

FINAL REPORT ON THE ACCIDENT TO THE EUROCOPTER AS355F1 REGISTERED OO-HSB IN ZUIENKERKE ON 23-NOV-2008

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FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident,

In accordance with Annex 13 of the Convention on International Civil Aviation, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Article 13 of the King's Decree of 9 December 1998 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility in the accident.

Unless otherwise indicated, recommendations in this report are addressed to the Regulatory Authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

The investigation was conducted by L. Blendeman and D. Wintershoven.
The report was compiled by D. Wintershoven.

NOTE:

For the purpose of this report, time will be indicated in UTC, unless otherwise specified.

Synopsis

Date and hour of the accident

November 23rd 2008 at 15.01UTC (16.01LT)

Aircraft

Eurocopter AS355F1 Ecureuil / Twinstar OO-HSB

Accident location

Brugse Steenweg Zuierenkerke, Houthave Belgium (51°16'N 3°08'E) at 18km NE of EBOS

Aircraft owner

Heli Service Belgium

Type of flight

Aerial work; HEMS (helicopter emergency medical service)

Persons on board

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	1	0	0	1
Minor	0	1	0	1
None	0	1	0	1
Total	1	2	0	3

Abstract

OO-HSB, the MEDEVAC helicopter of Heli Service Belgium¹, was standing by at the AZ Sint Jan hospital in Brugge for the emergency medical service of the Brugge region.

The helicopter was operational at 06.57² up to 13.51 when the weather had degraded (snow). About one hour later, the weather improved and the pilot started to prepare the helicopter for further operations by removing the snow. At that time (14.45), the operating room received a call from HC100³ for a drowned person at Sun parks Holiday Centre De Haan. The ER⁴ dispatch called the pilot to check whether the helicopter was available, to which the pilot responded affirmatively.

OO-HSB was operational at 14.54 and took off at 14.58 with on board a nurse and a doctor.

Shortly after taking off at an altitude of approximately 350ft and a velocity of about 105KT a horn, indicating a low RPM, sounded in the cockpit.

Simultaneously the pilot noticed a loss in altitude of about 150ft/min.

The pilot lowered the collective and performed a flare in an attempt to regain

¹ HSB

² UTC

³ Help centre.

⁴ Emergency Room

RPM.

The pilot reported he saw that one engine was running at the maximum continuous rate (maximal T_4) while the other wasn't, and showed a 10% torque.

Because of the low altitude and high rate of descent the pilot decided to perform an emergency landing on a field straight ahead.

OO-HSB came in with tail wind. The pilot noticed that the field was crossed by ditches and tried to land behind it. Flaring, during the landing phase, reduced the speed. However, the helicopter touched down in front of the ditch with high velocity remaining.

The helicopter skidded for about 20m. The nose and right skid hit the ditch making the helicopter to tip over on its right flank and to break up into pieces. After standstill, the pilot cut off engine power and all three persons crawled out of the wreckage.

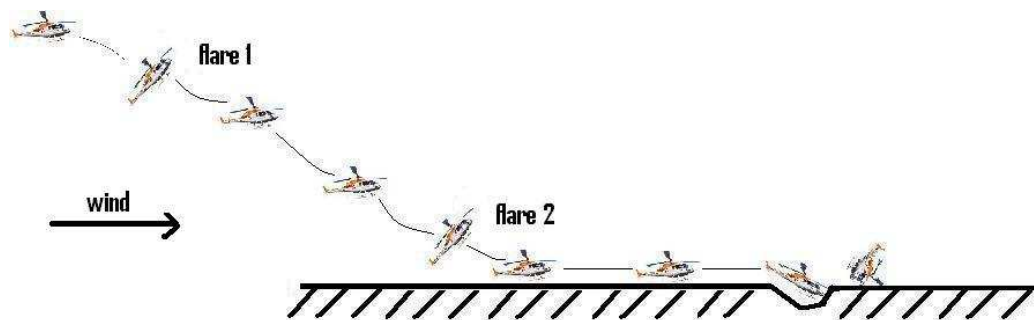


Figure 1: Schematic representation of the emergency landing and crash.

1. Factual information.

1.1 History of flight.

HSB is providing Helicopter Emergency Medical Service (HEMS) for the St Jan hospital in Brugge. This was done with the OO-HSB, an AS355F1 Ecureuil helicopter.

The night of the 22nd and the 23rd November the helicopter was parked inside the appropriate hangar at the hospital. The next morning, the 23rd, the helicopter was moved outside in front of the hangar, left side facing south, and after the necessary procedures⁵ the pilot called in to declare the helicopter was operational from 06.57.

Later that day, at 13.51, the pilot reported to be unavailable for HEMS missions due to worsening of the weather conditions⁶.

In the next hour the weather improved; it stopped snowing. The pilot prepared the helicopter by removing most snow. He recalled to have wiped most of the helicopter but not the rotor blades and engine intake grids.

At 14.45 a call was received by the emergency dispatch to request a helicopter for a mission at Sun parks holiday center De Haan. The pilot was asked if the helicopter was still unavailable. He stated that the flight could be performed. The pilot made the necessary checks and prepared the helicopter and was available at 14.54. OO-HSB took off in the direction of De Haan, situated 14km to the NW, at 14.58 with on board the pilot, a nurse and a doctor. The pilot took off in a forward motion seen how this was a cleared space. He ascended to about 350ft with a velocity of about 105KT.

The nurse stated that the pilot mentioned he had put on the engine anti-icing and that this happened at the beginning of the flight, when flying over the express road nearby.

Then the pilot turned on the heating system in the cockpit using the lever at the left side behind the pilot seat. Shortly after, a warning horn sounded in a continuous manner indicating a low rotor RPM. It was at this time that the pilot became aware of their losing altitude⁷.

In an attempt to regain rotor RPM the pilot performed a flare⁸.

⁵ Pre-flight checks: helicopter check, meteo, NOTAM's

⁶ Heavy winds, snow showers, limited visibility.

⁷ The doctor stated that she noticed a loss of altitude before the horn sounded.

⁸ The pilot performs a flare by pitching the nose up with aft cyclic. This would normally cause the helicopter to gain altitude, but the pilot reduces collective to prevent the climb from occurring. This generates a power decrease (FADEC), which requires right pedal to be applied as well. This allows the rotor to regain RPM.

When scanning the instrument panel, the pilot noticed the left engine delivered only 10% torque, while the other engine was running at maximal continuous power (100%).

He notified the nurse of the power loss and that he would try to restart the engine. The pilot brought the throttle of the left engine⁹ back to idle position.

The pilot stated to be surprised to see that the EGT remained at about 700°C after being brought to flight-idle.
The horn sounded a second time.

During these events, which are graphically represented in figure 1, the helicopter continued to loose altitude.

Eventually the pilot decided to perform an emergency landing on the field below. Because of the low altitude, OO-HSB was unable to turn. OO-HSB came in with tail wind. The pilot noticed that the field was crossed by ditches and tried to land behind it. Landing, while flaring, reduced the speed. However, the helicopter touched down in front of the ditch with high velocity remaining.

The helicopter skidded for about 20m. The nose and right skid hit the ditch causing the helicopter to tip over on its right flank and incurring substantial damage.

The pilot turned off the engines and checked the passengers. The three people crawled out of the helicopter.

1.2 Injuries to persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	1	0	0	1
Minor	0	1	0	1
None	0	1	0	1
Total	1	2	0	3

The pilot suffered a superficial injury to the head, a swollen hand and a sore right shoulder as well as a broken bone in the foot that needed medical attention.

The doctor suffered some superficial scratches on the arm.

⁹ Left engine when viewing the helicopter from behind.

1.3 Damage to aircraft.

The helicopter was destroyed; the tail rotor was ripped off, the main rotor was destroyed by the impact with the ground and the cabin was severely damaged as well.



Figure 2: View of the OO-HSB wreckage.

1.4 Other damage.

A small amount of kerosene leaked onto the ground.

1.5 Personnel information.

Sex: male

Age: 51 years

Nationality: Belgian

License:

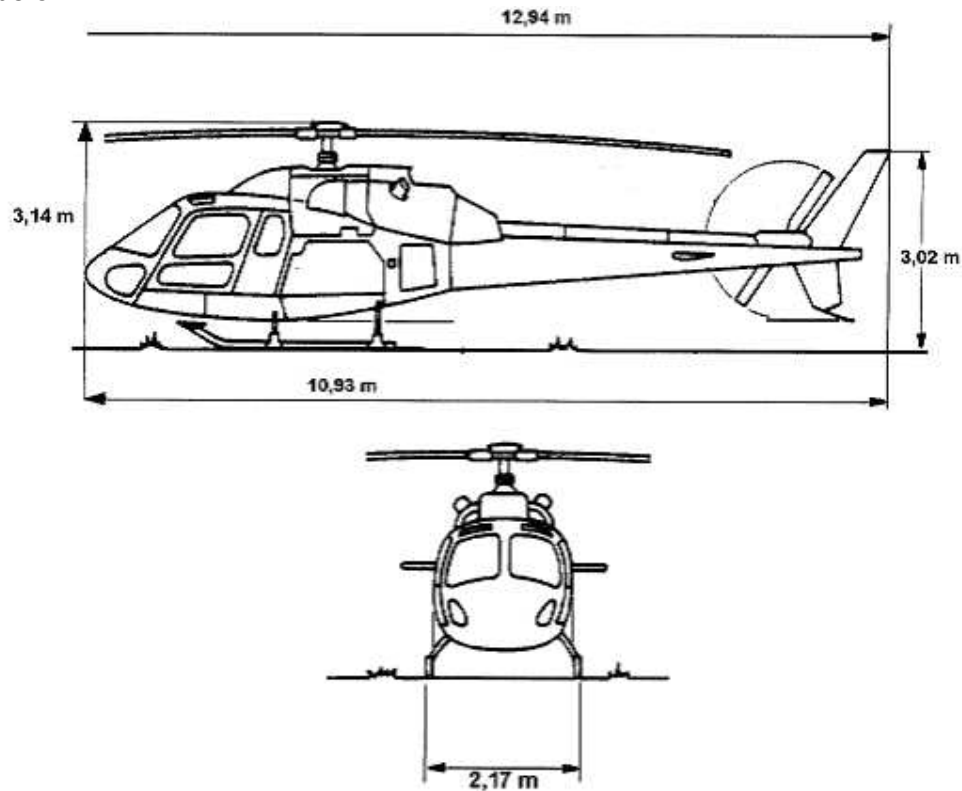
- Commercial helicopter transport license (CPL(H)) 100042 delivered on 21/11/2008, valid until 21/11/2013. Night flight, English (valid until 24/04/2011).
- Commercial pilot aeroplanes (CPL(A)) 100042 delivered on 21/04/2006, valid until 24/04/2011. IR(A) & SEP (land).

Medical: class 1, valid until 23/05/2009.

The pilot has approximately 22000 flight hours as a helicopter pilot. He is licensed to fly AS355/355N, B206/206L, EC120, R22, R44, FI(H). He is also a licensed instructor (valid until 23/11/2009).

1.6 Aircraft information.

The AS355F1 is a twin-engine helicopter with a maximum capacity of 7. It is equipped with two Allison 250-C20F turbo-shaft engines. The AS355F1 has MTOW¹⁰ of 2400kg. The main dimensions are given below.



Airframe:

- Manufacturer: Eurocopter
- Type: AS355F1
- Serial number: 5223
- Built year: 1982
- Registration: OO-HSB
- Certificate of registration: 4685, issued on 27/02/1997
- Certificate of airworthiness: 4658

Engine:

- Manufacturer: Allison
- Type: 250-C20F
- Total flight hours:
 - Engine 1: 8911.9 FH
 - Engine 2: 8662.9 FH
- Serial number:
 - Engine 1: CAE840345
 - Engine 2: CAE840447

¹⁰ Maximum take-off weight.

Owner:
Heli Service Belgium. Gaasbeeksesteenweg 140, 1500 Halle.

Certificate of airworthiness:
Issued on 02/04/2008.

Airworthiness review certificate:
Issued on 04/04/2008, valid until 04/04/2009.

1.7 Meteorological conditions.

A high-pressure area was located North of Scotland, with associated frontal system located East of the British Isles, the channel and West of France, moving East.

The METAR¹¹ read out from EBOS, located 18km NE from the accident site, delivered following data around the time of the accident:

		wind direction[MAG]	wind velocity[KT]	wind gusts[KT]
Time UTC[hh.mm]	13.50	180	15	/
	14.20	170	18	/
	14.50	190	15	26
	15.20	190	11	/

Figure 3: METAR wind data.

		visibility[m]	precipitation	clouds[ft]	
				scattered	broken
Time UTC[hh.mm]	13.50	1500	snow and rain	800	1500
	14.20	2500	light snow	500	700
	14.50	8000	light snow	500	800
	15.20	8000	/	500	800

Figure 4: METAR precipitation data.

		temperature[°C]	saturation temperature[°C]	atmospheric pressure[QNH]
Time UTC[hh.mm]	13.50	0	-1	992
	14.20	0	-1	990
	14.50	1	-1	990
	15.20	1	-1	980

Figure 5: METAR temperature and pressure data.

¹¹ Meteorological aerodrome report.

Because of its position when parked outside the hangar (during the period of unavailability), the left side¹² of the helicopter was into the wind.

Below two radar images are shown. These give an overview of the precipitation over Belgium at the time of the accident.

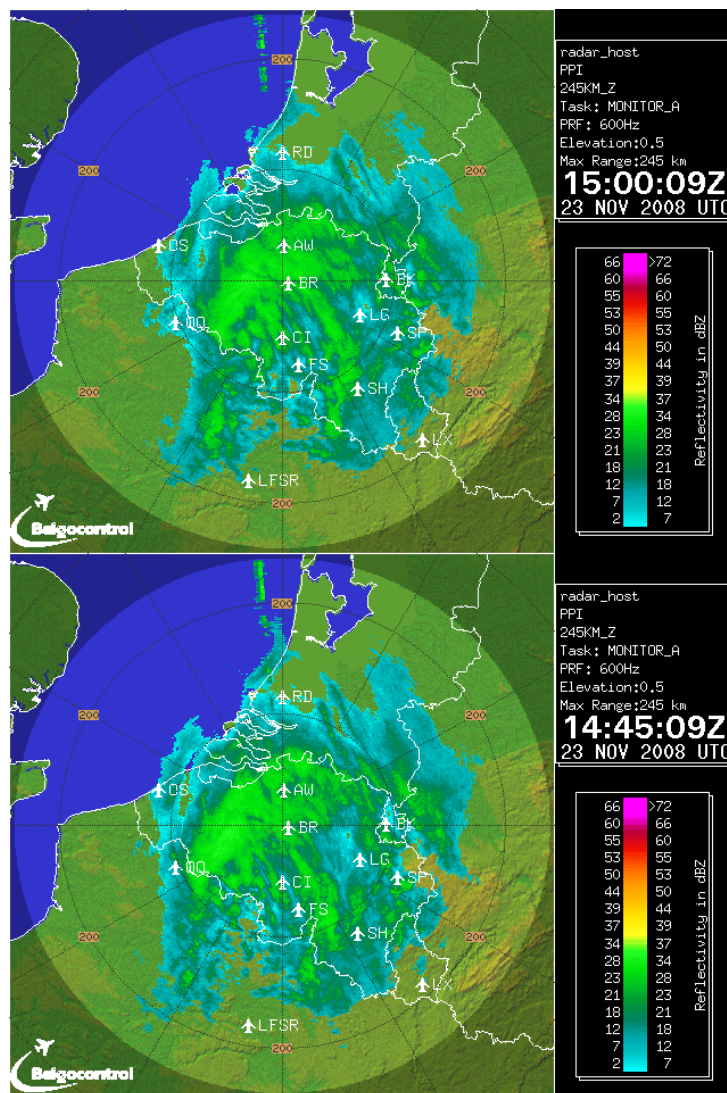


Figure 6: Radar images from BELGOCONTROL around the time of the accident.

¹² Seen from behind.

1.8 Aids to navigation.

Not applicable: certified VFR only.

Nonetheless OO-HSB was equipped with a Garmin GPS100 system.

The read out from the GPS system is shown graphically below.

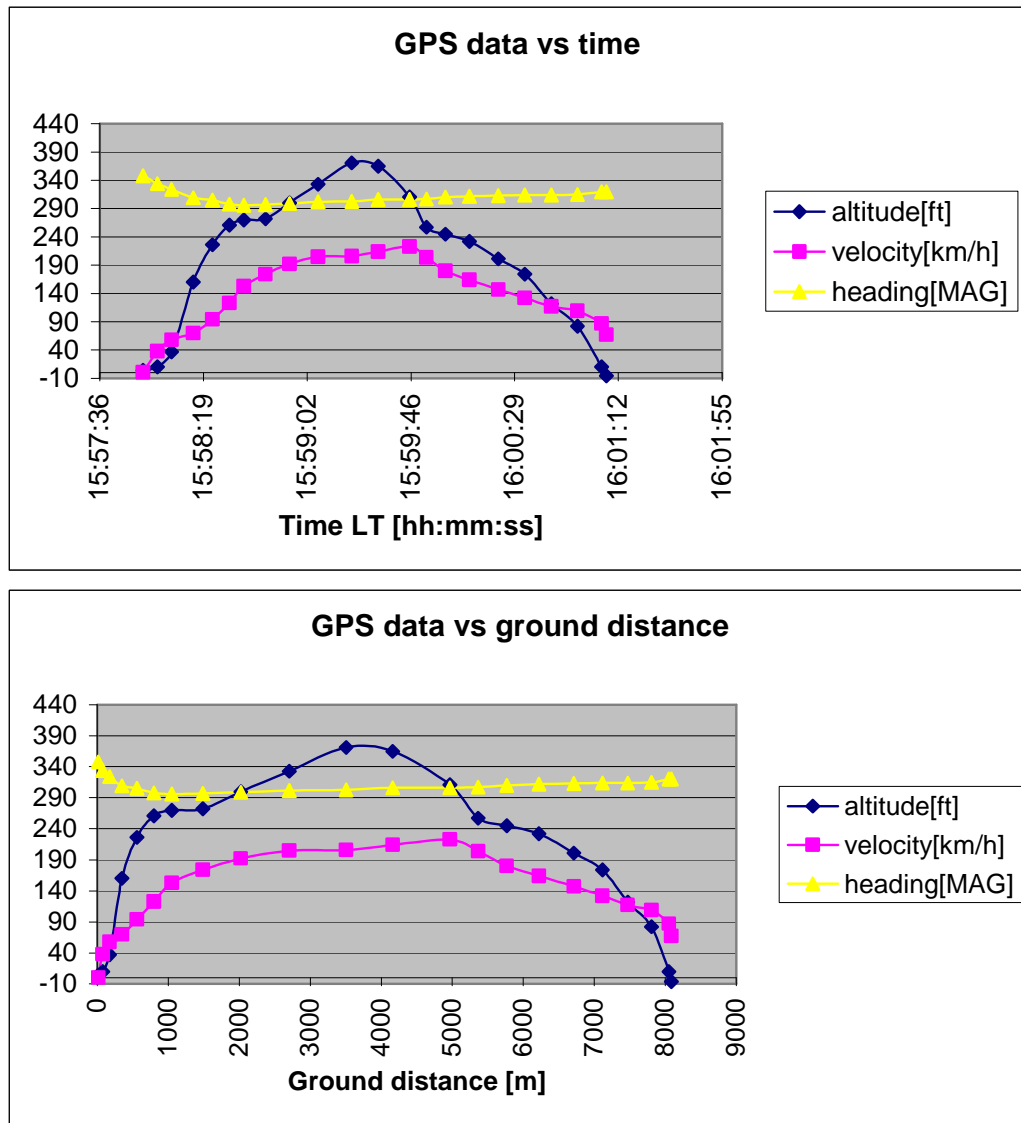


Figure 7: GPS data read out.

1.9 Communication.

OO-HSB was equipped with two communication units. A VHF nav/com KX165 and a VHF com KX195 box. This allowed the pilot to receive simultaneously two channels for radio communication¹³.

The helicopter was also equipped with a KT96A transponder.

No relevant communication was established around the time of the accident.

1.10 Aerodrome information.

Not applicable.

1.11 Flight recorders.

Not applicable.

1.12 Wreckage and impact information.

Due to the high horizontal velocity at landing the helicopter slid over the moist ground, covered with snow and impacted a ditch about 20m further. The skid marks in the ground were clearly visible (shown below).



Figure 8: Skid marks in the ground.

As a consequence, the nose and right skid of the helicopter impacted the other side of the ditch and caused OO-HSB to roll over on its right flank, incurring substantial damage.

¹³ Thus to have a 2-way link on one of the both channels.



Figure 9: Damage incurred to OO-HSB.

Due to the impact with the ditch, the tail boom broke and the tail rotor was projected away about 30m.



Figure 10: Tail boom and tail rotor of the OO-HSB

1.13 Medical and pathological information.

The pilot suffered a superficial injury to the head, a swollen hand and a sore right shoulder as well as a broken bone in the foot that needed medical attention.

The doctor suffered some superficial scratches on the arm.

The nurse stated to the police to be slightly injured just after the accident. But no further record of injury was found.

1.14 Fire.

Not applicable.

1.15 Survival aspects.

Both pilot and passengers were adequately strapped onto their seats. This minimized greatly the risks for serious injuries.

The local police department of Blankenberge-Zuierenkerke was contacted at 15.08 and proceeded towards the accident location. At the time of their arrival the fire department of De Haan-Wenduine was already on scene. The victims had already received first aid.

1.16 Tests and research.

Visual inspection showed that the incurred damages to the structure of the helicopter originated from the impact during the emergency landing.

Both engines were submitted to a thorough inspection with following observations:

- The N1 shafting system was free and continuous from the compressor to the accessory gearbox as observed on both engines.
- The N2 shafting system turned freely by hand and was continuous from the rotor to the power turbine output on both engines.
- All available pneumatic, fuel and oil line coupling ("B") nuts and their associated fittings were checked by hand and found at least finger tight on both engines.
- Continuity of the flight controls (collective & cyclic) from the control stick to the main rotor pitch change links was established on both engines.
- The throttle was manipulated by hand and helicopter to engine rigging was established on both engines.
- Free movement of the throttle throughout entire range of movement was established on both engines.
- The trim switches were found to be operational.
- Both of the overrunning clutch assemblies were still attached to their mounting pads and engaged with the power take-off (PTO) gear shaft.
- The #1 engine inlet investigation revealed minor 1st stage leading-edge blade damage from ice ingestion.
- The #2 engine inlet was unremarkable.
- Both engines P/T – 4 wheels were unremarkable as viewed through the exhaust stacks.

The investigation team decided not to remove the engines from the helicopter based on the inspection results and the pilot's statement.

1.17 Organizational and management information.

HSB is Belgian helicopter operator holding an AOC¹⁴ compliant with the JAR OPS 3 regulations.

The helicopters for the HEMS operate only in VFR-day-conditions and in performance class 1¹⁵; this implies a take-off weight less than 2200kg.

The flight crew members must meet the requirements of the JAR-OPS Part 3 Subpart N training as well as following additional requirements:

- Meteorological training concentrated on the understanding and interpretation of available weather information.
- Preparing the helicopter and specialized medical equipment for subsequent HEMS departure.
- Practice of HEMS departures.
- The assessment from the air of the suitability of HEMS operating sites.
- The medical effects of air transport on patients.

For HEMS operations the flight crew must perform some additional line checks with special emphasis on:

- Local area meteorology.
- HEMS flight planning.
- HEMS departures.
- The selection from the air of HEMS operating sites.
- Low-level flight in poor weather.
- Familiarity with established HEMS operating sites in operators local area register.

The pilot of the OO-HSB holds the position of ground operation manager at HSB and is as such responsible for the boarding procedures of the passengers and the security procedures around the helicopter, as described in their flight operations manual PART A. Another duty of the ground operation manager is the correction of known safety hazards.

1.18 Additional information.

Not applicable.

1.19 Useful or effective investigation techniques.

Not applicable.

¹⁴ Air operator certificate.

¹⁵ Described in the Flight operations manual, PART A: the helicopter is certified to fly with one engine inoperative independently of the flight conditions (no minimal height of flight speed required).

2. Analysis.

2.1 Icing.

During the day, the helicopter was stationed outside the hangar when the weather worsened.

The meteorological information shows that icing conditions were met before and during flight, i.e. it was snowing and raining and the temperature was around freezing point.

It is therefore likely that ice and snow build-up took place on several parts of the helicopter when stationed outside.

The investigation of the left engine compressor revealed that the blades' leading edges of the first stage were rough, a condition generally associated with ingestion of ice.

Icing represents a real threat to helicopters with several possible consequences:

- Icing of the rotor blades can set off vibrations, which can lead to loss of control of the helicopter.
- In-flight ice shedding from the main rotor or tail rotor can cause structural damage and vibrations.
- Snow or ice ingestion by turbine engines can cause a flameout and damage to the engine.
- ...

The normal precautionary- and protective measures against icing involve following procedures:

- Parking the helicopter inside a hangar whenever possible.

Applying protection on several critical parts of the helicopter:

- The rotor blades: by putting blade socks on the blades.
- The engine air intakes: by the use of a cover. In this particular case an accumulation of snow and ice was very likely on the left¹⁶ engine air intake grid, which was facing the wind.
- An accumulation of snow and ice on the exhaust nozzles can be prevented by the use of a cover.

All of the above safety measures are described in HSB's flight operations manual. However, none of them were applied.

The pilot stated to have cleared most of the helicopter of snow before the flight; nevertheless he did not wipe the rotor blades or the engine air intake grids.

Due to the fact that the left engine was positioned into the wind, the fact that no covers were put on the engine intakes, no socks were

¹⁶ Seen from behind the helicopter.

used for the rotor blades and taking into account the weather conditions, it seems likely that:

- The (main) rotor blades encountered icing, before or during flight.
- The left engine intake grid encountered an accumulation of snow and ice, possibly inducing icing of the engine inlet.

The statements of the pilot and the doctor of their losing altitude during flight, strengthen the former possibility due to the fact that the blades would generate less lift. However, no statements were made of enhanced in-flight vibrations that could be expected with rotor icing.

The latter possibility is vouched by the damage found on the first compressor stage of the left engine. This could also partially explain the loss of power¹⁷ during the flight due to the disturbed airflow, and the ingestion of the ice mass itself.

At some point close to the take-off¹⁸, the engine inlet anti-icing was put on. This would have heated the engine inlet, which might have caused the accumulation of ice and snow on the grid and engine inlet to break up and be ingested by the engine.

2.2 Performance.

During flight the helicopter was losing altitude. Particularly during the last moments, with the left engine in flight-idle, the pilot struggled to maintain altitude. This, in turn, forced him to perform an emergency landing.

Although the helicopter is certified as performance class 1¹⁹, and thus should have been able to maintain altitude with OEI²⁰, following factors caused the helicopter to be unable to deliver the required power:

- The activation of the anti-icing, which reduces engine power,
- The activation of the cabin heater, which uses bleed air from the engines and causes the delivered power to drop.

The flight characteristics of the AS355F1 given in figures 11, 12 show that, at optimal climbing speed (IAS²¹: 55KT; 102km/h), the rate of climb would decrease about 47% from 710 ft/min to 380ft/min by activating the anti-icing and heater.

¹⁷ Manifested by a low RPM and a low torque of the engine.

¹⁸ Before or just after take-off depending on the statement.

¹⁹ Always operable with one-engine-inoperative.

²⁰ One-engine-inoperative.

²¹ Indicated Air Speed.

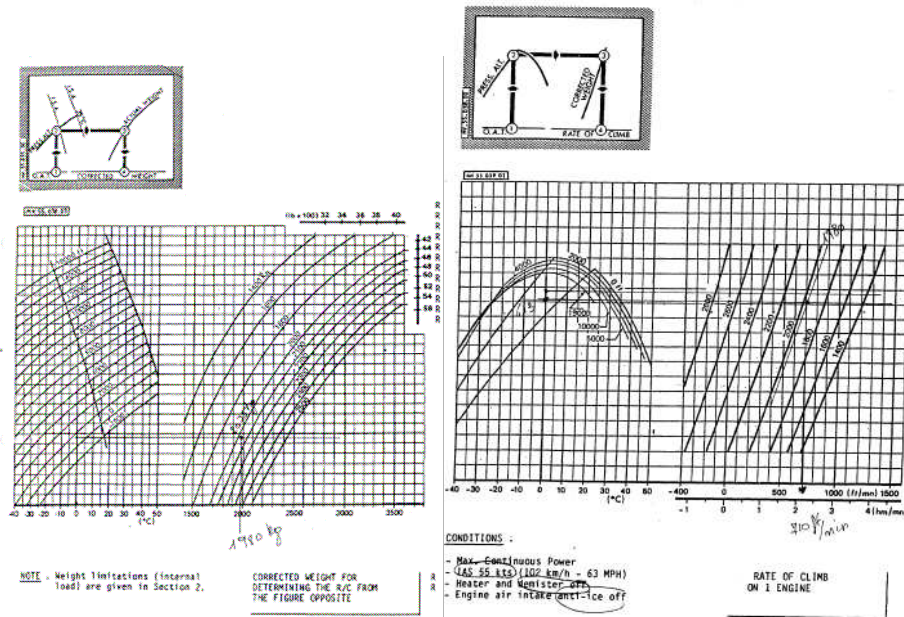


Figure 11: Rate of climb at optimal climbing speed (IAS) with OEI and no anti-icing, heater.

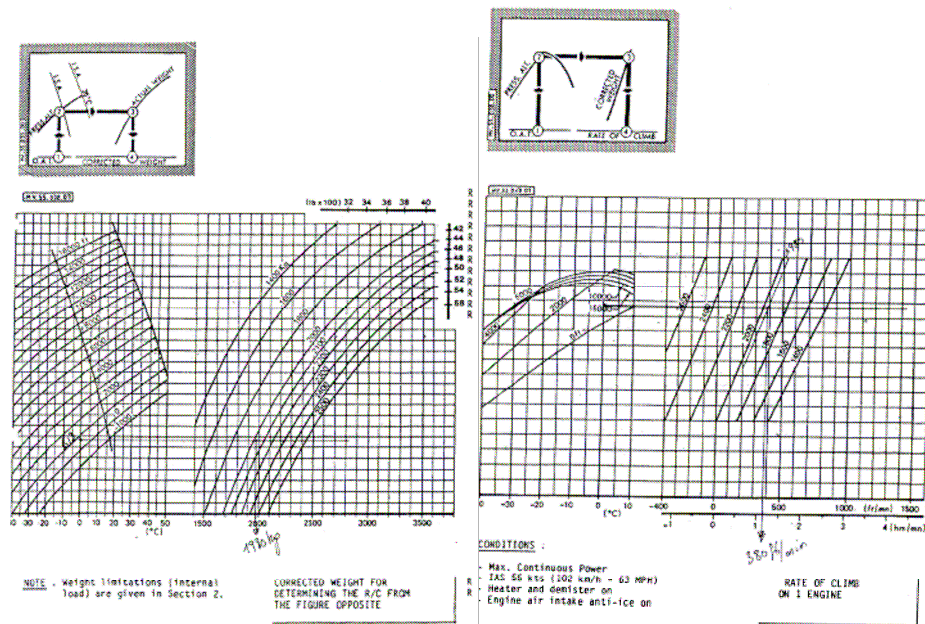


Figure 12: Rate of climb at optimal climbing speed (IAS) with OEI and anti-icing, heater on.

In this particular case, most of the flight was performed at velocities well above the optimal climbing speed (figure 7²²), which results in a rate of climb close to nil due to the increased drag the engine has to overcome (relative to optimal climb speed).

It is therefore likely that, with one engine in flight-idle, the anti-icing and cabin heater on, the engine could not deliver enough power to climb (at that speed).

This explains the loss in altitude of the OO-HSB.

²² Mostly above 75KT up to 125KT TAS (see figure 7).

2.3 Flight in degraded meteorological conditions.

It should be noted that the fact there were no covers put on the engine air intakes or no socks on the rotor blades is of course related to the nature of the helicopter's mission i.e. HEMS. It is obvious that because of this nature, the helicopter has to be operational and ready for take-off in the shortest possible time span.

The above leads to the question whether the helicopter should have flown in the weather circumstances at the time of the mission.

The weather during the mission can clearly be categorised under icing conditions. According to the AS355's flight manual icing conditions are defined as follows (see figure 13):

- Temperatures below +5°C,
- Visual dampness.

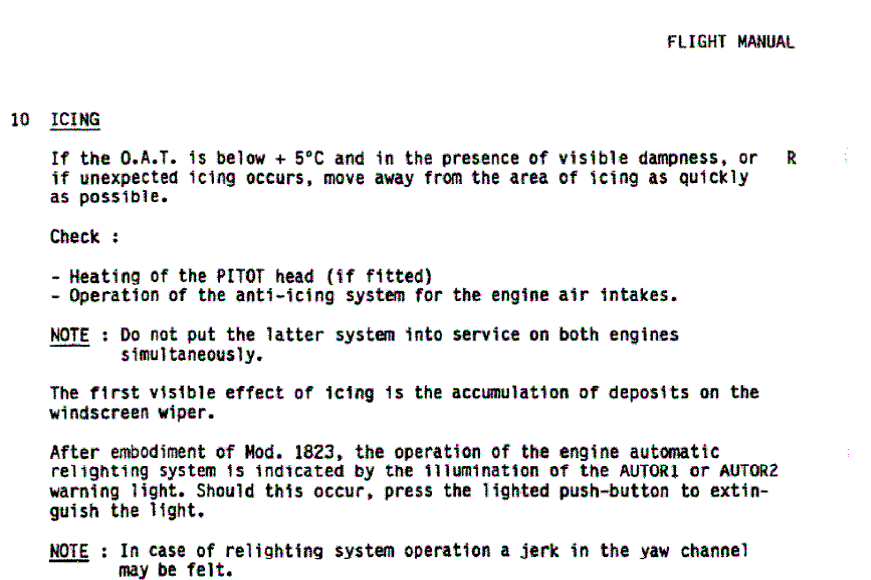


Figure 13: Extract A355's flight manual.

Furthermore, the company's flight operations manual states that flying in icing conditions is prohibited, with no exception for HEMS (figure 14).

Only when icing conditions are, unexpectedly, encountered in flight the helicopter may continue the flight, with certain actions undertaken and always trying to move away from the area.

HELI SERVICE BELGIUM nv Gasbeeksesteenweg 140 B-1500 Halle Tel : 02-361 21 21 Fax : 02-360 27 70	FLIGHT OPERATIONS MANUAL PART A	Page 5 Edition 3.0 Amendment 3 Date 12/10/2005
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Take-off and Landing

The take-off, initial climb, final approach and landing phases of flight in the vicinity of thunderstorms may present the pilot with additional problems therefore:

- do not take off if a thunderstorm is overhead or in the take-off flight path
- at destination hold clear if a thunderstorm is overhead or in the approach flight path.
- divert if necessary.

Ground Precautions

The helicopters must be adequately secured (see Part B) on the ground when severe thunderstorm activity is forecast or present if it is inevitable to leave aircraft in the open.

Avoidance – Guide to pilots

Avoid any storm that by visual inspection is tall, growing rapidly or has an anvil top. Avoid flying under a cumulo-nimbus overhang

8.3.8.2 ICING CONDITIONS

Flying in icing condition is prohibited. If such conditions where unpredictable and cannot be avoided in flight, Pitot head, static vent and reignition system (B206 & AS355) should be selected 'ON' for all flights through icing conditions, and other equipment used for anti- or de-icing according to the prevailing conditions and as recommended in the flight manual. (See section 8.2.4) Icing may occur quickly, particularly in the case of rotor icing. An early precautionary landing is required in the event of evidence of:

- any main or tail rotor blade icing
- any significant airframe icing
- any icing which significantly restricts vision through the screen

Figure 14: Extract flight operations manual.

From the meteorological data (section 1.7) it is fairly certain that icing conditions were present at the time of the mission, and that the helicopter should not have flown.

3. Conclusions.

3.1 Findings.

- The pilot had a valid license.
- The helicopter was airworthy.
- OO-HSB was left outside between 13.51 and 14.45 in icing conditions.
- The flight took place in icing conditions.
- The left side of the helicopter was into the wind.
- No covers were put on the engine intakes, no sock were put on the rotor blades.
- The pilot did not wipe the rotor or engine intakes before flight.
- OO-HSB was losing altitude during flight.
- During flight a low RPM horn sounded.
- The left engine, presumably, had a 10% torque.
- Damage to the 1st stage of the left engine compressor was found during inspection.
- No other discrepancies on the helicopter, dating from prior to the crash, were found.

3.2 Causes.

The accident was most likely caused by the non-adherence to procedures pertaining to the protection of the helicopter against icing conditions.

The following contributing factors have been identified:

- "Get-there-itis"; the pilot's urge to fly even though circumstances were dubious.
- Ice ingestion of the left engine.
- Possible icing of the rotor blades.
- The activation of the anti-icing and cabin heater.
- Landing with tailwind and the presence of a ditch.

The ice ingestion caused a (possibly temporary) loss of power. This, along with the possible icing of the rotor, the use of the anti-icing and cabin heater forced the pilot to respond with an emergency landing because of the low flight altitude.

The high horizontal velocity when landing and the presence of a ditch in the field caused the helicopter to tip over and incur substantial damage.

4. Safety recommendations.

The necessary procedures that could have avoided this accident are present in the company's flight operations manual and the helicopter's flight manual.

4.1 To HSB.

The pilots should be made aware of the importance of the guidelines and procedures described in the flight manual and the company's flight operations manual for operations in cold weather conditions.

Therefore the AAIU.be recommends a sensitisation of the HSB pilots who fly HEMS missions to the cold weather procedures.

The AAIU.be emphasizes the importance of recurrent training for winter operations.