Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	28 December 2010
Location:	Near Jena-Isserstedt
Aircraft:	Helicopter
Manufacturer / Model:	MD Helicopters Inc. / MD 600N
Injuries to Persons:	Two persons severely injured, one person with minor injuries
Damage:	Aircraft destroyed
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU 3X154-10

Factual Information

History of the Flight

On the day of the accident the crew flew with a helicopter MD 600N in the area Gera, Hermsdorf and Jena. They had the assignment to assess possible damages and roof loads due to snow. Where needed, the downwash was to be used to blow fresh snow from platform roofs.

After the assessments for Gera and Hermsdorf had been carried out, the helicopter was refuelled at Jena-Schöngleina Airfield. Afterwards, the crew flew to Jena-Isserstedt. They were to pick-up a staff member of the local building supplies store and determine whether the platform roof needed cleaning by flying over it. The helicopter landed about 120 m south-west of the building supplies store in a cleared area of a street so that the passenger could come aboard. Witnesses observed a big snow cloud being raised by the helicopter and it hovering for a longer period of time above the snow cloud before it finally landed. After the passenger had boarded the helicopter, it started straight up out of this area. Again, a big snow cloud was observed. At about 1521 hrs[1] while gaining speed, but with still low horizontal velocity, an engine failure occurred in about 100 ft AGL.

The crew stated that it was tried to execute an autorotation onto the street right in front of and perpendicular to the helicopter (Appendix 1).

The helicopter impacted the street with a high rate of descent and came to rest on the fuselage. Both pilots were severely injured and the passenger in the cabin suffered minor injuries.

During the interview conducted by the police after the accident the co-pilot stated that on this day another engine failure including emergency landing had occurred in the area of Hermsdorf during a snow clearing assignment. At the time the helicopter had been in low height above a platform roof. The engine was restarted and the flight resumed. The passenger on board the helicopter at the time confirmed these statements.

The Pilot in Command (PIC) stated that at the time of the first engine failure the co-pilot had been on the helicopter's controls. He had asked the co-pilot if he thought the engine failure had occurred due to snow or water ingestion or if he had moved the twist grip by accident. By way of answer the co-pilot had briefly nodded which the PIC had interpreted as consent to the part about moving the twist grip by accident. Without further discussion he had re-started the engine in order to relieve the platform roof. The co-pilot contradicted this description. The PIC stated he had checked the area of the main rotor and the engine inlet cowl after each stop to refuel even though he had assumed an operating error as cause for the engine failure. He had never detected any ice or snow accretion.

1 All times local, unless otherwise stated.

Personnel Information

The 47-year old Pilot in Command (PIC), who sat in the front right seat, held a Commercial Helicopter Pilot's Licence (CHPL) first issued on 30 August 2006 according to JAR-FCL German and valid until 30 August 2015. The license included the ratings as PIC and Type Rating Instructor (TRI) for Bell 206/206L, HU369/MD500N/600 and HU269. In addition, he also held the rating for Flight Instructor (FI(H)) for training commercial and private helicopter pilots. He had a class 1 medical certificate with restrictions valid until 4 May 2011 and for commercial transportation of passengers valid until 4 November 2010.
His total flying experience on helicopters was about 1,280 hours. About 605 hours of which were flown on the type in question.

The pilot was an employee of the helicopter operator and he was also the head of maintenance. He stated that in his function as a flight instructor he left the actual pilot's seat to the co-pilot for the steering of the helicopter. This was common practice at the operator to let younger pilots accumulate flight hours and to make them familiar with this type of aerial work.

The 33-year old co-pilot, who sat in the left front seat - the seat of the PIC - held a Commercial Helicopter Pilot's Licence (CHPL) initially issued on 28 July 2010 according to JAR-FCL German and valid until 28 July 2015. His license included the type ratings for Bell 206/206L, HU369/MD500N/600 and HU269. He held a class 1 medical certificate valid until 15 July 2011.

His total flying experience was about 215 hours. About 82 hours of which were flown on the type in question.

The co-pilot had completed his training at the operator of the helicopter. He stated that at the time of the accident he had a trainee contract with the operator to train as head of maintenance. This contract did not include the conduct of flights. He stated that the PIC had offered him to conduct the ferry flights on the day of the accident so he could accumulate some flight hours. During the snow clearing work he had remained in the helicopter but was not assigned any tasks and did not view himself as a crew member.

Aircraft Information

The single-engine helicopter MD 600N manufactured by MD Helicopter Inc. is a lightweight multi-purpose helicopter for up to eight occupants. It is equipped with a Rolls-Royce 250-C47M engine with an electronic control unit (ECU), a six-blade main rotor, skids and a NOTAR for anti-torque. Maximum take-off mass is 1,860 kg.

The helicopter was built in 2001 and had the manufacturer's serial number RN055. The empty weight was about 1,031 kg. The last Airworthiness Review Certificate (ARC) was issued on 8 July 2010 at 1,787 operating hours. At the time of the accident, the helicopter had a total of approximately 1,941 operating hours.

The ECU was read out by a representative of the engine manufacturer in the presence of a BFU staff member and resulted in the following data:

ECU total operating hours:	2,411 hours
Engine total operating hours:	1,981 hours
Total number of engine start-ups:	2,523
Error messages and limit exceedings:	None

The helicopter was equipped with a standard engine inlet screen. The manufacturer of the helicopter also has, in addition to the standard engine inlet screen, so-called particle separators in his product line. According to the flight manual, chapter 2.2 flights in falling or blowing snow are prohibited with the standard engine inlet screen.

Meteorological Information

According to the Meteorological Aviation Report (METAR) of Erfurt Airport (EDDE) 30 km away, at the time of the accident visibility was more than 10 km, wind came from 060° with 8 kt, there were scattered clouds (SCT) in 1,500 ft GND and temperature was -7°C with a dewpoint of -8°C. Barometric air pressure (QNH) was 1,022 hPa. Atmospheric humidity was about 93%.

Communications

After the take-off in Jena-Schöngleina no radio communications were conducted.

Airport Information

The helicopter landed outside an airport on the cleared part of a street. The area had the dimensions of about 5 m x 8 m and was surrounded by 1.80 m high snow walls.

The choosing of the landing area occurred form the air. The road was neither closed off nor safeguarded.

The PIC stated that he did not see the snow mounds during the approach and landing due to the worsening lighting conditions in the afternoon.

He chose to conduct a steep climb so as not to have to overfly onlookers and waiting cars.

Flight Recorders

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

A video camera partly recorded the take-off of the helicopter. The recording allowed the drawing of conclusions concerning the course of events, the airspeed and height when the engine failure occurred (see Appendix 2).

Wreckage and Impact Information

The accident site was located about 800 m south-west of Jena-Isserstedt on a street west of the building supplies store running in North - South direction (see Appendix 1).

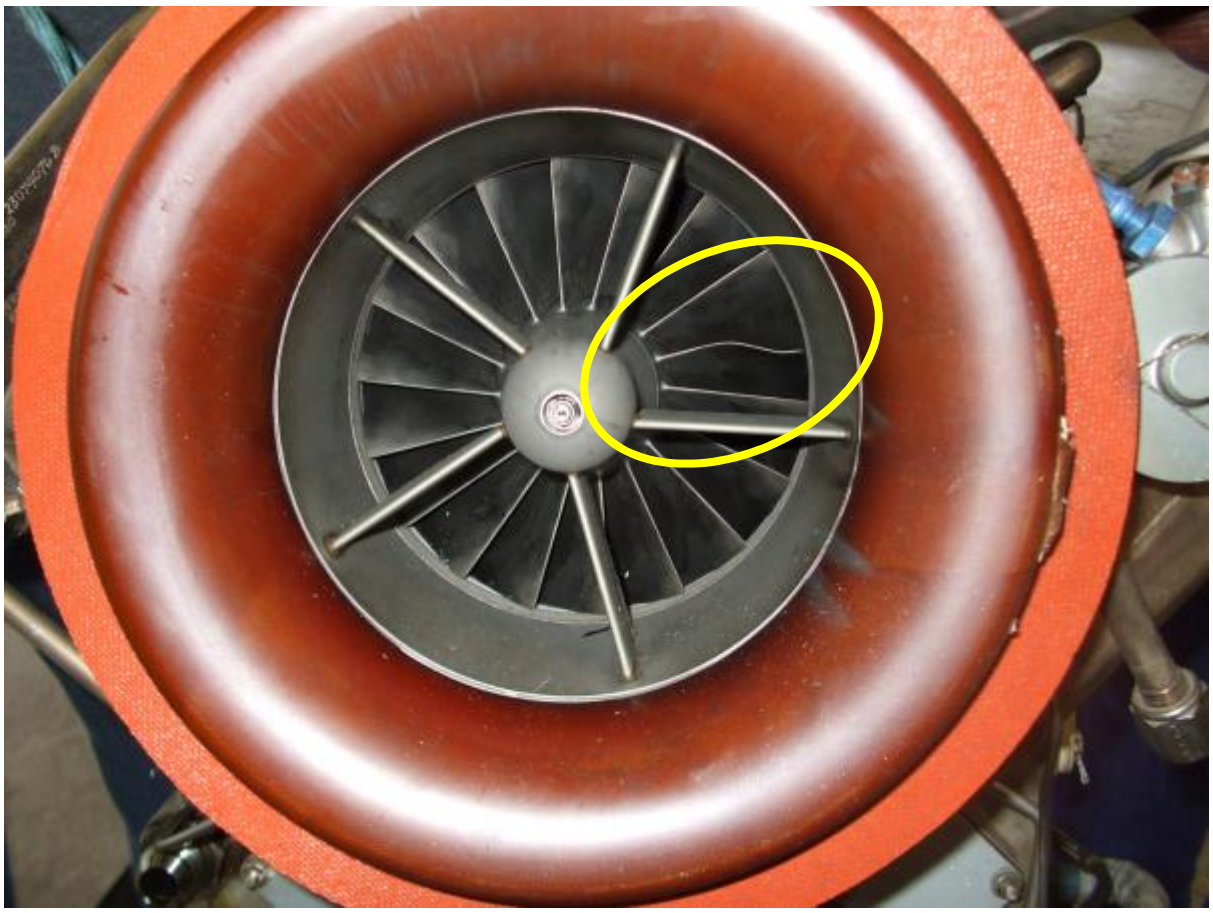
Accident site and helicopter wreckage Photo: BFU

The helicopter lay on its fuselage; the left skid was severed and the right was bent outward from the fuselage structure. In the cockpit area the windscreen was destroyed and the instrument panel lay in front of the cockpit. The tail boom had become severed about 1 m from the tail section and was still attached to the fuselage via the push-pull-cable linkage of the NOTAR. All six main rotor blades were damaged; some of them were bent forward and down (direction of impact). The main gear box was pushed into the fuselage structure.

The helicopter was salvaged and then examined in the presence of accident investigators of the helicopter manufacturer and the engine manufacturer.

It was determined that the cyclic lateral and yaw controls were connected whereas the cyclic longitudinal control was severed in the area of the cockpit seats. The pitch of the main rotor blades could be changed with the pitch control. The twist grip was jammed in the opened position. The Bypass flap for the engine inlet cowl was open by about 2 cm. The operating lever for the Bypass was in the Close position. The

push-pull cable between the operating lever and the Bypass flap was connected; it was not possible to actuate the operating lever. The engine main drive shaft and the drive shaft of the NOTAR-Fan were severed in the area of the clutch on this side of the main gear box. The engine and the NOTAR-Fan could be moved manually without sound. The free-wheeling unit opened and locked as designed. Except for a bent compressor blade the engine showed no irregularities.



Damage on the engine compressor Photo: BFU

The oil level in the main gear box was within limits. The gear box could be moved manually and showed no irregularities. The fuel sump in the main tank did not show any contaminations. All fuel feed pipes were connected and the pop-outs for clogged or open bypass pipes were in, not popped out. Once the airframe fuel filter was opened, severe contaminations were determined. The remaining fuel in the filter bowl was grey-black. It was collected for further investigations.

A Luftfahrt-Technischer-Betrieb (LTB; certified maintenance organisation) disassembled the engine and sent it to the engine manufacturer in the USA for further examinations.

Medical and Pathological Information

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

Fire

There was no fire.

Tests and Research

The US American engine manufacturer examined the engine and the electronic control unit (ECU) in the presence of the National Transportation Safety Board (NTSB). No further damage besides the bent compressor blade was determined. Afterwards the engine was subjected to a test run in accordance with Rolls-Royce PTS 899 requirements (run as received). It was determined that engine start-up was normal and the engine accelerated to Ground Idle (N1: 31,212 rpm). Only an abnormal high pitched sound could be heard during acceleration. At 37,664 rpm acceleration was stopped due to vibrations.- Afterwards the engine was shut down normally. In summary, it was determined that the engine showed normal behaviour during start-up, acceleration up to 37,664 rpm and shut-down. The recognised abnormal high pitched sound and the vibrations during the testing were due to the bent impeller blade and the disruption of airflow through the engine.

The Bundeswehr Research Institute for Materials, Explosives, Fuels and Lubricants (WIWEB) in Erding examined the contaminated fuel sample from the airframe fuel filter of the helicopter. No indications for quality deficiencies of the fuel (Jet A-1) were found. Carbon was the cause of the murky colour. It was assumed that it was grit originating from the carbon brush of the electronic fuel pump. Neither the helicopter manufacturer nor the engine manufacturer could understand or explain it, however.

Organisational and Management Information

The operator of the aircraft was certified by the Luftfahrt-Bundesamt (LBA) according to JAR-OPS 3 and was also a Flight Training Organisation (FTO) certified according to JAR-FCL 2. The operator conducted the flight as sub-contractor for another helicopter operator. This helicopter operator was the primary contractor for the determi-

nation of snow loads on roofs of stores and their removal. Their capacities to conduct such flights were, however, exhausted.

The main contractor stated that roofs were to be cleared of snow. The local situation was to be determined and the inspection and possible snow removal was to be conducted in agreement with the store manager. The boarding of a passenger was not really planned but a possibility in the scope of local orientation.

In order to clear the snow it was necessary to hover relatively low and with low vertical speed several times across the roof. The plan was that the downwash would raise the snow and with the support of the wind be blown from the roof.

For the day in question a flight order dated 27 December 2010 existed. This order described the mission as follows: *Inspection flights to determine the damage and snow load on the roofs. Further actions will be discussed with the local customer. Mr [...] decides himself whether or not he participates in the mission (trainee); if, he is made familiar with the conduct of inspection flights to detect damages (according to the work experience contract with BFD). Mr [...] remains pilot in command - Adhere to winter operation of the helicopter!* Picking up passengers was not part of the flight order.

The crew did not inform the operator's management of the first engine failure during a snow clearing mission above a roof.

The helicopter operator had a permission for aerial work with helicopters issued by the Gemeinsamen Oberen Luftfahrtbehörde Berlin-Brandenburg (regional civil aviation authority); valid until 30 November 2011. Part B, item 6 stipulated: *The minimum safe altitude above nature protection areas, cities and densely populated areas, industrial zones, crowds, and areas where there has been an accident or catastrophe shall not be infringed (Air Traffic Order, Para 6 section 1). Furthermore, an infringement is only permissible to the extent which is for the performance of the task verifiably required and as long as no persons are put in any danger or property of third parties is not damaged. […]*

According to witness statements and descriptions of the events on the day of the accident, the stores in question were open to customers between the holidays and during the helicopter operations.

JAR-OPS 3, German, regulates commercial flight operations with helicopters. JAR-OPS 3,470 ff stipulates that during commercial flights above difficult terrain with no emergency landing site within reach, helicopters with the flight performance class 1

or, when indicated, flight performance class 2 are to be used. JAR OPS 3,540 ff stipulates for single-engined helicopters (flight performance class 3) that the conduct of the flight is to be planed and conducted in a way that an emergency landing in case of engine failure is possible at all times.

Aerial work is not part of JAR-OPS 3 regulations. When conducting aerial work the Regulation on Operation of Aircraft (LuftBO) must be adhered to.

Para 53 Single-engined Aircraft of the Regulation on Operation of Aircraft requires:

(1) Single-engined aircraft are only permitted to operate during the day, under visual meteorological conditions (VMC) and only on flight routes which provide sufficient emergency landing options. […]

(2) Subsection 1 applies to double-engined aircraft which can no longer reach their destination or alternate airport after one engine failure.

Additional Information

The engine manufacturer issued a Commercial Service Letter (CSL A – 6114) warning engine failure may occur due to ice and snow ingestion.

ENGINE FLAMEOUTS DUE TO SNOW OR ICE INGESTION - WARNING

Owners, operators and pilots are warned that helicopters/aircraft using the Model 250 engine in falling or blowing snow, or icing conditions, require special equipment. Snow or ice can build up on aircraft parts, inlet ducts or plemun chambers and break loose in "slugs". Slugs of snow or ice entering the compressor of these engines models can cause flameout.

Helicopter/aircraft manufacturers use different approaches to prevent slugs of snow or ice from being ingested by the engine. Some of these devices include special particle separators, reverse inlet scoops, and various types of inlet screens. Additionally, some helicopters/aircraft utilize auto-reignition kits to relight the engine in the event the a flameout occurs. Some helicopters/aircraft also use a continous ignition system. It is the responsibility of the owner, operator and pilot to determine that the helicopter/aircraft is properly equipped and devices are in proper working order for operation in conditions where snow or ice can build up on the aircraft.

It is also very important to inspect the engine inlet area on pre-flight check when the aircraft has been exposed to an ice, snow or sleet storm. Accumulations of ice and/or snow can collect in remote areas of the engine inlet air flow path. Removal of these accumulations is necessary, especially downstream of the protective devices, to prevent a possible flameout caused by break-off of these accumulations during flight.

The airframe POH (pilot operating handbook) or equivalent should be referenced concerning the operation of de-ice and anti-ice provisions for the aircraft.

Excerpt from CSL A - 6114 Source: Rolls-Royce

Single-engine helicopters can be autorotated to the ground in case of engine failure. In order for the autorotation to be successful the pilot's skills and a commensurate airspeed/altitude combination at the moment of the engine failure are critical. These

are described in the respective flight manual in the form of a Height-Velocity Diagram. Flight operations under observation of the Height-Velocity Diagram is strongly recommended (refer to the excerpt of the flight manual under Warning).

WARNING **Observe the shaded regions of the Height–Velocity Diagram. These represent airspeed/altitude combinations from which a successful autorotation landing would be difficult to perform. Operation within the shaded area is not prohibited, but should be avoided.**

Use of Chart:

The recommended takeoff profile line shows the airspeed/altitude combinations recommended for takeoff using not more than 10% above hover power until clear of height-velocity diagram shaded areas.

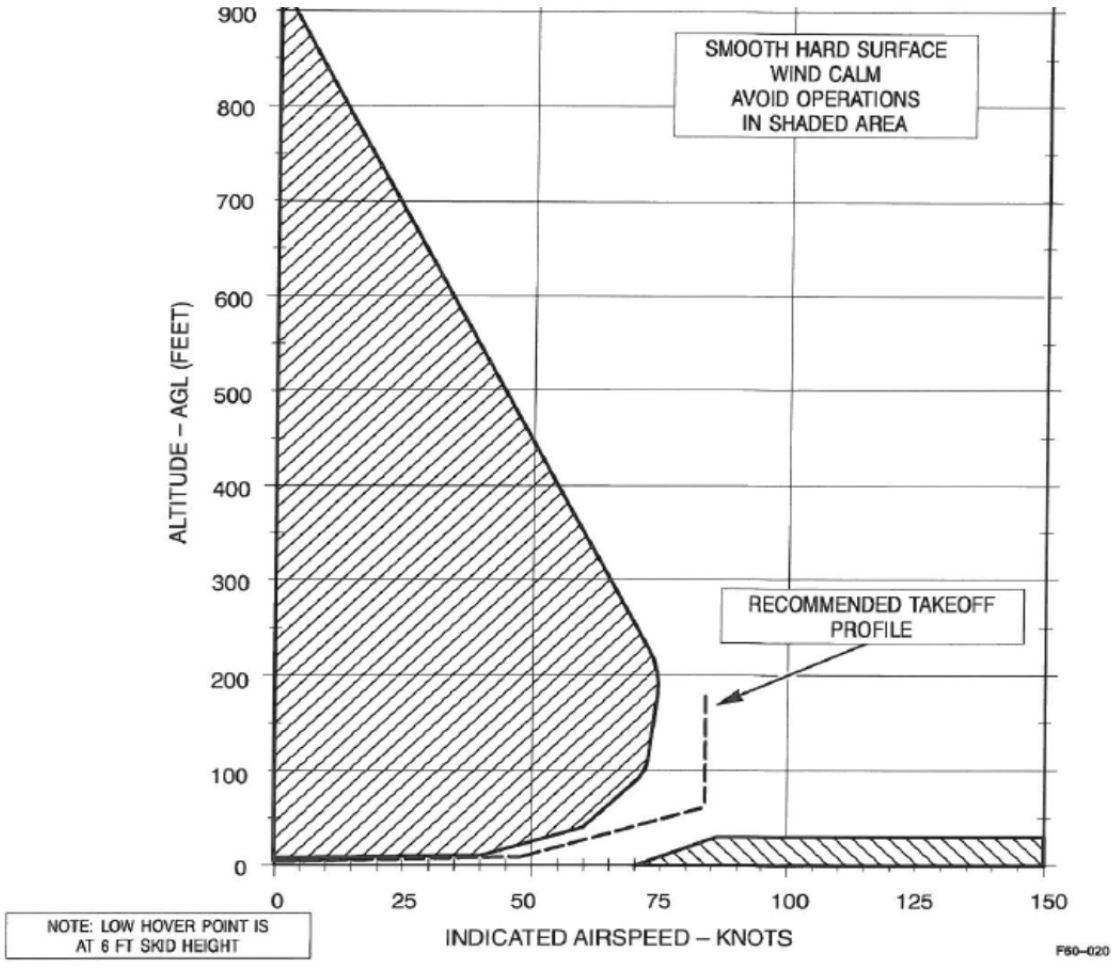


Figure 5–7. Height – Velocity Diagram

Height-Velocity Diagram for autorotations Source: Airplane Flight Manual

Analysis

The crew was properly licensed and due to their flying experience qualified for the flight.

The helicopter was properly registered and maintained. Mass and centre of gravity were within their prescribed limits.

The weather was sufficient for a flight according to Visual Flight Rules (VFR). There was no precipitation and no snow fall was predicted.

In the winter of 2010/2011 several helicopter operators offered and performed the service to assess the snow load of roofs and blow the snow down using the downwash. The downwash was to raise the snow and blow it off the roof with the help of the wind and therefore lessen the snow load of the roof. In order to be more effective it was necessary to hover several times relatively low and with slow forward speed across the roof. Video recordings of such snow clearing showed the danger that helicopters can get into their own raised snow cloud where white-out conditions can occur and loss of orientation is possible. They at least showed that the helicopters partly remained in the raised snow cloud (see Appendix 3). Besides the danger of a spatial disorientation it is highly likely that ice and snow accumulate mainly in the engine inlet air flow path because of the large amounts of air being sucked in. This should be considered while preparing for such flights.

The helicopter in question was not equipped with a particle separator in front of the engine inlet cowl. It would very likely have protected the engine from ice and snow. On the day of the accident one engine failure had already occurred during a low hover across a platform roof to clear the snow. The crew concluded that it probably occurred due to ingestion of snow and ice. They had restarted the engine and continued with the work order. The operator's management claimed that the crew did not inform them of the engine failure and therefore they could not initiate subsequent counter measures. However, it is to be noted that the PIC as head of maintenance was part of the operator's management.

The BFU does not understand why the supervision authorities require in case of engine failure twin-engine helicopters with flight performance class 1 or 2 for SAR missions, commercial air transport in areas with no emergency landing options but single-engine helicopter operation is tolerated in the scope of aerial work - in this case above frequented stores. Given the scope of the operation in regard to height and

airspeed an accident in case of an engine failure with a single-engined helicopter is nearly inevitable.

The accident occurred shortly after take-off during the approach to a store after an off-field landing in a cleared street. The chosen landing area was not closed off and due to its small size and the high snow mounts and the closeness to a road not very suited. The downwash raised a snow cloud during landing and take-off due to the missing snow clearing. This caused the pilot to take-off vertically out of the snow cloud. In a flight phase with low forward speed the engine failed. A video recording showed that the engine failure and the helicopter's impact with the ground occurred within 4 seconds.

The examination of the engine did not reveal a technical cause for the sudden engine failure. The damage found on one of the compressor blades supports the assumption that the engine failure was due to a sudden ingestion of ice. Already in the past small amounts of sucked-up and clumped-together snow and ice caused engine failures.

Conclusions

The accident occurred due to a sudden engine failure shortly after take-off caused by the ingestion of ice in a height and with a speed not sufficient for autorotation.

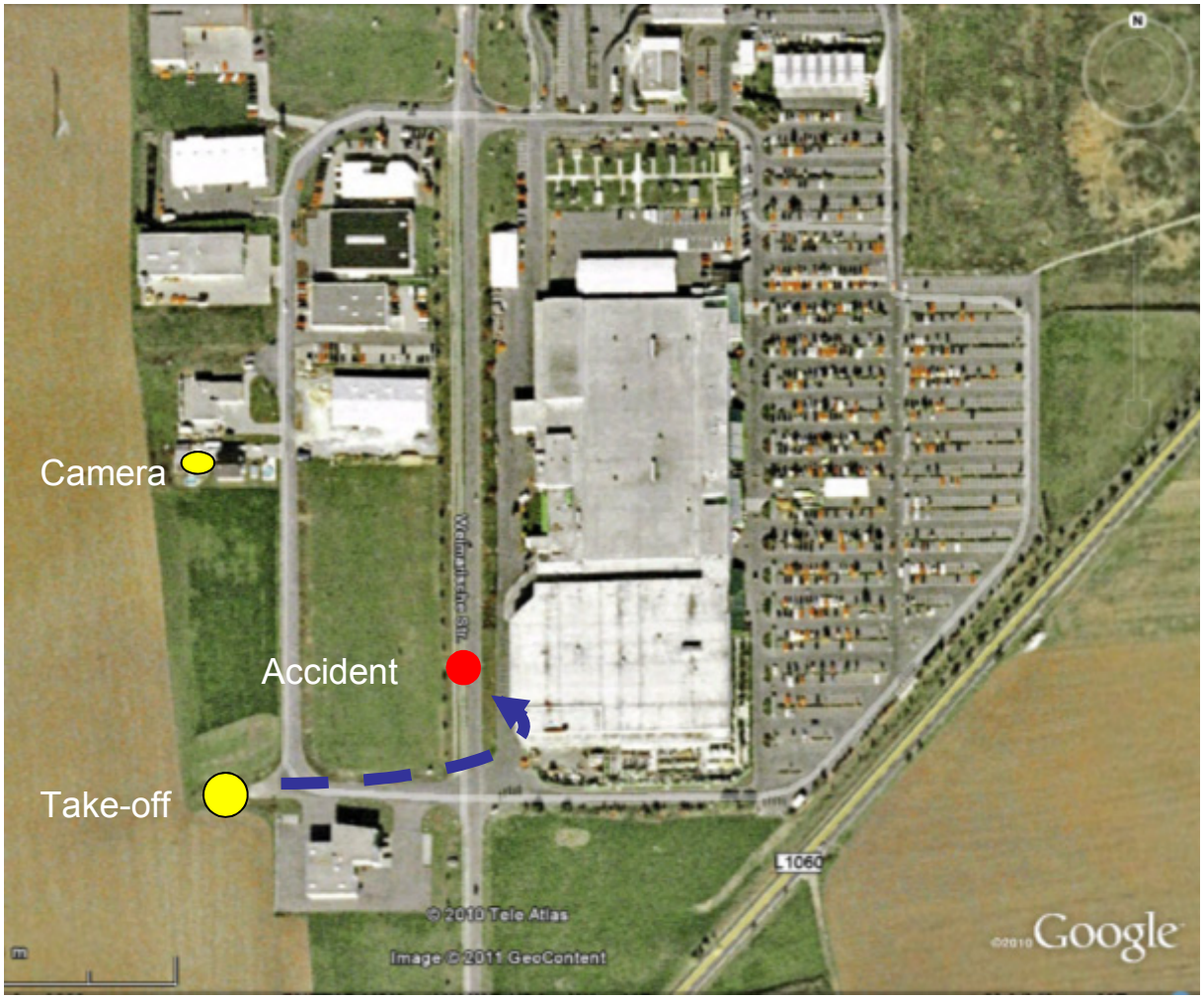
Safety Recommendations

On 4 January 2011, after the accident, the LBA issued a circular for all helicopter operators: "Working flights to clear snow from roofs" (Appendix 4).

18/2012: The Federal Ministry of Transport, Building and Urban Affairs (BMVBS) should together with the Luftfahrt-Bundesamt (LBA) and all Luftfahrtbehörden der Länder (regional regulatory authorities) ensure that during flight operations where emergency landings due to engine failure cannot be carried out at all times or where third parties are possibly put in danger, only helicopters with the flight performance class 1 under consideration of category A procedures are used.

Investigator in charge:	Axel Rokohl
Field Investigation:	Reinhard Bölkow, Axel Rokohl
Braunschweig:	17 April 2012

Appendices



Appendix 1: Overview accident site Source: Google Earth™, BFU

Appendix 2: Recording of the video surveillance Source: Police / BFU

Appendix 3: Angled view of the helicopter from the ground during snow clearing Photos (2): Press

Arbeitsflüge zur Schneeräumung von Dächern

Sehr geehrte Damen und Herren,

bedingt durch die anhaltend starken Schneefälle im Dezember 2010 wurden in diesem Winter verstärkt Hubschrauber für die Räumung von großflächigen Dächern eingesetzt.

Aus gegebenem Anlass weisen wir Sie darauf hin, dass bei der Planung und Durchführung von Flügen zur Schneeräumung großer Dachflächen mit erhöhter Umsicht und Aufmerksamkeit vorzugehen ist.

Vor dem Einsatz sollten nachfolgend aufgeführte Bedingungen erfüllt sein:

1. Die Bestimmungen der „Allgemeinerlaubnis für den Einsatz von Hubschraubern" sind einzuhalten. Andernfalls ist der Einsatz mit der zuständigen Landesluftfahrtbehörde abzustimmen.
2. Die Piloten haben sich vor dem Einsatz intensiv auf die Besonderheiten des Schwebefluges über großen Schneeflächen vorzubereiten. Der Verlust der räumlichen Orientierung durch aufgewirbelten Schnee (White-Out) ist unbedingt zu verhindern. Der Einsatz eines weiteren Flugbesatzungsmitgliedes als „Beobachter" wird hierzu als sinnvoll erachtet.
3. An Bord des Hubschraubers dürfen sich ausschließlich Flugbesatzungsmitglieder des Luftfahrtunternehmens aufhalten. Bei Einsatz eines weiteren Flugbesatzungsmitgliedes ist vorher die Aufgabenverteilung und Kommunikation durch den Luftfahrtunternehmer festzulegen.
4. Vor dem Einsatz im Schnee sind die Anweisungen des Herstellers bzw. die Angaben im Flughandbuch des jeweiligen Hubschraubermusters zu berücksichtigen. Sofern lt. Flughandbuch gefordert, sind die Hubschrauber mit Vorrichtungen/Ausrüstungen zur Verhinderung des Ansaugens von Schnee und Eis auszurüsten (z. B. snowbaffles, snowdeflectors o.ä.).
5. Für den Zeitraum der Befliegung der Hallendächer dürfen sich keine Personen im Arbeitsbereich des Hubschraubers aufhalten. Sollte es notwendig sein, Personal für die Beobachtung im oder am Gebäude einzusetzen, wird eine stabile Funkverbindung zum Piloten vorausgesetzt.
6. Der Auftraggeber muss sicherstellen, dass die zulässige Traglast des Daches durch den Rotorabwind („Downwash") nicht überschritten wird.
7. Die Außenlandegelände sind entsprechend zu sichern.
8. Das flugbetriebliche Verfahren ist in einer betriebsinternen Anweisung (z.B. SOP) zu beschreiben und bei Ihrem zuständigen Flugbetriebsprüfer vorzulegen

Unabhängig von den o.g. Bedingungen entscheidet der Hubschrauberführer letztlich in eigener Verantwortung, ob die Aufgabe fliegerisch durchführbar ist und die öffentliche Sicherheit und Ordnung nicht beeinträchtigt oder gefährdet wird.

Appendix 4: Circular of the Luftfahrt-Bundesamt Source: LBA

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 - FlUUG) 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.

Published by:

Bundesstelle für
Flugunfalluntersuchung
Hermann-Blenk-Str. 16
38108 Braunschweig

Phone +49 531 35 48 - 0
Fax +49 531 35 48 - 246

Mail box@bfu-web.de
Internet www.bfu-web.de