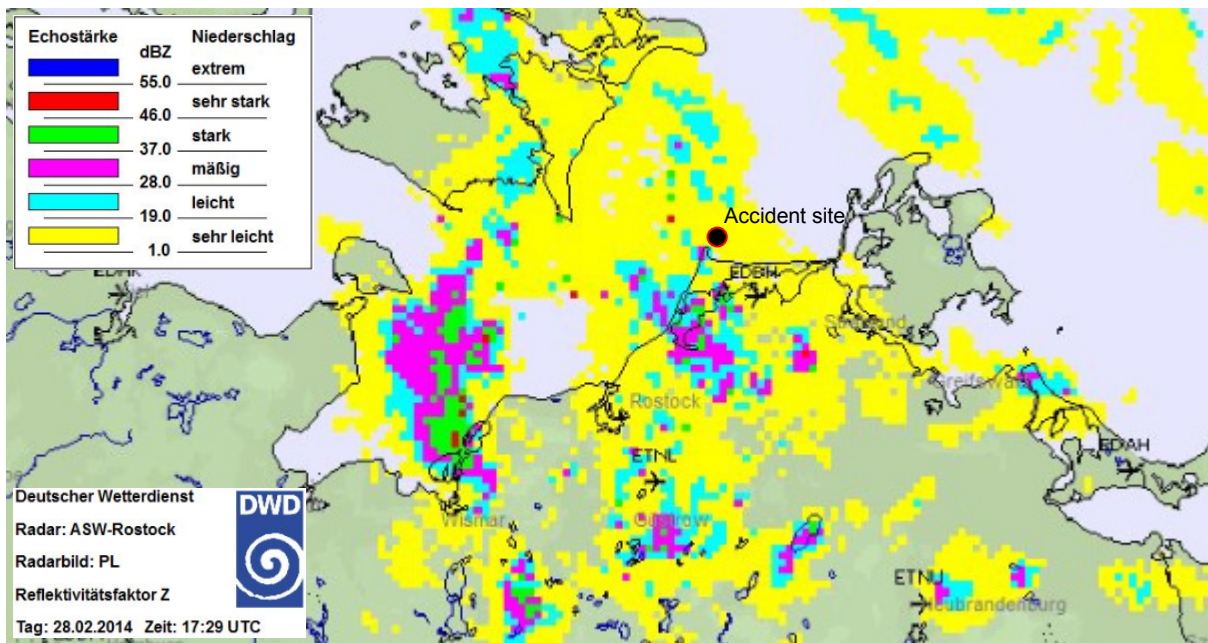
For the accident near Prerow, the Deutscher Wetterdienst (DWD, German meteorological service provider) compiled an official flight meteorological expertise. The expert determined the following:

At the time of the accident an occlusion front determined the weather. Its area of precipitation shifted from south-west towards the Baltic Sea.

The weather station Barth close by reported at 1700 UTC wind 110° with 4 kt. Ground visibility was 3.8 km in slight rain. The cloud base was 3/8 in 2,700 and 8/8 in 4,800 ft. The temperature was 7°C and the dewpoint 5°C.

A maritime buoy "Darsser Schwelle (located 54,7° north and 12,7° east) reported at the same time wind 110° with 12 kt above the surface of the water and a ground temperature of 5°. Water temperature of the Baltic Sea was about 3°. [...]

The radar images show at least slight rain at the time and the area of the accident. Above the water more humidity accumulated. Therefore ground visibility in Barth could have been below 3.8 km. Lower stratus clouds even below 1,000 ft, at least in shreds, cannot be ruled out. At the time of the accident it was night. Overcast sky with almost no moon increasing the remaining light means hardly any contrasts above the Baltic Sea.



Radar precipitation image (1829 hrs)

Image: DWD

1.8 Aids to Navigation

Among other things, the helicopter was equipped with a Garmin GNS 530 GPS.

1.9 Radio Communications

Radio communications between the pilots and Bremen Radar had been made available to the BFU as transcript. The helicopter's CVR recorded radio communications of the helicopter crew with the sea rescue vessel crew and the Maritime Rescue Coordination Centre (MRCC) Bremen. The radio communications were examined in regard to flight conduct, possible distraction, or misunderstandings.

1.10 Aerodrome Information

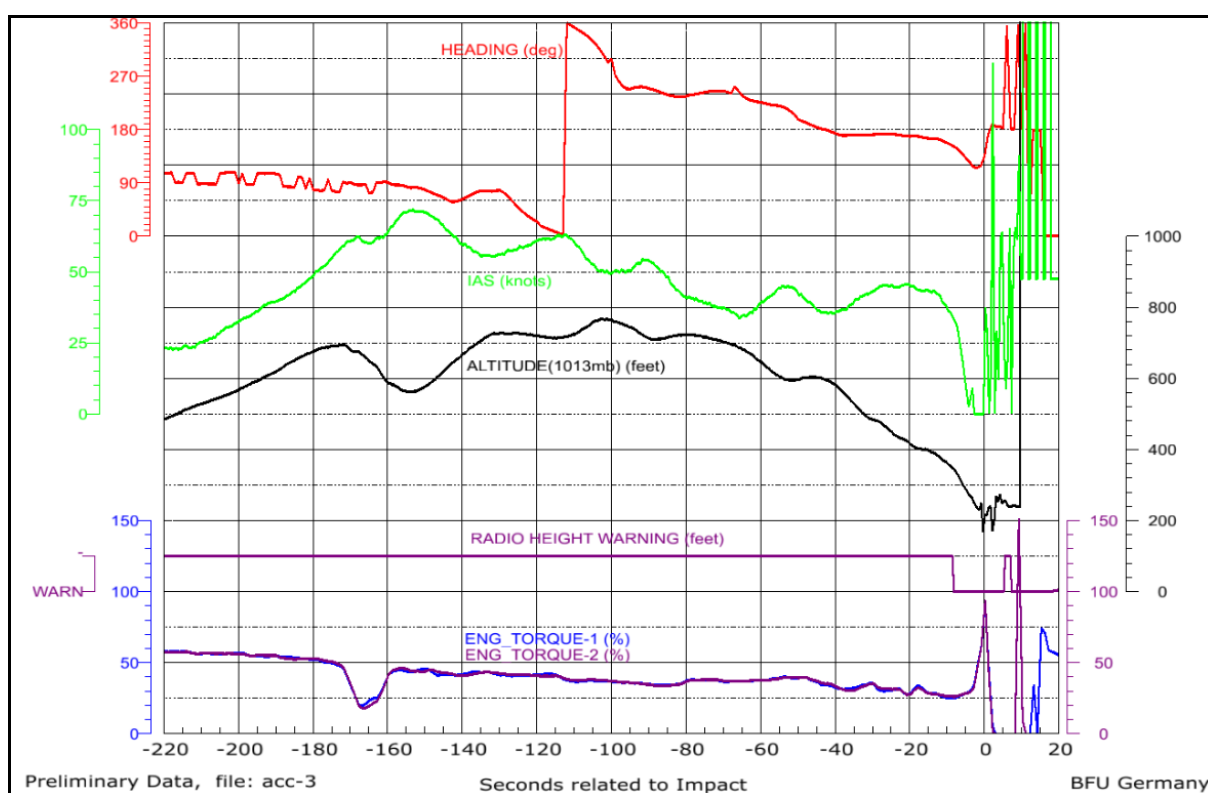
Not applicable.

1.11 Flight Recorders

The helicopter was equipped with a Madras CVDR Fairchild FA 2300 combi Cockpit Voice Recorder (CVR), which recorded the sounds of the last two operating hours, and Flight Data Recorder (FDR), which recorded 47 flight and engine parameters.

The combi recorder was read-out at the BFU and the data available for evaluation. About 20 seconds after the collision with the surface of the water the recording ended.

The CVR recordings did not contain any conversations regarding technical problems of the helicopter, or illuminated warning lights, or any other acoustic warnings or suspicious background sounds. During the entire flight the atmosphere was friendly and communication business-like. According to the recording the radio altimeter was selected to 100 ft GND (visual and audio).



FDR excerpt of the last 220 seconds prior to the collision with the water

Source: BFU

Several air traffic radar stations recorded the flight. The radar track was interrupted at the end of the approach for the hoist manoeuvres. The radar track continued once the helicopter had taken off again after the hoist manoeuvres. Shortly before the helicopter collided with the surface of the water the radar track ended.

The BFU enquired whether the air traffic service provider had recorded any other flights over sea of the helicopter involved. Data of flights on 13 February 2014 (seven hoist manoeuvres and two approaches) and on 22 February 2014 (nine hoist manoeuvres and three approaches) were available. An evaluation of the recorded

approach profiles of these flights in regard to stability criteria, i.e. altitude, sink rates and speeds, was not possible due to the low recording rate of the radar.

1.12 Wreckage and Impact Information

The helicopter was found approximately 3 NM north of Prerow in a water depth of about 7 m. The skids were pointing upward. The emergency floats had not been activated. The left cockpit door was open; the right door was found next to the helicopter. The left cabin door was open and the right closed. Of the four rotor blades, the one with the red marking had been torn off the blade grip and was found in the vicinity of the helicopter. The helicopter's position in the water was documented. Then the helicopter was recovered with the help of the multi-purpose ship "Arkona" and police divers.



Condition of the helicopter during recovery

Photo: BFU

After recovery it was determined that the fuselage was almost intact. All cowlings and maintenance hatches were closed and no components missing except for the torn-off rotor blade. After initial technical examination and documentation on board the ship "Arkona" the helicopter was transported to the naval base "Hohe Düne" in Rostock.

There the BFU examined the helicopter with the help of the helicopter manufacturer and the operator involved.

It was determined that the main gear box had tilted back by about 9°. The foremost two retaining rods of the gear box had fractured, and the two aft retaining rods were compressed. It was possible to manually turn the main gear box. Rotation was continuous from the drive inputs to the main rotor shaft, to the tail rotor drive flange, the hydraulic pump, and the oil cooler fans. The right fan drive shaft had been sheared off. At the tail rotor drive flange the Thomas coupling was destroyed and the brake actuator assembly of the rotor brake had been torn off. The foremost tail rotor drive shaft bearing had been torn out of the tail boom. The tail rotor drive shaft had been pushed back by about 5 mm. It was possible to manually turn the drive shaft. The tail rotor gear box transmitted the turn to the undamaged tail rotor. It was possible to manually turn the two engines. Rotation was continuous in N1 and N2 drive trains. Both main drive shafts between engine and main gear box were twisted and pulled under load forward off the gear tooth system. The compressors of both engines showed heavy damage by foreign objects. The free-wheeling units of both engines functioned properly. Both engine thrust levers in the cockpit were in position "Flight".

The controls were checked: The tail rotor push rod including pedals was intact. Control inputs on the control stick were transmitted up to the rotor blades. Inputs on the pitch were transmitted up to the tandem hydraulic system (systems 1 and 2). Between the hydraulic system and the swash-plate the commensurate control rod had fractured. In this area the upper fuselage cowling had been pushed back up to the stop of the control rods. Between swash-plate and rotor blades all control links were intact.

All chip detectors of the engines, the tail rotor gear box, and the main gear box were checked. They were all free of metal chips. The fuel filters were filled with fuel and clean. One pop-out for contaminated filters was activated, all others for the hydraulic system, the oil and fuel supply were not. The pop-out for the hydraulic filter of system 1 was visible by about 4 mm. The filter was opened and checked. It was free of contamination and inconspicuous. Hydraulic system 1 had been selected which corresponds with normal operating conditions.

During the technical examination no indications for technical malfunctions were found.

In the leg area of the co-pilot's side the Operator Checklist Offshore for MBB-BK 117 B-2 dated 28 November 2012 was found. It contained information regarding the rescue hoist (normal operation, emergencies, limitations and hoist limitations), the emergency floats (normal operation, emergency and malfunction procedures and limitations), and additional instructions for flights over sea (before take-off, casting out, coasting in checklist and first dip check). Other checklists for normal or emergency procedures were not found in the cockpit.

1.13 Medical and Pathological Information

The post-mortem examination determined drowning for all three fatally injured persons. There were no severe injuries due to the collision with the surface of the water.

1.14 Fire

There was no evidence of in-flight fire or fire after the impact.

1.15 Survival Aspects

The crew wore survival clothing as personal protective equipment (pilots and HHO-CM: Viking PS-4042, emergency physician: Viking PS4003) and life vests (Viking PV-9365).

The sea rescue vessel crew had witnessed the helicopter's collision with the water and drove to the accident site at once. They arrived at the accident site at 1840 hrs and could see the signal light of the co-pilot's life vest. He called attention to him by calling out. A little while later the PIC was found floating face-down in the water. His life vest with manual actuator had not been activated or inflated.

Subsequently, several ships searched the surface of the water for signs of the HHO-CM and the emergency physician. At about 2240 hrs a private survey vessel was asked to search under water using its sonar. At about 0017 hrs it located an object in the area of the accident site.

At about 0200 hrs divers found the helicopter, the HHO-CM and the emergency physician. The two people were found in the vicinity of the open left cabin door. The HHO-CM wore his harness and connecting belt (Petzl Newton Fast Jack) connecting

him to the fuselage and preventing him from accidentally falling out of the helicopter. The emergency physician was hooked into the hoist hook with his security belt for rescuers (Bornack Attack Worker).

The helicopter was equipped with emergency floats. During the recovery the safety pin for the release valve was found in the cabin. The switch for the emergency floats (EMER FLOATS) at the overhead panel was in the ON position, i.e. the floats had been armed for immediate activation. The pressure gauge for the emergency floats' pressure tank showed a green-area pressure. Subsequent examination revealed that all pipes and screw connections were intact.

During the investigation the PIC's life vest and the emergency floats of the helicopter were activated and functioned properly.

Survival in Cold Water

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 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.

NATO published a study titled "The Human Factors of Surviving a Helicopter Ditching" (Dr. C.J. Brooks, Survival Systems Ltd., Dartmouth, Nova Scotia). In summary the author came to the conclusion: *Flying in a helicopter over water is potentially very dangerous. In a survivable ditching potentially 15% of crew and passengers will drown in a daylight accident. This may increase to at least 50% in a night time accident.*

The author recommends: *Be protected properly with a life jacket and survival suit. Be trained in a reputable underwater escape trainer fitted with exits and be mentally and physically prepared at all times. Strap in correctly, stow your equipment securely, be particularly alert during the critical phases of flight, assume the crash position on the*

command “ditching, ditching, ditching,” follow the standard procedures for locating and jettisoning your exit, and you will end up safely ashore.

1.16 Tests and Research

Not applicable.

1.17 Organisational and Management Information

1.17.1 General

The helicopter was operated by a German company, whose focal point was conduct of air rescue services with helicopters and ambulance flights with airplanes. The operator had 21 helicopter rescue stations spread all over Germany. The rescue station involved and one other operated 24/7. Helicopters of the types EC135, BK117 and EC145 were flown in single-pilot operations during the day and in multi-pilot operations at night. Five of the helicopters were equipped with automatic flight control systems. Flights in accordance with instrument flight rules as part of air rescue services were not intended by the company. At the end of 2012 the first rescue station was founded in Husum for offshore wind park companies operating at the North Sea. On 31 October 2013 flight operations at this station were stopped.

On 1 October 2013 the rescue station at Rügen Airfield (Gütting) for wind park companies operating at the Baltic Sea commenced its work. The on-call ambulance service was conducted 24 hours per day. The crew consisted of two pilots with Instrument Rating (IR) and company offshore training, a paramedic trained as HHO-CM, and an emergency physician. A total of 11 pilots, 5 paramedics, and 12 physicians covered the station's duty roster.

Between 3 October 2013 and the day of the accident, a total of 45 flights (maintenance, training at the airfield and over sea at ships with 236 hoist manoeuvres), and a total flight time of 38:17 hours and a block time of 42:22 hours were conducted. Of these 9:15 hours were flown at night.

The wind park company stated that response time between alert and take-off should be no more than 45 minutes, or if possible the injured person at sea should already be attended to, i.e. the emergency physician should have arrived. The operator

stated that the helicopters should take-off within 15 minutes after alert during the day and at night within 45 minutes.

Flight time on direct route between rescue station and the possible HEMS missions wind park Baltic 1 and Baltic 2 was approximately 14 or 18 minutes with an assumed cruising speed of 120 kt.

1.17.2 Flight Operations Procedures and Training

The operator had amended the Operation Manual (OM) Parts A - D with respective chapters for flight operations with rescue hoist on land and over sea and for flight operations over sea. The Luftfahrt-Bundesamt had approved the OM and the commensurate procedure descriptions.

The commensurate standard operating procedure (SOP HHO-Offshore, Issue 01, and dated 31 January 2013) for approaches for hoist manoeuvres stipulated the following:

3. Approach Procedure

3.1 General

The standard approach procedure is flown against the wind. Obstructions within the wind park and the position of booms and at ships could make a deviation from the standard procedure necessary.

Therefore there is a difference between standard approach procedure left and right. These approach procedures differ mainly in how much visual contact the pilot has with the area of operations during the traffic pattern.

3.2 Reconnaissance

Prior to each approach reconnaissance has to be flown. During the reconnaissance:

- Determination of the available power.*
- Determination of wind and approach direction*
- Determination of obstructions in the vicinity of the hoist point*
- Identification of obstructions in the approach and departure sectors*
- Identification of hoist area*
- Determination of emergency landing direction*

The descent occurs with V_y up to a point approximately 500 m in front of the ship / platform in 50 ft above the hoist area. The lateral distance to the hoist area should be at least 30 m.

*From this point on speed is decreased by constant height until maximum torque of 2*60% is reached. ETL shall not be infringed. The reached torque shall be written down.*

*Is torque higher than 60% or is it not possible to maintain the height until a torque of 2*60% is reached; reconnaissance has to be terminated because for a later approach the OEI performance is not ensured.*

This torque ensures the continuation of the flight without loss of altitude in case of engine failure up to a point which lies beyond the ship.

3.3 Standard Approach Procedure

The standard approach procedure is conducted from reconnaissance.

- Increasing speed to V_y*
- Climb to 200 ft ASL*
- Commencing a 180° turn, bank angle $\leq 15^\circ$*
- Further climb to 300 ft ASL*
- Mid-downwind leg (target abeam) report of the PNF/HCM "Target abeam, before landing check completed".*
- Preparatory actions commence (preparation of the cabin, etc.)*
- During every turn the target is reported by the HCM / 2. Pilot during standard approach procedures left, and by the PIC during standard approach procedures right.*
- If the hoist point is in the 4 / 8 o'clock position 180° turn, bank angle 20°*
- Area of operations in 12:30 / 11:30 o'clock position, HCM / 2. pilot reports "Final approach", PIC acknowledges visual contact*
- 300 ft and approximately $\frac{3}{4}$ nm, speed is reduced and descent commenced with constant angle (maximum rate of descent 200 - 300 ft/min)*
- Descent to 50 ft above hoist height*
- HCM / 2. Pilot reads from 300 ft ASL up to 100 ft every 50 ft and then every 25 ft the RAD Alt height*

If during reconnaissance it is determined that there are obstructions in the standard approach procedure the approach height is increased so that an increased height of at least 100 ft above the highest obstruction is ensured.

The pattern day and night is identical, apart from the pilot flying reporting after reconnaissance: "positive rate of climb; positive speed".

3.4 Free Approach

Should the standard approach procedure be considered unsuitable after the assessment of the terrain conditions at the target area, free approach has to be chosen.

Here special attention has to be paid to

- Obstructions in the wind park*
- Visibility*
- Weather conditions*

The final approach corresponds with the standard approach.

The operator stated that already in spring 2013 the approach procedure had been changed and the reconnaissance and the traffic pattern altitude at night increased to 500 ft AMSL.

The Operation Manual Part A, Chapter 8.4.4.4 Radio Altimeter stipulated: [...] c) *Should the radio altimeter sound in flight climb should be commenced immediately and altitude and position be checked in a safe altitude.*

For onshore VFR-night flights the company stipulated a second pilot functioning as co-pilot. The Operation Manual Part A, Chapter 5.1.1.2 Co-pilot read: *Deployment of "pure" co-pilots (only employees licensed as second helicopter pilots) is presently not intended [...] but deployment of the PIC in the function as co-pilot [...] during VFR-night flights.* The Operation Manual Part A, Chapter 1.5.2 Co-pilot described the responsibility and general tasks of co-pilots. Chapter 8.9.2.2 Planned Night Transfer Flights with Two Pilots described: *The PNF supports the flying tasks of the PF. Especially during the take-off and landing phases he monitors the instruments and reports the values such as rate of climb / descent, speed, altitude and obstacle clearance, indicating emergency landing areas to the PF. TDP / DPATO and LDP / DPBL are read.*

The Operation Manual Part A, Appendix 2, Item 5.3 and Appendix 3, Items 3.3.1 and 5.3 stipulate that during hoist manoeuvres over sea and offshore night flights the crew consists of PIC, a second pilot as safety pilot, a hoist operator, and an emergency physician. Item 3.2 Glassy Sea stipulated in regard to landing approaches over sea: [...] *Due to missing surface structure of the water and reduced depth perception of the pilot it is difficult to estimate speed and altitude. Especially in low altitudes the hazard of false estimations exists. [...] During approach HCM / 2. pilot should read speed and altitude as support.*

The Operation Manual Part A, Item 3 Meteorological Critical Values, Item 3.3.2 Minimum Visibility with Extended Crew stipulated 5 km as the minimum visibility at night above sea. Item 3.2 Cloud Base stipulated the cloud base at night as higher than 1,200 ft.

In addition to the operation manual, the 17-pages procedure description Standard Procedure for Crew Cooperation (Issue 00 dated 14 May 2013) described the task distribution, callouts, and checklist procedures for all flight crew members who are deployed in multi-pilot operations in accordance with Operation Manual Part A.

In regard to training there was a company Sea Training Programme (STP) dated 10 June 2013. *The sea training programme shall give the crew the possibility to sufficiently train procedures which are required during missions and extend their experience. The STP is a six-month programme which stipulates the minimum*

requirement which each pilot and hoist operator in offshore operations have to meet within the period between 1 January and 30 June and 1 July and 31 December of each year.

For pilots the STP six-month plan included:

Index	Übung	Tag	Nacht
PF 1	Winch Schiff	10 cyc	10 cyc
PF 2	Hi-Line Tag	5 cyc	5 cyc
PF 3	WEA Top Winch	10 cyc	
PF 4	WEA Transition Piece Winch	5 Verfahren	
PF 5	Helideck	3 Landungen	3 Landungen

In addition Operation Manual Part A, Appendix 1, Item 1.5 Counting Method for Hoist Cycles stipulated: [...] Here only cycles shall be entered where transition into or out of hover has taken place. And Item 1.6 Recent Flying Experience: All pilots and HHO crew members conducting helicopter hoist operations have to meet the following in addition to the requirements of OM-A 5.2 for the last 90 days: 3 hoist cycles during the day or at night, where each cycle has to include transition into or out of hover.

The Operation Manual Part A, Appendix 2 Flight Operations Stipulations for Helicopter Hoist Operations Offshore (HHO - Offshore), Item 2 defined the applicable flight performance criteria:

2.1 General

According to JAR-OPS 3 it is allowed to operate helicopters above sea in flight performance classes 1 and 2. For offshore flight operations [...] the flight performance criteria which are defined in the respective flight manuals are applied:

BK 117: FMS 10-47 (Supplement for Emergency Floats)

BK 117: FMS 10-35 (Supplement for Rescue Hoist)

Should the critical engine fail during hoist operation the helicopter has to be able to continue operation with the remaining engine(s) and subsequent performance adjustment without putting the person(s) / load(s) hanging on the hoist, third parties or things at risk. These requirements do not apply for HEMS flights if the emergency physician or casualty or ill person has to be hoisted. (ACJ Appendix 1 of JAR-OPS 3.005(d))

The SOP HHO-Offshore Items 4.2.2, 4.3.5, and 4.4.2 Performance Determination stipulated the following in addition to the standard approach procedure: *During final approach below the translational lift the available torque is checked while maintaining altitude. Torque reserve of at least $2 * 10\%$ should be available. For each additional person on board an extra torque reserve of 3% should be planned. If torque reserve is insufficient the hoist operation is to be terminated.*

1.17.3 Approval of Flight Operations and Procedures

The BFU has questioned the Luftfahrt-Bundesamt in writing regarding the contents and chronological approval process of the operator involved and the approved offshore flight operations procedures. It took four months to get the requested information.

According to the LBA statement the first approval for the conduct of offshore flight operations was issued on 14 December 2012. The approval for helicopter hoist operations was issued on 29 November 2012. The last extension of the approval of offshore helicopter hoist operations at wind energy plants was issued on 17 September 2013.

The approval occurred in accordance with the appropriate aviation regulations (JAR-OPS 3, AMC / IEM to JAR-OPS 3, LuftVG (Federal Aviation Act), LuftVO (Regulation on Aviation), Part-FCL). The LBA stated repeatedly that there were neither approval requirements nor JAR-OPS 3 requirements for offshore flight operations procedures. Other publications regarding offshore helicopter operations (e.g. 1.18 Additional Information) were known but did not have any relevance because of their information and guideline characteristics and therefore lacking legal obligation.

All of the procedures the operator had submitted regarding offshore flight operations and rescue hoist operations had been checked. There are no aviation regulations regarding procedures and specifications regarding the use of automatic flight control systems, adherence to stabilised approach profile, task distribution and qualifications of the safety pilot / co-pilot on board and therefore the LBA did not consider or request them. The LBA did not conduct an exemplary weight and performance calculation for a real mission scenario. From the LBA's point of view this is the responsibility of the respective pilot in command. The pilot has to decide whether a flight can be conducted or not.

The LBA points out, however, they had required a Helicopter Underwater Escape Training (HUET) which goes beyond the requirements of JAR-OPS 3. The LBA did not consider that a crew member might be trapped in his harness fastened to the cabin or the rescue hoist during emergency ditching.

The LBA is of the opinion that the 24 hours stand-by of the crew for a seven day period without interruption is common practice for rescue services and possible even under adherence to the 2. DV LuftBO (2. Executive Order of the Regulation on Operation of Aircraft). The LBA did not provide the BFU with an explanation as to how the rest periods required by aviation regulations were adhered to.

1.18 Additional Information

1.18.1 Offshore Night Flight Operations / Lessons of the Oil and Gas Industry

Since 2012 flying ambulance services with helicopters for offshore wind park companies has become a new business field for operators in Germany. The necessary flying procedures are comparable to other offshore helicopter missions. During the transport of oil and gas industry or wind park employees, sea pilot's service with helicopters or the national Search and Rescue service (SAR), platforms or ships have to be approached during the day and at night. Especially for helicopter missions due to offshore oil and gas production, internationally there are a number of studies, operating procedures and accident analyses. Some examples:

Flight Safety Foundation (2015): *Basic Aviation Risk Standard Offshore Helicopter Operations*

UK Civil Aviation Authority (2014): *Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas*

International Association of Oil & Gas Producers (OGP Report No. 390, 2013): *Aircraft Management Guidelines*

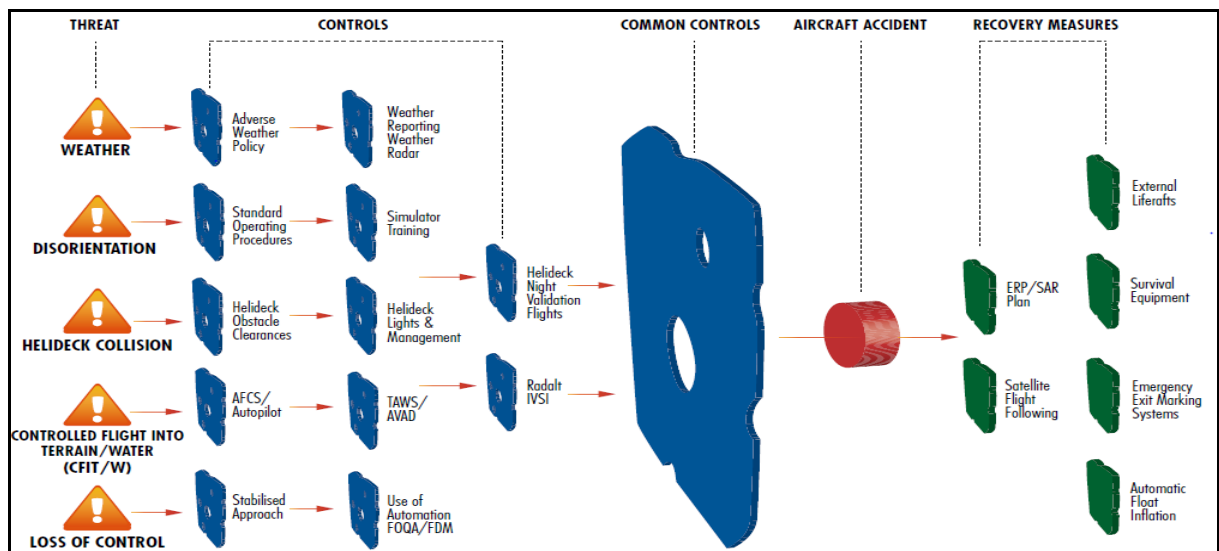
SMS Aviation Safety Inc. (2012): *Operational Safety Risk Analysis of Night Helicopter Transport Operations in the Canada-Newfoundland and Labrador Offshore Industry*

SINTEF (2010): *Helicopter Safety Study - Offshore*

Federal Aviation Administration (1999): *Approval of Offshore Standard Approach Procedures, Airborne Radar Approaches, and Helicopter En Route Descent Areas*

Gerry Gibb – *Safety Wise Solutions: A Risk Management Approach to Helicopter Night Offshore Operations*

The International Association of Oil & Gas Producers (OGP) conducted an investigation of all known civil offshore helicopter accidents at night which occurred between 1999 and 2007. Among other things, it was determined that the likelihood of an accident is approximately six times higher at night than during the day. Two of the core accident components were Controlled Flight Into Terrain/Water (CFIT/W) and Loss of Control.



5 Controlled Flight Into Terrain/Water (CFIT/W) – controls

An airworthy aircraft under the control of crew is flown into the ground (or water) resulting in an accident.

Control 5.1 AFCS/Autopilot

Aircraft operated at night should be fitted with a serviceable autopilot or AFCS with the associate crew responsibilities clearly defined in the operator's SOPs. All helicopters expected to conduct SAR or hoist-operations at night should have an auto-hover capability (see *AMG Appendix 9*).

Control 5.2 TAWS/AVAD

Aircraft that may be tasked to provide flight at night and on long-term contract should be fitted with an approved and serviceable Class A Terrain Awareness and Warning System (TAWS) or AVAD capability with appropriate voice warnings compatible with offshore approach procedures. The operator should have corresponding procedures outlining the action to be taken by the crew in the event of an alert.

Control 5.3 Radalt/IVSI

All aircraft flown at night should be equipped with at least one radio altimeter with dual displays with visual and audio warnings. Both displays should be serviceable for any flight at night or conducted under IFR irrespective of any allowances offered by the approved Minimum Equipment List. (MEL).

Furthermore aircraft operated at night should be fitted with two instantaneous vertical speed indicators.

6 Loss of control - controls

A crew loses control of an airworthy aircraft and results in an accident.

Control 6.1 Stabilised approaches

Aircraft operators are to detail type-specific stabilised approach and mandatory go-around procedures in the relevant section of the Operations Manual (*Ref: Flight Safety Foundation ALAR Briefing Note 7.1*).

Control 6.2 Use of automation

Aircraft operators should reference use of automation in the relevant section of the Operations Manual, considering both the benefits and associated hazards.

Control 6.3 Flight Operations Quality Assurance (FOQA)/Flight Data Monitoring (FDM)

Long-term contracts should require a FOQA/FDM capability that is routinely used to assess, among other things, approach and landing standards. Night approaches and landing should also be trended separately.

Increased hazards and possible countermeasures during offshore night flights

Source: OGP

Due to a number of offshore air accidents in the area of the North Sea, in October 2014 the largest world-wide operating offshore helicopter companies have founded HeliOffshore. The aim of this organisation is to compile cross-company procedures and standards to improve flight safety. The following areas have been identified as key areas for accident avoidance: *Automation during flight, pilot monitoring, stabilised approaches, accident survivability, application of health and usage monitoring systems (HUMS), and information exchange.*

1.18.2 Planned Aviation Regulations

In connection with the implementation of the Commission Regulation (EU) No 965/2012, the Member States criticised that the respective national offshore flight operations regulations were not considered. Therefore EASA is currently working on a subsequent amendment (Subpart K) Helicopter Offshore Operations (HOFO). Among other things, the following amendments were suggested in the Notice of

Proposed Amendment (NPA) 2013-10 dated 6 June 2013, Comment Response Document (CRD) TO NPA 2013-10 dated 14 August 2014 and Opinion 04/2015 dated 20 May 2015:

Opinion 04/2015: SPA.HOFO.110 Operating procedures (a) *The operator shall, as part of its safety management process, mitigate and minimise risks and hazards specific to helicopter offshore operations. [...]* (b) *The operator shall ensure that: [...]* (5) *pilots make optimum use of the automatic flight control systems (AFCS) throughout the flight;* (6) *specific offshore approach profiles are established, including stable approach parameters and the corrective action to be taken if an approach becomes unstable;* (7) *for multi-crew operations, procedures are in place for a member of the flight crew to monitor the flight instruments during an offshore flight, especially during approach or departure, to ensure that a safe flight path is maintained;* (8) *the flight crew takes immediate and appropriate action when a height alert is activated; [...]*

Opinion 04/2015: SPA.HOFO.145 Flight data monitoring (FDM) system (a) *When conducting CAT operations with a helicopter equipped with a flight data recorder, the operator shall establish and maintain a FDM system, as part of its integrated management system, by 1 January 2019.* (b) *The FDM system shall be non-punitive and contain adequate safeguards to protect the source(s) of the data.*

NPA 2013-10: AMC1 SPA.HOFO.100(c) Helicopter offshore operations RISK ASSESSMENT (a) *The operator's risk assessment should include, but not be limited to, the following hazards: (1) collision with windmills; (2) collision with sky sails; (3) collision during low level IMC operations; (4) IMC or night offshore approaches; (5) loss of control during operations to small or moving offshore locations.*

(b) *For IMC or night offshore approaches, the following mitigating measures may be considered: (1) multi crew operation; (2) establishment of flight crew minimum experience requirements; (3) the status and lighting of the offshore location is available to the flight crew to determine operational limitations; (4) minimum weather conditions for nights operations; and (5) minimum wind speed, maximum crosswind and maximum wind variation.*

NPA 2013-10: AMC1 SPA.HOFO.165 Crew requirements FLIGHT CREW TRAINING AND CHECKING: (a) *Flight crew training and checking programmes should: (1) improve knowledge of the offshore operations environment with particular consideration of visual illusions during approach introduced by lighting, motion and*

weather factors; (2) improve crew cooperation specifically for offshore operations; (3) provide flight crew members with the necessary skills to appropriately manage the risks associated with normal, abnormal and emergency procedures during flights by day and night; (4) if night operations are conducted, give particular consideration to approach, go around, landing, and take-off phases; (5) include instruction on the optimum use of the helicopter's automatic flight control system (AFCS); (6) emphasise on monitoring the pilot's skills; and (7) include standard operating procedures. (b) Emergency and safety equipment training and checking should focus on the equipment fitted/carried. Water entry and sea survival training, including operation of all associated safety equipment, should be an element of the recurrent training as described in AMC1 ORO.FC.230(a)(2)(iii)(F).[...]

1.18.3 Errors and Possible Procedures during Offshore Approaches

Accidents during offshore approaches at night comparable to this case are, among others:

AAIB Report 7/2008, [...] when preparing to land on the North Morecambe platform, in the dark, the helicopter flew past the platform and struck the surface of the sea.

CIAIAC Report A-002/2010, [...] crashed in a controlled flight into water, inadvertently by the crew [...]

AAIB Report 1/2011, [...] the flight crew made a visual approach to the platform during which the helicopter descended and impacted the surface of the sea. [...]

The US American Federal Aviation Administration (FAA) defines Controlled Flight Into Terrain, Loss of Control, and Situational Awareness as follows:

a. Controlled Flight into Terrain: CFIT occurs when an airworthy aircraft is flown, under the control of a qualified pilot, into terrain (water or obstacles) with inadequate awareness on the part of the pilot of the impending collision.

b. Loss of Control: The term, loss of control, refers to emergency situations from which a pilot may have been able to recover but did not, such as problems with situation awareness, recovery from windshear, mishandling of an approach, and recovery from a stall.

c. Situational Awareness: Situational awareness means the pilot is aware of what is happening around the pilot's aircraft at all times in both the vertical and horizontal

plane. This includes the ability to project the near term status and position of the aircraft in relation to other aircraft, terrain, and other potential hazards.

The Flight Standards Directorate of Pakistan describes in AIR SAFETY CIRCULAR ASC-010 "STANDARD OPERATING PROCEDURES": *Several studies of crew performance, incidents and accidents have identified inadequate flight crew monitoring and cross-checking as a problem for aviation safety. Therefore, to ensure the highest levels of safety each flight crewmember must carefully monitor the aircraft's flight path and systems and actively cross-check the actions of other crew members. Effective monitoring and cross-checking can be the last barrier or line of defense against accidents because detecting an error or unsafe situation may break the chain of events leading to an accident. Conversely, when this layer of defense is absent, errors and unsafe situations may go undetected, leading to adverse safety consequences. [...] Crew monitoring performance can be significantly improved by developing and implementing effective SOPs to support monitoring and cross-checking functions, by training crews on monitoring strategies, and by pilots following those SOPs and strategies. [...]*

In 2013 the "Loss of Control Action Group" of the UK Civil Aviation Authority published the paper "Monitoring Matters - Guidance on the Development of Pilot Monitoring Skills (CAA Paper 2013/02)".

The Flight Safety Foundation described in "Approach And Landing Reduction Tool Kit" ALAR Briefing Note 7.1 (published in 2000) flight operations mistakes which may result in non-stabilised approaches and CFIT accidents with airplanes. Described were basics, advantages, and training actions for stabilised approaches and countermeasures to avoid non-stabilised approaches or at least recognise them in time and terminate them. In large parts these contents can be transferred to helicopter flight operations.

Due to an accident during night flight operations involving the same company the BFU issued Safety Recommendation No. 25/2012:

The LBA (German Civil Aviation Authority) should ensure that operators conducting VFR-Night approaches to sparsely lit landing sites should specify practical and detailed procedures in their handbooks that are appropriate to the special demands of this type of operation, and which specify systematic, consistent and comprehensive use of the resources available to the conduct of the flight.

For years so-called Flight Data Monitoring in transport aviation has been common and mandated by aviation regulation. So far in Germany there is no corresponding aviation regulation for commercial helicopter flight operations. However, Flight Data Monitoring is largely common and its benefit admitted in international helicopter offshore operations. In 2009 the International Helicopter Safety Team (IHST) published the Helicopter Flight Data Monitoring - Toolkit: *Helicopter Flight Data Monitoring (HFDM) is a systematic method of accessing, analyzing and acting upon information obtained from flight data to identify and address operational risks before they can lead to incidents and accidents.*

The information and insights provided by HFDM can also be used to reduce operational cost and significantly enhance training effectiveness and operational, maintenance and engineering procedures. Information from HFDM programs is unique since it provides objective data that otherwise is not available.

An HFDM program is a key component of a Safety Management System (SMS).[...]

In 2012 the “Global Helicopter Flight Data Monitoring Steering Group” published the HELICOPTER FLIGHT DATA MONITORING, INDUSTRY BEST PRACTICES: [...] *Flight Data Monitoring is the only reliable method of monitoring flight crew compliance with Standard Operating Procedures, it captures all occurrences that take place during flight, even those which the crews are unaware of, and it identifies issues irrespective of a company’s reporting culture. When operational changes are made, the results are easily measured for effectiveness, can show tangible improvements in safety, and complete the “Plan, Do, Check, Act” cycle. Where crew memories or perceptions are skewed in comparison to the Flight Data, the flight section can be re-played and, if desirable, added to simulator training scenarios for practical training.*

1.18.4 Helicopter Offshore Operations in Germany

On 5 June 2014 the BFU invited all helicopter operators operating in the area of North Sea and Baltic Sea, the Bundespolizei (German Federal Police), and the Bundesmarine (German Navy) to a meeting regarding the current offshore flight operations in Germany. Among other things, the flight operations procedures, the minimum flying requirements of the crews, sea survival training, and the equipment were discussed.

In regard to offshore approach procedures in sometimes marginal visual meteorological conditions it was determined that the respective operator has developed and more or less formulated procedures. In spite of similar tasks, the same approach targets, and sometime the same aircraft types there are no mutually used standards.

In regard to airspace structure and flight monitoring the participants especially noted the neglect concerning the present and future air traffic volume due to offshore wind parks. For comparison purposes the existing regulations (Helicopter Main Routes, Helicopter Traffic Zones, Helicopter Protection Zones) of the neighbouring countries (The Netherlands, Denmark) for helicopter flight operations in connection with oil and gas production were consulted.

Since September 2014 for test purposes a shared route and way point system in the area of the North Sea is used in agreement with the Deutsche Flugsicherung (DFS) and some offshore operators. Prearranged vertical separation and communications procedures are used.

1.19 Useful or Effective Investigation Techniques

Not applicable.

2. Analysis

2.1 Course of the Flight

Based on the radar data, the FDR and CVR recordings it was possible to reconstruct the course of the flight from take-off to accident (Appendices 1 and 2).

After take-off the crew flew to wind park Baltic 1 supported by the flight director and subsequently to the prearranged meeting point with the sea rescue vessel. Prior to reaching the vessel and the visual identification the approach was flown manually without the support of the flight director.

The first direct approach had to be terminated due to the low visibility and the late identification of the sea rescue vessel. The approach was repeated by flying a narrow left-hand traffic pattern. During this subsequent approach the co-pilot in the left-hand seat was pilot flying. His reference point and possible reference concerning the flight

attitude was the illuminated ship which was in his field of vision. Then three hoist manoeuvres were conducted.

The PIC in the right-hand seat took over controls after the subsequent departure from the ship. He too manually conducted a left-hand traffic pattern without support of the flight director function, or use of the heading (HDG), altitude (ALT), or speed (IAS) modes. Except for the final approach the ship was always left of the helicopter, in an area the PIC for the most part could not see since he was in the right-hand seat. In addition, there were no other illuminated ships in the vicinity, nor could the close shore be seen. Therefore he had to control the helicopter solely with the flight instruments in low altitude, comparatively low airspeed, and no visible external references. The BFU does not understand why he chose a left-hand traffic pattern. At the same time the crew discussed the conducted hoist manoeuvres and the problems with the Hi-line. In addition, radio communications with Bremen Radar and the sea rescue vessel had to be conducted. The PIC as pilot flying participated in the discussion and conducted the radio communications himself. These communications increased his workload and it is highly likely that they distracted him from focusing on manually controlling the helicopter purely according to the instruments. In transport aviation sterile cockpit regulations and silent cockpit concepts are recommended and applied, respectively (e.g. Airbus Flight Operations Briefing Notes, Standard Operating Procedures and Operating Philosophy, September 2006).

During the first approach descent was already commenced in the downwind leg. Even before visual contact with the ship had been established airspeed was strongly decreased and descent continued to approximately 150 ft AMSL. According to the CVR recording the PIC in the right-hand seat had inadvertently climbed to 500 ft AMSL once he had visual contact with the ship. He briefly tried to descend but then terminated the approach because he experienced his position as too high and too close to the ship.

Subsequently a climb to approximately 500 ft AMSL occurred and another left-hand traffic pattern commenced. This time probably with the intent to stay closer to the ship in order to sooner have visual contact during final approach. According to the CVR recording during this traffic pattern the HHO-CM and the co-pilot had constant visual contact with the ship. The PIC as pilot flying did not have any visual contact. Again the descent commenced from the downwind leg. Then a sort of base leg was flown and the descent continued. Speed fluctuated between 60 and 35 KIAS. In this

phase the search light aimed left was switched on. During the turn toward the planned final approach heading of 90° the nose was lifted slightly, speed reduced to almost zero KIAS, and the helicopter descended until contact with the surface of the water (Appendix 1, FDR Analysis). The flight parameters show that the PIC did not continuously scan the instruments and that he was overwhelmed with the manual control of the helicopter without external visual references. The warning of the radio altimeter when passing 100 ft GND did not result in verbal reaction or the termination of the approach.

The recordings of the four approaches (the first terminated direct approach, the subsequent traffic pattern to the hoist manoeuvre, and the following two traffic patterns) show permanent altitude and speed fluctuations. The BFU is of the opinion that there never were stabilised, continuously controlled approaches. The traffic patterns and approaches were flown without the help of the flight director and mostly without external visual references. The descent was commenced even though the target, the sea rescue vessel, was neither identified nor had clear visual contact been established. It is highly likely that the Pilot Non Flying (PNF) had not recognised the fluctuations in speed and altitude during the approaches. According to the CVR recordings the PNF neither advised the PF of the fluctuations nor did he interfere.

None of the approaches during this training flight matched the procedures described in the OM, and the SOPs Crew Cooperation, which, according to the operator, had been trained. It was verifiably determined that during the hoist manoeuvres the corresponding approaches and departures had been omitted. Therefore the BFU is of the opinion that there was some discrepancy between the basic rule “Train as you fly, fly as you train!” and the objective monitoring of the applied procedures and conducted manoeuvres.

2.2 Crew

Based on their total flying experience and their ratings the two pilots were very experienced. Compared to the high flying experience during the day, their flying experience with helicopters at night and in accordance with Instrument Flight Rules (IFR) was low. The night flying experience over sea at night of 7:36 hours and 4:48 hours, respectively, was very low. Subsequently, the offshore approach experience at night was very low.

Both pilots communicated friendly with each other and were helpful, but were not very effective regarding the controls and the conduct of the flight. The benefit of a multi-pilot crew was not utilised because of the high total flying experience each had, the confidence in their own skills and in the experience of the other. Reciprocal monitoring and effective support in each flight phase as defined by MCC and monitoring of flight parameters by the respective PNF were insufficient.

The recorded flight path and the CVR recordings showed limited crew situational awareness in combination with insufficient monitoring of the instruments during the approaches to the sea rescue vessel. The BFU is of the opinion that there is no other explanation why the pilots had flown with almost no external references, mostly no visual contact with the ship, in low altitude, close to the water, and neither noticed nor commented on the airspeed, altitude, and attitude fluctuations, and the deviations from the standard approach procedure.

According to the CVR recording during the last seconds prior to the contact with the surface of the water while turning into the planned final approach heading of 090° both pilots concentrated on the compass. The air speed decreasing toward zero, the high rate of descent, and the warning of the radio altimeter were not noticed. Neither the CVR nor the FDR recordings showed any initiated countermeasures. It is likely that this is a consequence of the low IFR and offshore experience, as well as little training of such procedures and non-adherence to such standards.

2.3 Helicopter

The helicopter was certified for HEMS operations over sea in the scope of the company's Air Operator Certificate (AOC). In accordance with aviation regulation the helicopter had a certificate of registration and was kept airworthy by the maintenance organisation of the operator.

The parameters recorded by the FDR, the conversations and sounds recorded by the CVR, the statement of the co-pilot, and the technical examination of the helicopter after recovery showed without a doubt that no technical problem posed a distraction or caused the contact with the surface of the water.

During the investigation it was determined that there are limitations for the helicopter type and its additional equipment. These have to be adhered to in order to ensure safe, optimal, and also permissible flight operations.

The take-off mass (approximately 3,309 kg) for the training flight on the day of the accident corresponded with the characteristic mission mass during a real offshore rescue mission. Take-off mass and centre of gravity were within prescribed limits. On the day of the accident flying time between take-off and the first hoist manoeuvre was approximately 24 minutes. At the time of the first hoist operation, maximum gross mass was at the upper limit (3,200 kg) considering a fuel consumption of 4 kg per flight minute, the consumption for engine start-up and take-off preparation on the ground. During a real emergency mission at Baltic 1 or Baltic 2 wind parks the gross mass would probably be above the prescribed limit during the hoist operation considering a shortened engine start-up and a shorter flight time especially if the mass of a rescued person has to be considered also.

In regard to the performance and power reserve of the helicopter in use and the performance reduction due to the additional equipment (rescue hoist and emergency floats) it is clear that emergency ditching in case of engine failure during rescue hoist operation is unpreventable. Taking into consideration the temperature and wind conditions prevailing at the time of the accident, the maximum gross mass for Hover Out of Ground Effect (HOGE) with One Engine Inoperative (OEI) would have been approximately 2,900 kg. Comparing this mass with the actual gross mass shows that the company references to flight performance class 1 and the necessary torque reserve of at least 10% per engine in the OM and the SOP could not be adhered to. This was accepted by the company and the supervising authority even for training flights referring to aviation regulations stating that during emergency missions it is permissible to waive the power reserves of flight performance class 1. The BFU is aware that almost all helicopter types used for offshore flight operations in Germany show similar performance shortcomings in regard to OEI hover performance. From a flight safety point of view this is not acceptable.

Among other things, the OGP standards and in the future also EASA recommend the use of automatic flight control systems to support the pilots. The operational limitations due to the extended rescue hoist (maximum 60 KIAS) and the airspeed and altitude limitations owed to the flight director (minimum 75 KIAS or 500 ft AGL) limit the use of the automatic flight control system. These limitations make it necessary to have mature procedures regarding altitude, approach speed, manual control, etc. to render the flight-safety improving use of the automatic flight control system possible.

To have only one radio altimeter display was unfavourable. It was located on the instrument panel of the PIC in the right-hand seat and was therefore outside the normal field of vision of the co-pilot in the left-hand seat. OGP standards recommend e.g.: *“All aircraft flown at night should be equipped with at least one radio altimeter with dual displays with visual and audio warnings. [...]”*

The automatic actuation of the emergency floats in case of ditching recommended in the OGP standards and in the future required by EASA (ToR RMT.0120 Ditching Occupant Survivability) was not available for the BK117 C-1.

2.4 Meteorological Conditions

According to the CVR recording, and the expert opinion of the DWD, the sky was overcast, there neither was moonshine nor starlight, humidity was high, and there was slight precipitation. The visibility of light was considerably reduced. There neither were any illuminated ships in the vicinity nor could light sources at shore be seen.

The sea rescue vessel had a length of 23 m and was therefore a rather small ship. Depending on the flight direction or line of vision the ship was still only a small silhouette / visual reference in a dark environment devoid of contours even with the entire lighting on deck switched on.

During the base leg the search light was switched on in addition to the already illuminated landing lights. As a result the high humidity surrounding the helicopter must have been very milky and bright which would have made it more difficult to see the sea rescue vessel and the surface of the water. The smooth sea was probably a contributing factor for the crew not noticing approaching the water's surface.

During the approaches flown by the PIC, occurring without visual contact to the rather small illuminated ship or any other visible external reference to determine flight attitude, it has to be assumed that flight conditions corresponded with instrument flight rules in clouds without visual contact with the ground.

The co-pilot's statement that visibilities were better than predicted has to be interpreted as loss of situational awareness regarding altitude and visibility. The co-pilot's statement does not correspond with the recorded flight parameters, conversations on board, and the DWD expert opinion.

2.5 Organisations and Procedures

2.5.1 Single-Pilot and Multi-Pilot Operations

The operator involved has decade-long experience with onshore air rescue operations during the day or at night. During the day the pilots generally flew single-pilot operations supported by a HEMS crew member (HCM) and at night multi-pilot operations.

The task offshore rescue services was new for the operator involved and therefore the Operation Manual (OM) Parts A - D were amended with the Appendices Offshore. The operating procedures in the appendices, the training descriptions of the procedures in Part D, and the descriptions of the standards for approach, landing and HHO procedures basically described single-pilot operations. The OM and the Operator Checklist Offshore only made callout stipulations for the hoist operator/paramedic and the pilot flying concerning the described hoist procedure. Only the standard approach procedure (*[...] During every turn the target is reported by the HCM / 2. Pilot during standard approach procedures left, [...] area of operations in 12:30 / 11:30 o'clock position, HCM / 2. pilot reports "Final approach", PIC acknowledges visual contact [...] / 2. pilot calls out < 100 ft every 50 ft and then <50 ft every 10 ft the RAD Alt height [...]*) described the safety pilot/co-pilot, his function, qualification, experience, etc. in spite of the company stipulations of a second pilot during offshore hoist operations and night offshore flights.

The Operation Manual, Chapter Planned Night Transfer Flights with Two Pilots described procedures and task distribution for a cockpit crew of two for onshore flight operations. In 2013 the Standard Procedure for Crew Cooperation was issued. It described *Task Distribution – Pilot-Flying/Pilot-Non-Flying (PF/PNF), Briefings (VFR and IFR), Two-Way-Communication and Call-Out-Procedure, Checklist Philosophy and Application of Checklists*. The CVR recordings of the day of the accident show, however, that the crew has only partially acted and communicated in accordance with the OM or the standard procedure. From the BFU point of view this can also be explained by the repeated change between single-pilot operation (HEMS onshore operations during the day or hoist training flights at the airport) and multi-pilot operation (night transfer flights or offshore operation). The BFU is of the opinion that changing from single-pilot operation to multi-pilot operation should be avoided in

order to train, internalise and effectively utilise the safety-improving cooperation and mutual control of multi-pilot operation.

2.5.2 Approach Procedure

The described standard approach procedure corresponded with a narrow traffic pattern with two 180° turns as it is described in the Operation Manual (OM) of the helicopter manufacturer (OPM 106, Chapter 3) hoist operation procedures. Obstacle situation permitting, the standard approach procedure could either be flown with a right-hand or a left-hand turn. The relevant difference was [...] *how much visual contact the pilot has with the area of operations during the circuit pattern*. The BFU is of the opinion that generally a turn direction should be chosen where the pilot flying always has visual contact with the destination.

The standard approach procedure - narrow traffic pattern - was contradictory to internationally common wide offshore approach procedures which are similar to IFR-Non-Precision-Approaches, and does not meet the usual stabilised approach configuration standards. There were no stipulations in the OM for stabilised approaches, e.g. with the help of the flight director, callouts, mutual monitoring or termination criteria, except for the final approach description in the standard approach procedure. Even though there were so little stipulations none of the recorded approaches met the descriptions in the OM. The described procedure stipulated a descent starting during the final approach after visual contact with the target had been established and no more turns were necessary.

2.5.3 Training and Instrument Flight Rules

The ambulance services at Gütting had begun the beginning of October 2013. During the investigation the small number of flight hours was noted. Up until the time of the accident, 45 flights with approximately 38 flight hours had been conducted by a total of 11 pilots, 5 hoist operators, and 12 emergency physicians. The BFU has come to the conclusion that this does not correspond with a continuous training and intimate familiarisation with offshore procedures during the day and at night.

The air traffic service provider had recorded the accident flight and some flights conducted the previous 30 days. The analysis showed that the training hoist manoeuvres during the day and at night were conducted without departure and subsequent approach which is contrary to the stipulations. That means the hoist

manoeuvre was trained but the offshore departure and approach procedures only to a limited extent.

The BFU is also of the opinion that the IFR training experience with manual instrument flight attitude control was very low. This is verified by comparing the day flying experience of the crews involved with the night and IFR flying experience and with the airspeed and altitude fluctuations the FDR had recorded. Flying in accordance with instrument flight rules is not part of the common deployment scenario of primary and secondary air rescue services.

2.5.4 Flight Data Monitoring

A Flight Data Monitoring (FDM) system concerning the conduct of the flight, adherence to procedures, and timely recognition of repeated deviations, training insufficiencies, or flight operations hazards did not exist in the company. Neither the LBA nor aviation regulation required it so far. Beginning on 1 January 2019 Commission Regulation (EU) 965/2012 (SUBPART K) HELICOPTER OFFSHORE OPERATIONS (HOFO) will make a FDM system mandatory in Germany. The BFU is of the opinion that, as part of an effective safety management system, operators should voluntarily implement FDM systems as soon as possible.

2.5.5 Stress through Working Hours

Both pilots had had several days of 24-hours stand-by duty at the rescue station. Both pilots were on stand-by the entire time. They had to continuously check the weather information and stay close to the station because they never knew if and when they would be alerted and then had to perform the necessary tasks. Otherwise it would not have been possible to comply with the response time, arrival of the emergency physician at the site within 45 minutes. The wind park company stated this response time had been contractually guaranteed. The same is true for the take-off time of 15 minutes during the day and 45 minutes at night after the alert the helicopter operator had stated. The BFU came to the conclusion that in regard to the duty hours, the flight duty hours, the breaks, and the standby hours, the uninterrupted stand-by of seven days does not correspond with the adherence to rest periods stipulated in the 2. DVO (executive order) LuftBO (Regulation on Operation of Aircraft). Especially, if the necessary maintenance and training flights which are conducted during standby are taken into consideration. The BFU sent several

enquiries to the LBA and simply received the answer that such on-call service was possible. The BFU did not receive any explanation regarding the correlation with aviation regulation. The operator referred to the small number of missions, the available rest options, and comparison with other European operators. The CVR recording did not indicate any fatigue or physical limitations.

2.5.6 Survival Aspects

The severity of the accident, in spite of the sea rescue vessel being so close by, shows that all crew members had been caught completely off guard by the impact with the water. The training was not sufficient to activate the emergency floats, prevent the helicopter from sinking, open harnesses and so-called quick-out karabiners, use the available Helicopter Emergency Egress Device (HEED), and activate the life vest after leaving the helicopter.

The FDR recording and the relatively minor damage of the fuselage indicate low impact energy. The minor injuries of the crew members support this. Therefore it is even more tragic that it was not possible to use the available sea survival equipment more effectively. The BFU is of the opinion that sea survival training should correlate with the helicopter type and the equipment used. The activation of the floats, opening of harnesses and so-called quick-out karabiners, and the use of HEEDs, etc. should be trained extensively.

2.6 Aeronautical Regulations

At the time of the accident, helicopter operators operated commercial air transport and air rescue services in accordance with JAR-OPS 3. Since 28 October 2014 they have to act in accordance with Commission Regulation (EU) 965/2012. The above-mentioned regulation stipulated: crew qualification/training, helicopter performance, survival equipment, basic planning requirements for fuel reserves, meteorological minima during the day and at night for offshore flights. Until now there were no civil aviation regulations in Germany for offshore flight operations beyond JAR-OPS 3. Contrary to our European neighbouring countries there are no especially issued measures regarding the airspace structure above North Sea and Baltic Sea. Years ago, the Netherlands, Norway, and Great Britain implemented and approved helicopter routes, helicopter protection zones, instrument approach procedures in uncontrolled airspace, etc.

In the past, national civil aviation authorities of European countries with active offshore helicopter flight operations in support of oil and gas production have passed extensive flight operational regulations in addition to JAR-OPS 3 requirements. These countries requested an amendment of the Commission Regulation (EU) 965/2012 for offshore helicopter flight operations as a means of European standardisation of national aviation regulations. EASA is planning an amendment (SUBPART K) HELICOPTER OFFSHORE OPERATIONS (HOFO) of Commission Regulation (EU) 965/2012 including commensurate Acceptable Means of Compliance (AMC) and Guidance Material (GM). With the enactment of this Subpart currently missing mandatory, explicit flight operations stipulations for offshore helicopter flight operations would then apply for Germany also. So far the BFU Safety Recommendation 25/2012 regarding helicopter flight operations has not been implemented but would then be realised by law and apply for offshore operations also.

The BFU questioned the Luftfahrt-Bundesamt regarding the contents and chronological approval process of the operator involved and the approved offshore flight operations procedures. Repeatedly the LBA referred to the current aviation regulations which contain no or only marginal stipulations for offshore flight operations or the applicable helicopter procedures. Due to lacking legal validity, the LBA explicitly did not consider recommendations and regulations of other European countries. The BFU is of the opinion that this attitude toward experiences of other countries and publications regarding offshore helicopter flight operations is contradictory to a responsible supervision of such operators. For example, JAR-OPS 3.1045 Operations Manual - Contents and Structure prescribes that the operator has to ensure that the Operations Manual Part A General/Basic contains all operational basics independent of aircraft types, instructions and procedures which are relevant for safe operations. This requirement does not exclude experiences, learnings, and proven procedures of offshore helicopter flight operations derived from oil and gas production. The BFU is of the opinion that the LBA approved Amendments of the Operation Manual show missing or for offshore flight operations unusual procedures. The LBA statements given the BFU show shortcomings regarding supervision and comprehension concerning the newly developing commercial offshore helicopter flight operations due to renewable energy sources.

2.7 Learnings Derived from Offshore Flight Operations Accidents during Oil and Gas Production

A number of studies, investigations and accident analyses concerning offshore helicopter flight operations in connection with oil and gas production describe, among other things: minimum requirements for flight crew qualification and experience, the equipment of the helicopter, and the applicable procedures. These often exceed JAR-OPS 3 or Commission Regulation (EU) 965/2012 requirements.

In general, it is preferable to avoid approaches to ships and platforms at night. If a flight is unavoidable the importance of a stabilised approach is pointed out. It is recommended either during the day or at night: consequent use of the automatic flight control system, fixed task distribution with standardised callouts within the crew, and the adherence to the stipulated procedures with pre-defined termination criteria.

3. Conclusions

This flight was an offshore training flight for a normal ambulance mission as part of normal offshore ambulance flight operations of an operator approved by the Luftfahrt-Bundesamt. It was conducted with a helicopter type certified in accordance with FAR29/JAR29, now CS29, for large rotorcraft. Therefore safety standards should have been in place which, under normal circumstances or conditions, would allow for a safe conduct of the flight.

Nevertheless, the helicopter collided with the surface of the water and sank. Three of the four crew members lost their lives. The analysis of the facts shows that this accident is comparable to several other helicopter accidents which occurred in countries with offshore oil and gas production. The experiences, learnings and recommendations of these countries have not been taken into consideration in Germany by the supervisory authority or the operator involved.

3.1 Findings

3.1.1 Aeronautical Regulations

- The lack of national regulations concerning offshore helicopter flight operations

- So far, insufficient stipulations in JAR-OPS 3 and Commission Regulation (EU) 965/2012 regarding operationally applicable offshore flight operations procedures
- The planned amendment of Commission Regulation (EU) 965/2012 for helicopter offshore flight operations is not yet in force
- So far, the German supervisory authority for commercial flight operations has not taken into consideration the experiences and flight operations procedures of European countries with offshore oil and gas production.

3.1.2 Organisations and Procedures

- The operator involved had decade-long experience with onshore air rescue services.
- Helicopter flight operations were basically conducted in primary and secondary rescue services in accordance with Visual Flight Rules (VFR) onshore with the commensurate procedures.
- Of the entire helicopter fleet only a few were equipped with automatic flight control systems.
- There were no company procedures for the use of the automatic flight control system.
- In the scope of air rescue services flights in accordance with Instrument Flight Rules (IFR) were not intended.
- Offshore flight operations during the day and at night were a new area of business for the operator involved.
- Up until the day of the accident no offshore missions had occurred and only a small number of training flights to train the crew in the applicable procedures.
- The offshore procedures described in the Operation Manual basically aimed at single-pilot operations.
- Depending on the mission, the pilots either flew single-pilot or multi-pilot operations.
- The described standard approach procedure deviated from the internationally common offshore approach procedure.

- The Operations Manual did not state explicit criteria for a stabilised approach, mutual monitoring instructions, and go-around criteria for a non-stabilised approach.
- There was no Flight Data Monitoring System.
- The sea survival training did not completely match the helicopter type and equipment used.
- The BFU is of the opinion that the uninterrupted 7-day stand-by did not correspond with aviation requirements.

3.1.3 Meteorological Conditions

- It was a dark night without moonshine.
- Humidity was high with slight precipitation.
- Visibility of light was considerably reduced.
- There was a slight wind and the sea smooth.
- The sea rescue vessel was a rather small ship with little lighting.
- In this area there was no other source of light for orientation.
- The shore was not visible.
- Attitude determination by visual reference was not possible.

3.1.4 Helicopter

- There was no technical defect which could have distracted the crew or would have caused the impact with the water.
- The helicopter type was subject to limitations regarding the maximum gross mass during rescue hoist operations, the possible OEI hover performance out of ground effect, and the flight operations limitations during use of the flight director and the equipment, which limited safe and admissible flight operations.

3.1.5 Crew

- Both pilots held airline transport pilot's licenses, instructor ratings, and were type rating examiners.

- Both pilots' total hours of onshore flying experience during the day was very high. Compared to this the total hours of IFR and night flying experience with helicopters was very low.
- Both pilots' total offshore flying experience at night was very low.
- Communications between them showed deficiencies concerning mutual support and monitoring which normally characterises the flight-safety improving actions of multi-pilot operation.
- It is probable that both pilots concentrated on the heading during the turn towards the final approach so that the decreasing airspeed and the high rate of descent were not noticed.
- The warning of the radio altimeter during the approach was not noticed.
- The non-stabilised traffic patterns and approaches were not noticed.
- The course of the flight and the actions of the crew until the accident correspond with the FAA definitions for Loss of Situational Awareness, Loss of Control, and Controlled Flight Into Terrain.

3.1.6 Course of the Flight

- It was an offshore helicopter rescue hoist training at a ship at night.
- There was no time pressure.
- From the first direct approach to the sea rescue vessel, the flight was conducted manually without use of the flight director.
- The first left-hand traffic pattern was conducted by the co-pilot in the left-hand seat with visual contact to the ship.
- The PIC in the right-hand seat conducted the two subsequent left-hand traffic patterns. The pilot flying did not have visual contact with the ship except for the final approach.
- Due to the open cabin door and the extended hoist boom airspeed should be reduced.
- During the traffic pattern airspeed and attitude repeatedly fluctuated strongly which the crew did not comment on.

- Each descent was commenced even though the pilot flying did not have visual contact with the ship.
- Deviation from the operator's standard approach procedure.
- During the turn from the base leg into the final, airspeed reduced to zero and altitude decreased continuously until the collision with the surface of the water.
- Power was not increased and the approach terminated once the warning of the radio altimeter sounded.

3.2 Causes

The accident was due to unintentional Controlled Flight into Terrain/Water (CFIT/W).

Immediate Causes:

- Little experience of the crew regarding the applicable procedures at night over sea
- The approach deviated from the described approach procedure
- In regard to the altitude, the airspeed, and the rate of descent the approach was not stabilised
- The descent was commenced prior to being on final approach and without visual contact with the ship
- Insufficient monitoring of the flight instruments
- Loss of situational awareness in combination with loss of control
- Non-reaction to visual and audio altitude warnings of the radio altimeter

Systemic Causes:

- Insufficient descriptions of tasks and procedures regarding the flight safety improving crew cooperation particularly for the offshore scenario
- Insufficient company specifications for the use of the flight attitude stabilising functions of the autopilot system during approaches and departures and in traffic circuits above sea
- Lack of go-around criteria for a non-stabilised approach
- Lack of aviation regulations for offshore helicopter flight operations in Germany

- Insufficient assessment of the operator's procedures by the responsible supervising authority
- Insufficient understanding for the characteristics of offshore helicopter operations by the responsible supervising authority

4. Safety Recommendations

Actions by the operator:

Due to the accident, the operator involved revised the offshore helicopter hoist procedures. Among other things, reconnaissance and the standard approach procedure were revised and, according to the operator, the procedures trained since spring 2013 are now part of the OM. There now is a difference between flight operations during the day and at night. For night flight operations the minimum altitude until stabilised straight-in final approach and from the pilot flying acknowledged visual contact with the target was stipulated as 500 ft AMSL.

3.2 Reconnaissance

Prior to each approach reconnaissance has to be flown. During the reconnaissance:

- *Determination of the available power.*
- *Determination of wind and approach direction*
- *Determination of obstructions in the vicinity of the hoist point*
- *Identification of obstructions in the approach and departure sectors*
- *Identification of hoist area*
- *Determination of emergency landing direction*

Reconnaissance occurs as traffic pattern. Pattern altitude during the day is 300 ft ASL and 500 ft ASL at night:

- *Flight over the position to be reconnoitred into the wind by V_y*
- *Commencing a 180° turn, AOB 15°*
- *Report PF: "Downwind leg"*
- *PNF completes Before Landing CX and acknowledges: „completed“*
- *HHO-CM/ PNF begins callout in "Clock-Code"*
- *If the target is in 4 / 8 o'clock position: Commencing a 180° turn, AOB 20°*

3.3 Standard Approach Procedure

The standard approach procedure is conducted from the reconnaissance.

- *PF reports: Target in sight; PNF acknowledges visual contact, from this point on until hover position is reached communication is limited to PF and PNF. Other communication is only permitted if it is safety relevant.*

- *300 ft/day, 500 ft/night and approx. ¾ to 1 nm: Commencing descent with a constant angle (maximum rate of descent 200 - 300 ft/min), speed is being reduced continuously during the descent*
- *PF reports: „starting descent“, PNF acknowledges: "monitoring"*
- *PNF reports radar height up until a height of 200 ft in intervals of 100 ft, between 200 ft and 100 ft in intervals of 50 ft, and below 100 ft in intervals of 25 ft.*
- *PF reports: "In position", PNF calls out performance values, PF briefs the crew regarding the available or not available "Single Engine Capability"*
- *Precycle Briefing*

The weather minima to be considered were increased for offshore flight operations during the day to a visibility of 8 km, recognisable horizon, and a cloud base of 1,000 ft. Offshore night flight operations without functional automatic flight control system are prohibited.

In addition to the revised approach procedures, the minimum offshore experience before becoming pilot in command for offshore flight operations was increased to 50 hours and completion of one winter flight operations season. The validity of the proficiency check of all relevant normal and emergency offshore helicopter hoist operations were reduced from 12 months to 6 months. This is true for the pilots and the hoist operators / paramedics.

To improve and increase the effectiveness of crew cooperation the operator stipulated that only pilots, who otherwise fly with a weekly duty-roster at 24-hours rescue stations, will be deployed for offshore ambulance flight operations. This corresponds with the new company crew concept for rescue night flight operations. This shall ensure that the pilots are only working in so-called multi-pilot environments.

The instruction for crew cooperation was revised. Now there is a difference between Instrument Flight Rules (IFR) procedures and offshore procedures. The monitoring of the pilot non flying over the pilot flying during offshore approaches was standardised and written out in full.

To increase situational awareness the operator has mandated, and in 2014 already conducted, intensified CRM training for all crew members - including emergency physicians - deployed in offshore flight operations.

In 2014 the operator purchased a FNPT (Flight Navigation Procedure Trainer) simulator to intensify MCC and scenario-based mission trainings.

The operator checked and revised the contents of the sea survival training. Among other things, extensive training of the activation of the emergency floats was mandated. It was also stipulated that all crew members have to attend the sea survival training annually until they have completed three trainings. Then the training has to be attended every three years as stipulated in Commission Regulation (EU) 965/2012. Optionally crew members can attend refresher trainings earlier. In 2014 a different training provider was contracted. A HEED 3 including re-filling station was purchased for the rescue station Güttingen so that the use of HEED can be trained at any time.

The operator is planning to implement a Flight Data Monitoring System, to monitor flight operations, among other things. At the end of 2014 the technical requirements and necessary equipment for the helicopters used in offshore flight operations were commissioned.

Due to the planned and already implemented actions, the BFU refrained from issuing safety recommendations to the operator.

The Safety Recommendation BFU 25/2015 is still in effect:

The LBA (German Civil Aviation Authority) should ensure that Operators conducting VFR-Night approaches to sparsely lit landing sites should specify practical and detailed procedures in their handbooks that are appropriate to the special demands of this type of operation, and which specify systematic, consistent and comprehensive use of the resources available to the conduct of the flight.

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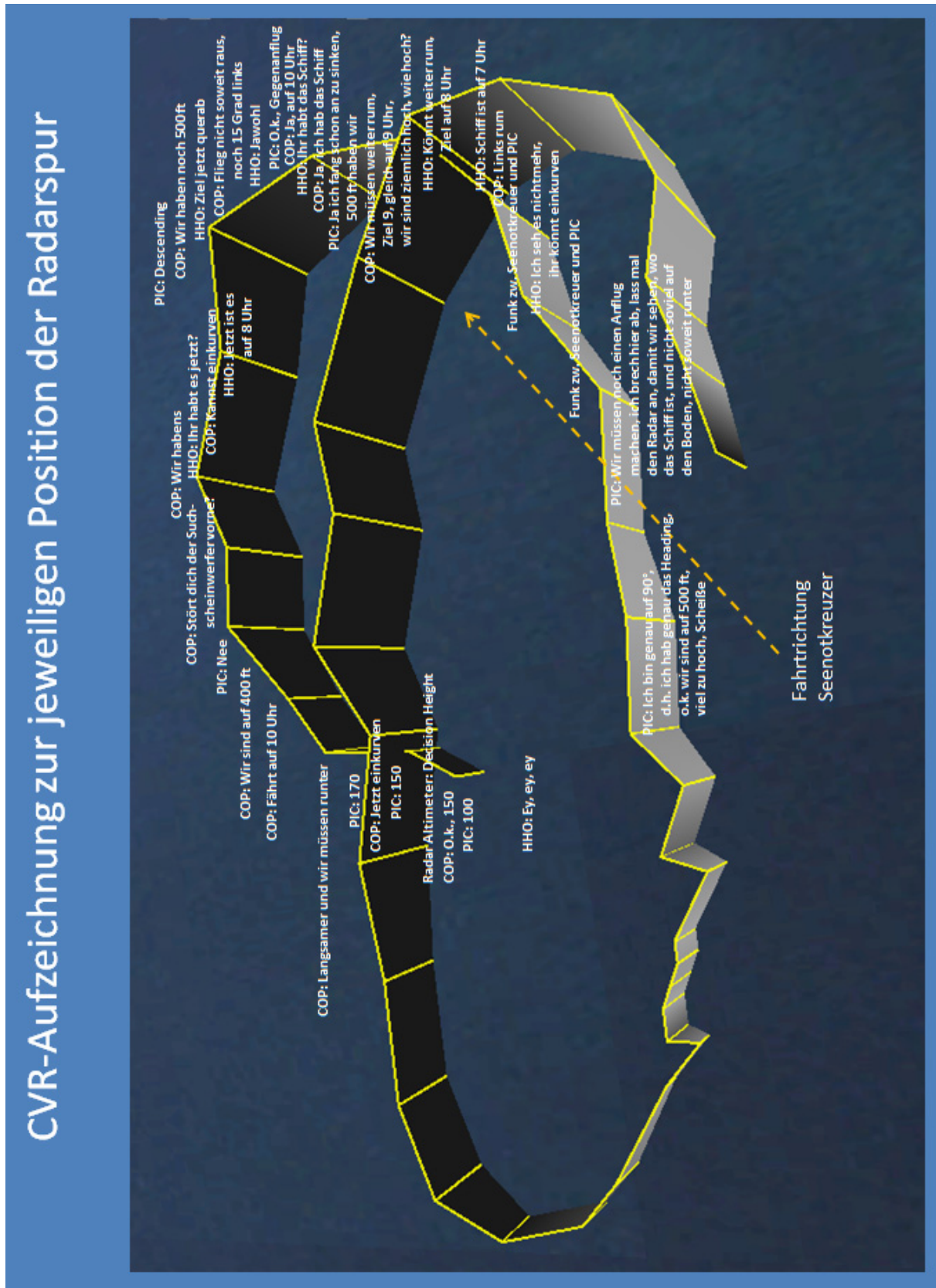
Braunschweig, 22 March 2016

5. Appendices

5.1 CVR recording to the respective position of the radar trace

5.2 FDR data analysis with information of the CVR recording

5.1 CVR recording to the respective position of the radar trace



5.2 FDR data analysis with information of the CVR recording

