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Service public fédéral Mobilité et Transports
Luchtvaart-Transport aérien

Air Accident Investigation Unit

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**FINAL REPORT ON THE ACCIDENT
OCCURRED ON 05/08/2007
AT AYWAILLE
ON AN EUROCOPTER AS350 BA
REGISTERED OO-HCW**

Ref. AAIU-2007-12
Issue date: 30 April 2008
Status: Final

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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.

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 is led by L. Blendeman, designated investigator. This accident was notified to the French BEA, that designated MM D. Verdoni and J-F Berthier, French accredited representatives, and Mr Laurent Zombralis, investigator. The investigation received the cooperation of Eurocopter, Turbomeca and Ixair.

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

Synopsis

Date and hour of the accident

Sunday, 5 August 2007, around 13.50 UTC.

Helicopter

Type: Eurocopter AS 350 BA
Registration: OO-HCW

Accident Location:

Aywaille / Remouchamps

Aircraft Owner

Heli and Co SA

Type of flight

Local flight

Persons on board

1 Pilot
5 Passengers

Abstract.

During the Spa Airport fly-in, Heli and Co was organizing first flights with the OO-HCW helicopter.

The helicopter embarked 5 passengers (2 males adult, 1 female adult and 2 children).

The helicopter took off from Spa airport for a local flight of ca 15 min.

Above Aywaille / Remouchamps, the helicopter was in a steady level flight, at an altitude of ca 500 ft and a speed of 100kts, when the helicopter had a violent uncontrolled yaw movement to the left, followed by vibrations.

The pilot reacted in putting the helicopter in auto-rotation reducing the engine power. The pilot then steered the helicopter in the wind direction and performed a sliding landing.

After complete shut-down of all systems, and disembarking of the passengers, the pilot noticed that the aft rotor transmission shaft was severed.

1. Factual Information

1.1. Chronology of the events.

On Sunday 5th August 2007, during the Spa Airport fly-in, Heli and Co was organizing popular flights with the OO-HCW helicopter.

The helicopter embarked 5 passengers (2 males adult, 1 female adult and 2 children). The helicopter took off from Spa airport, around 11.40 for a local flight of ca 15 min.

Above Aywaille / Remouchamps, the helicopter was in a steady level flight, at an altitude of ca 500 ft and a speed of 100kts, when the helicopter had a violent uncontrolled yaw movement to the left, followed by vibrations.

The pilot reacted in putting the helicopter in auto-rotation, and reducing the engine power. The pilot then steered the helicopter 270° to get in the wind direction and performed a auto-rotation sliding landing.

The landing area is a grassy meadow, showing a slight downward slope. The coordinates are: N 50°28,803 E 05°43,291.

After complete shut-down of all systems, and disembarking of the passengers, the pilot noticed that the aft rotor transmission shaft was severed.

One cowl, protecting the transmission shaft, is severely damaged, and lies, along with a 20cm-long part of the shaft, on the grass at a short distance (+/- 1 m) of the helicopter.

1.2. Injuries to persons

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	1	5	0	6
Total	1	5	0	6

1.3. Damage to aircraft

The aft rotor transmission shaft was ruptured, 3 cowls were damaged. One rotor blade (yellow) showed clear impact traces with the cowlings and aft rotor shaft.

Upon inspection of the engine, there were additional damages found on the free wheel and free wheel shaft.

1.4. Other damage

There are no other damage.

1.5. Personnel information

Pilot.

Sex: Male

Age: 43 years-old

Nationality: Belgian

Licence: First issue 2 August 1985, expiring 28 July 2010.

Class Rating: CPL (H).

Ratings: EC120, R44, B206, AS350B3;

Limitations: none.

Medical: Last 27/4/2007, expiring 28/4/2008.

The type training on AS350 was acquired in May 2006, and successfully re- tested in May 2007.

The pilot accumulated a total of 11621 Flight Hours, amongst which ca 200 FH on type and 28,6 FH during the month of July 2007.

The pilot is employed by the Company since the year 2000.

1.6. Aircraft information

The AS 350 Écureuil is a light helicopters originally manufactured by Eurocopter. The AS 350 BA is a 3-blades helicopter powered by a Turbomeca Arriel 1B engine. It has accommodation for 5 persons and a pilot.

Airframe

Manufacturer: Eurocopter

Type: AS350BA

Serial Number: 9080

Built year: 2006

Registration: OO-HCW

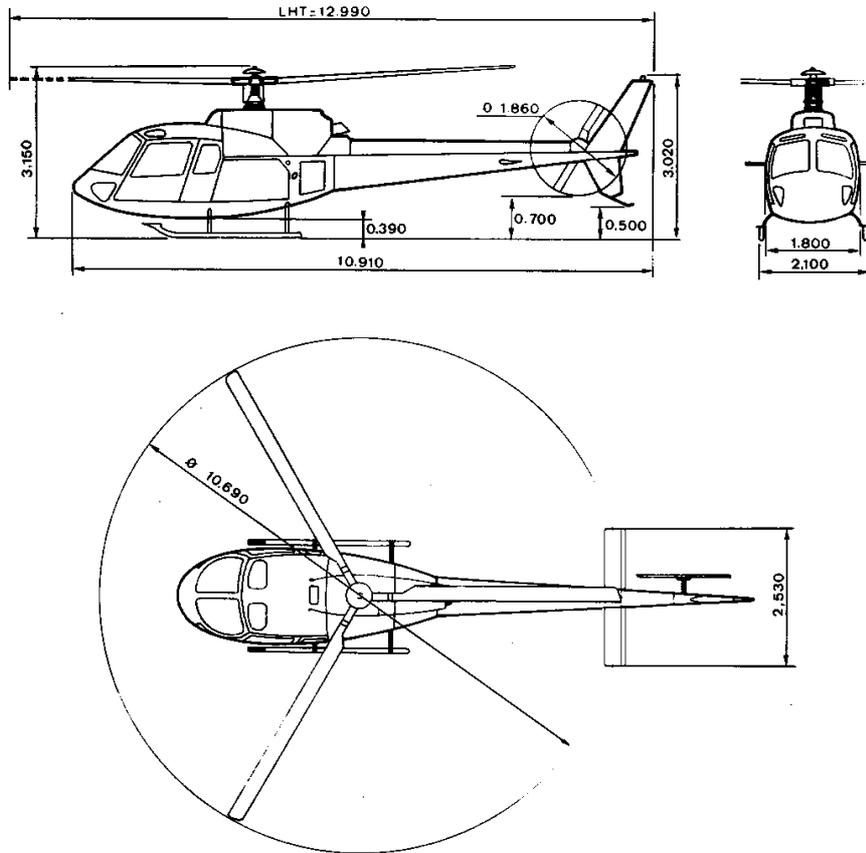
Certificate of Registration: N°10033, issued 10 February 2006.

Certificate of Airworthiness: issued 16 March 2006.

Airworthiness Review Certificate: issued 15 March 2007, expires 16 March 2008

Total Flight Hours: 285,3 FH

Total Flight Cycles: 314 FC



Engine

Manufacturer: Turbomeca
Type: Arriel 1B
Serial Number: 4454
Total Flight Hours: 285,3 FH
Total Flight Cycles: 314 FC

The helicopter is maintained by the Ixair group (Part-145 AMO N°FR.145.504) since April 2007. Before that date, it was maintained by Heli Service Belgium (Part-145 AMO N°BE.145.39.).

The magnetic seal of the Aft Transmission Box was replaced on 18 July 2007, (17FH, 13 FC before the accident) by Ixair, assisted by a technician of Eurocopter in Ixair's facility (Toussus-le-Noble). This maintenance action requires the removal and installation of the aft rotor transmission shaft.

Owner

Heli and Co S.A.
2, rue des Vergers
B-1340 Ottignies LLN

1.7. Meteorological information

Cavok

Wind Direction : 130°

Wind speed : 12 kts

Wind gusts : 18 kts

Temperature : 23°C

Atmospheric pressure : 1018 mb

1.8. Aids to Navigation

Not applicable.

1.9. Communication

Not applicable.

1.10. Airfield information

The helicopter took off from Spa Airfield, and intended to return to Spa.

1.11. Flight Recorders

Not applicable

1.12. Wreckage and Impact information

The helicopter performed a sliding landing, in a field, with a very light slope. The impact of the rotor blade with the aft rotor shaft occurred during landing slide.

The landing itself was smooth, as felt by all passengers.

The terrain is flat, but with irregularities, that could have induced bumping during the landing.



1.13. Medical and Pathological information

Not applicable.

1.14. Fire

Not applicable.

1.15. Survival Aspects

All occupants were attached with safety belts.

1.16. Test and Research

The following inspection and tests were performed:

- a. Fuselage external, as described under 1.12 above.
- b. Flight Control System, the mechanical transmission was inspected at Ixair facility, in Paris, with the support of Eurocopter specialists.
- c. Hydraulic system; the whole system was tested, using an alternate hydraulic power supply, to verify the working of all flight controls; both cyclic and collective. This was performed by Eurocopter specialist at Ixair in Paris.
- d. Hydraulic oil and fuel samples were taken and analysed at DGA – CEPr.
- e. The engine was tested at the Turbomeca testing facility in Tarnos on 2-3 October 2007. The free wheel was not tested as per Turbomeca procedure.
- f. The free wheel and shaft was inspected during routine inspection to return the engine to service, by Turbomeca. The free wheel and shaft was then further inspected on 31 January 2008.

All these tests and inspections were performed under the supervision of BEA-Fr or with their support.

2. Analysis

2.1. On-site inspection

The helicopter was sitting on the skids, apparently intact. The cowls housing the tail rotor drive shaft show some damage; one cowl section is torn open and is found on the grass in the close vicinity of the helicopter, alongside with a 20-cm long part of the tail rotor drive shaft .

The airframe is in good shape.

The tail boom is correctly attached to the fuselage.

The removal of the lower forward cowl allowed to check the front part of the flight controls; no anomaly was found. The movement of the flight controls is free, without hard point nor interference. All parts are connected, and the movement of the Cyclic and Collective control columns are transmitted correctly. The pedals are correctly connected to the Teleflex cable, and their movement is transmitted to the servo valve controlling the pitch angle of the anti-torque rotor.

The tail rotor drive shaft is severed at three locations. Starting from the rear of the helicopter, the first rupture is located at the connection between the rear flector and the aft transmission gear box. The flector is stretched out. The rupture surfaces are characteristic of an overload, in this case an axial load.



The intermediate rupture of the shaft is due to a contact between the shaft and one of the main rotor blade; yellow and blue paint were found on the “yellow” blade.

The damages found on the cowls are also consistent with a collision with a main rotor blade.



The last rupture shows the characteristics of a bending rupture; the shaft is bent for over 90°



The inspection of the rupture faces shows there were due to high loads. There was no obvious indication of corrosion or prior cracks.

The shaft is disconnected from the front end of the boom ; the intermediate flector has « machined » the anti-torque pitch angle control rod. This shows the mechanical continuity of the control rod.



Finally, when assembling the severed parts of the shaft, we notice it follows the shape of a screw, which indicates the ruptures were done while the shaft was transmitting a torque.



The flight controls were inspected on-site, and no anomaly was found. The servo controls do not show a blockage; when the cockpit controls are activated, the servos are moving (without hydraulic pressure).

The hydraulic system was inspected and no anomaly was found. All elements were found connected, the hydraulic fluid level was normal, no leak was found.

The electrical system was tested, and no anomaly was found.

A quick check of the engine could not reveal any obvious anomalies. The free turbine wheels rotate with the hand.

2.2. Rupture of the aft rotor shaft

Upon landing, the engine power was low, and the rotor was in autorotation. At the time of the flare, the main rotor blades have a tendency of flapping. The sliding contact with the uneven ground increased the flapping of the main rotor blades causing the yellow blade to contact the aft rotor shaft.

2.3. Flight Controls and engine inspection at Ixair

The flight controls were inspected at Ixair without hydraulic power. No anomaly was found.

The fuel pump was checked satisfactorily.

The engine was inspected by Turbomeca. The chip detectors did not reveal an abnormal wear, and the compressor and turbine rotated freely. There was no sign of damage found.

2.4. Dynamic testing of the hydraulic system and Flight Controls.

The hydraulic system was tested by Eurocopter using a bench tester, at Ixair. The following tests were performed;

- pressurization of the hydraulic system
- pre-flight tests as per Flight Manual Ch 4.
- check of the controls movements (collective and cyclic).

The tests showed the flight controls system, the hydraulics system and the warnings were performing satisfactorily.

2.5. Engine testing at Turbomeca.

The engine was tested at Turbomeca on 10 October 2007.

The following actions were performed:

- Borescope inspection.
- Permeability test of the injector.
- Performance test of the core engine.

The engine was found within the performance specification data. No anomaly was found in the fuel regulation.

The free wheel assembly was not tested.

2.6. Oil and Fuel tests.

Samples of the engine oil and fuel were taken and tested at DGA –CEPr. Both fluid were found conform to the applicable specification and showed no sign of contamination.

2.7. Engine parts inspection

As part of the actions required for the release to service of the engine, the engine was disassembled and component parts were inspected for condition.

The most important anomalies found were:

- The free wheel shaft showed a static bend of 0,28 mm
- The free wheel casing inner ring showed circular grooves.
- The free wheel showed some flaking.

The free wheel shaft (P/N 0292907670 S/N 1956B) had a Time since new of 283 FH. When new, the maximum bend was 124 microns at 155 degrees.

We could not have determined whether the deformations on the free wheel shaft could have originated from an incident (such as a ground resonance) prior to the event, and not noticed nor recorded, or be a consequence of the rupture of the aft rotor transmission shaft.

The bent free wheel shaft would have caused faint vibrations during operation but they would only be felt at low rpm.

The defects found on the free wheel inner casing are difficult to characterize. The aspect does not show evident signs of burning or brutal damage; the aspect is different from the aspect when new and from the glaze aspect upon first scheduled removal (3500FH).

The relevance of these damages is still being considered. There are no sufficient data to correlate these damages with a possible mode of defect that would have led to the event, such as a decoupling of the engine from the rotor transmission for a very short time, followed by a brutal reconnection.

3. Conclusions

3.1. Findings

- The pilot had a valid Pilot's license and medical certificate.
- The pilot had an adequate experience flying the type of helicopter.
- The helicopter had a total operating time of 283 FH, although it contains some parts with higher operating time (reconstruction).
- The helicopter had a valid airworthiness certificate and was maintained in accordance with the manufacturer's maintenance program.

3.2. Causes.

- The damages caused to the aft rotor shaft were due to the autorotation upon landing; the flapping movement of the yellow blade caused it to contact the aft rotor shaft.
- We could not confirm the origin of the brutal movement of the helicopter to the left reported by the pilot that caused him to land the helicopter.

The current theory, although not confirmed, would be that a decoupling of the engine with respect to the drive rotor occurred. This decoupling would have been very brief, as to allow the engine to increase speed without going into overspeed. When the free wheel re-engaged, the drive rotor accelerated causing a violent yaw movement to the left.

4. Safety Recommendations.

4.1. To EASA.

Owing to the difficulties to get verifiable data in accidents involving smaller helicopters and aircraft, for which there is currently no requirement for installation of Flight Data Recorders, the development and certification of simplified Flight Data Recorders, such as on-board video cameras would constitute an important improvement in understanding General Aviation accidents.

EASA should encourage the development of simplified Flight Data Recorder and consider the incorporation of a requirement for their use in General Aviation