



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Büro für Flugunfalluntersuchungen
Bureau d'enquête sur les accidents d'aviation
Ufficio d'inchiesta sugli infortuni aeronautici
Uffizi d'investigaziun per accidents d'aviatica

Aircraft accident investigation bureau

Final Report No. 1902 by the Aircraft Accident Investigation Bureau

concerning the accident

to the helicopter, Eurocopter France/Aerospatiale AS350B2, HB-XJC

on 30 April 2002

Zermatt Heliport, Zermatt Municipality / VS

Ursache

Der Unfall ist auf ein unkontrolliertes Ansteigen des *collective* während des Beschleunigungsvorganges zurückzuführen. Warum der *collective* nicht eingerastet blieb bzw. war, muss offen bleiben.

Zum Unfall beigetragen haben folgende Umstände:

Die technischen Mängel der Turbine verursachten ein besonderes Anlassverhalten und banden eine erhöhte Aufmerksamkeit des Piloten.

General information regarding this report

In accordance with the agreement on International Civil Aviation (ICAO Annex 13) the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

According to art. 24 of the Swiss Air Navigation Law the legal assessment of accident/incident causes and circumstances is no concern of the investigation.

The masculine form is used exclusively in this report regardless of gender for reasons of data protection.

If not otherwise stated, all times in this report are indicated in local time (LT) applicable in Switzerland, corresponding at the time of the accident to Central European Summer Time (CEST). The relationship between LT, CEST and coordinated universal time (UTC) is as follows: $LT = CEST = UTC + 2 \text{ h}$.

The german-language version of this report is authoritative.

The Aircraft Accident Investigation Bureau (AAIB) of Switzerland would like to thank the authorities and other organizations for the given support throughout the investigation.

Final Report

Aircraft	Eurocopter AS350B2	HB-XJC	
Certification	Commercial transport VFR by day		
Keeper	Lions Air AG		
Owner	Lions Air AG		
Operator	Air Zermatt AG, 3942 Raron		
Pilot	Swiss citizen, born 1950		
Licence	Commercial Pilot's Licence, helicopter CPL(H)		
Flying hours	total	9026 during the last 90 days	81
	on the accident type	147 during the last 90 days	37
Location	Zermatt Heliport		
Date and time	30 April 2002, approx. 16:00 h		
Type of operation	VFR private		
Flight phase	Preparation for take-off		
Accident type	Unintended lift-off		
Damage to persons			
	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly injured or uninjured	1	---	
Damage to the aircraft	Damage to the airframe		
Material damage to third parties	---		

General

Investigation

Immediately after the accident, there were indications of a possible technical cause. Consequently an investigation by the AAIB was opened on the same day.

1 History

Pre-flight history

The Lions Air AG helicopter HB-XJC, chartered by Air Zermatt, had to be flown from the Zermatt base to Raron after about 3 months in service. The pilot designated for the ferry flight had taken off at 06:45 in an Ecureuil AS350B3 helicopter from Raron and was then occupied with skiing flights from Zermatt. At 15:00 he landed again in Raron. By this time he had accumulated 174 minutes flying time. After the transfer by car, he took over helicopter AS350B2 HB-XJC in Zermatt at about 16:00. When he took over the helicopter, the pilot was made aware of a peculiarity in the start-up procedure for this aircraft.

History

After taking over the helicopter at Zermatt Heliport, the pilot started the engine. After the start-up procedure had been completed and the pilot prepared for take-off, he felt strong vibrations with ground resonance. Eye witnesses heard a howling noise. The helicopter lifted off, in an uncontrolled manner. At approximately 1 m above the ground, the pilot reduced power and the aircraft fell back to the ground. As it did so, the helicopter rotated about 90° around its vertical axis and landed hard on the skids. Visible damage was found at the joint between the fuselage and the tail boom.



Information on the aircraft

- The last 200 h check on the airframe and the last 300 h engine check were carried out on 27.03.2002.
- After the last flight on 29.04.02 no complaints were entered in the logbook.
- Helicopter AS350B2 HB-XJC
 - Serial number 2382
 - Operating time since manufacture 2423 h
 - Flying cycles since manufacture 4987
- Engine ARRIEL 1D1
 - Serial number 9072
 - Operating time since manufacture 2423 h
 - Load cycles since manufacture 6469
- The take-off mass of 1635 kg and the centre of gravity were within the limits at the time of the accident.
- The helicopter was not equipped with a data recorder (engine or flight data).
- The depth of the engagement groove on the collective locking head had a dimension of 0.8 mm.
- On 25 September 2003 the helicopter manufacturer published the alert service bulletin (ASB) no. 67.00.27. In it a minimum depth of 0,7 mm is required for the engagement groove.

Other pertinent information and results of the investigation

- Statement by the mechanic present: *"...At about 15:30 I placed helicopter HB-XJC on position 2. The pilot who was to fly the aircraft to Raron was present when the helicopter was being prepared. I then loaded one jacking wheel into the cabin and the other aft into the baggage compartment. In the process, I informed the pilot of the special characteristic of this helicopter. When the aircraft was on the stand, I carried out a walk around check. From my point of view, the helicopter was ready to fly."*
- The statement of Air Zermatt's chief pilot on the particular characteristic of HB-XJC read as follows: *"The start up for XJC behaved normal up to 45-50% NG. Only from 50% it was necessary to wait about 30 seconds before accelerating further. Even if the debit was fully opened, nothing happened. Only after the 30 second wait could the engine be further accelerated normally to nominal rpm."*
- In the logbook, for 30 entries and 70 start ups by seven different pilots, no complaints had been entered since the last 300 h engine check, which took place 34 days before the incident.
- The engine was examined. The following findings were made:
 - *"Consequently to the accident, the free wheel assembly displayed several discrepancies (...) and high speed bearings were replaced due to hard landing."*
 - *No signs of overspeed detected further to free turbine inspection."*
 - *In addition, centrifugal compressor blades had rubbed onto centrifugal compressor cover; first stage nozzle guide vane, second stage turbine blades, free turbine nozzle guide vane and blades suffered from cracking and first stage turbine blades were found impacted and the coating altered."*

- *“NOTE: the condition of the engine suggests that it has operated beyond normal temperatures.”*
- *FCU S/N B705B log card showed 2423 total hours.*
- The fuel control unit (FCU) was examined. The following findings were made:
 - *“The bench testing performed on the accessory exhibited several functional discrepancies (.....) due to an internal leak located on the non return valve.*
 - *acceleration curve: fuel flow found too low*
 - *maxi. flow 220.6 l/h for spec. = 243 l/h*
 - *static droop curve: NTL speeds found too low*
 - *with load variation (from 90% NG to maxi. NG), the response time was found out of tolerances*
 - *Warranty seal found missing on NG maxi stop and no record into the log book (mandatory).*
 - *Calendar limit exceeded (date of entry into service: 03/90): 2 years beyond limit (2500h/10years)”*
- The engine manufacturer made the following remark: *“Nota: FCU characteristics checks described in engine maintenance manual could have evidenced these functional discrepancies. These periodic checks are mandatory. There was no record of this type of check on the engine log book.”*
- The drain valve assembly had exceeded the calendar limit. (on condition / 10 years)
- Analysis of the fuel indicated no anomalies.
- The main rotor and tail rotor system did not provide any indications of abnormal oscillation or vibration behaviour.
- The inspection of the cowling, primary and centre structure, tail boom, lower part structure and in particular the landing gear shock absorbers and the RH and LH anti-vibrator installation produced no indications of possible extraordinary vibration or risk of ground resonance.
- The pilot was unable to recall either a visual or an acoustic warning:
“The headset attenuated the sound very well. The aircraft itself is also very well insulated. I did not perceive the howling of the engine. During start up, I was concentrating on the instruments. I didn’t have the feeling that the aircraft sounded different.”
- According to his own statement, the pilot did not notice any peculiarities up to the occurrence of the vibration. From his viewpoint, all manipulations were done correctly.
- The pilot, on a possible release of the collective¹: *“I can no longer rightly say. Perhaps it had been released on manipulation of the debit. At this point the helicopter was vibrating very vigorously.”*
- The eye witnesses who were present spoke of the vigorous vibration they observed: *“The aircraft started to shake immediately...”, “the helicopter then shook on position 2... the aircraft shook extremely...”.*

¹ *collective* – adjusting lever for collective adjustment of the rotor blades

Meteorological information

The centre of an extended low-pressure area was over Scotland. The associated occluded polar front had reached France. The weather in Switzerland continued fine, under the influence of a weak high-pressure area.

Weather at the time and location of the accident:

The following information on the weather at the time and location of the accident is based on a spatial and chronological interpolation of the observations of different weather stations.

Cloud:	1/8 base at 10 000 ft AMSL, 1-2/8 base at 25 000 ft AMSL
Weather:	-
Visibility:	around 30 km
Wind:	050°, 5-8 kt, isolated gusts up to 12 kt
Temperature/dewpoint:	+14 °C / -4 °C (relative atmospheric humidity 29%)
Atmospheric pressure:	QNH LSGS 1011 hPa Pressure at Zermatt measurement station (1638 m above seal level): 835.2 hPa
Hazards:	-
Position of the sun:	Azimuth: 253° Elevation: 36°

- According to persons present, the local wind on the Air Zermatt platform was light.

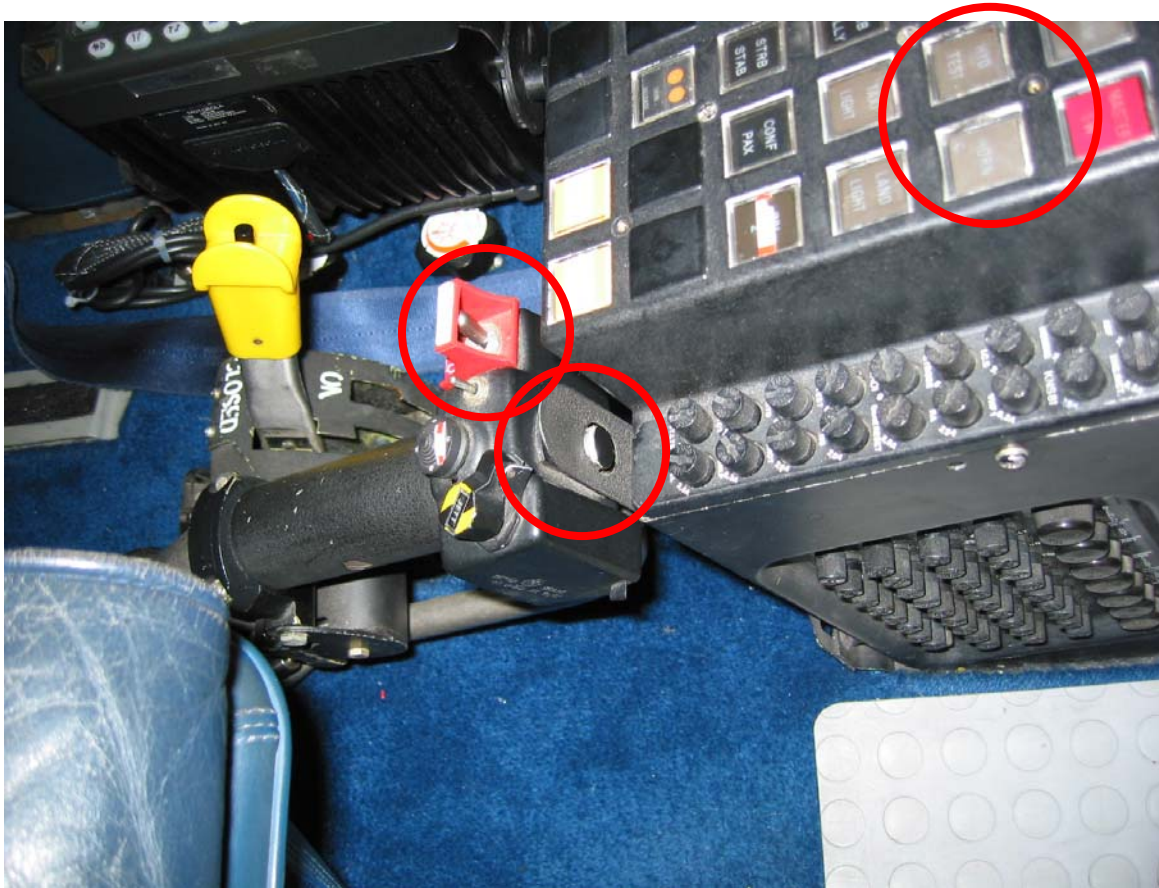
2 Analysis

2.1 Technical aspects

The following conditions must be met for the helicopter to be able to lift off:

1. The angle of attack of the rotor blades must be greater than that provided at the low pitch position, when the collective is in the locked position. The elastomeric thrust bearings on the Starflex rotor head have no load at approximately 7° pitch. A force of approximately 45-50 lbs on the collective is required in order to compress the elastomeric thrust bearing and fix the collective at low pitch. Normally the collective is released to relieve the elastomeric thrust bearing out of flight operations in the hangar or during maintenance.
2. At the given take-off mass, the main rotor must be accelerated nearly to the nominal speed of rotation in order to allow lift off with a free collective. A collective which is not locked may lift further, unnoticed, under slight shaking or vibration or when subject to increasing resistance of the rotor blades during the start-up and acceleration process.

Compliance with the engine temperature limits during the start-up and acceleration procedure generally demands a high degree of attention from the pilot. In the present case, there was an additional special factor on this aircraft which was new to the pilot, namely an extraordinarily long delay in the acceleration behaviour in the second phase. This may possibly have led to perception being too limited to notice a collective which was not locked or which had become free. During this first-time start-up, which was not normal as expected, the pilot was being fully gripped by the left hand for better control, probably without supporting it on the collective. This made the possible detection and discovery of a collective which was lifting more difficult.

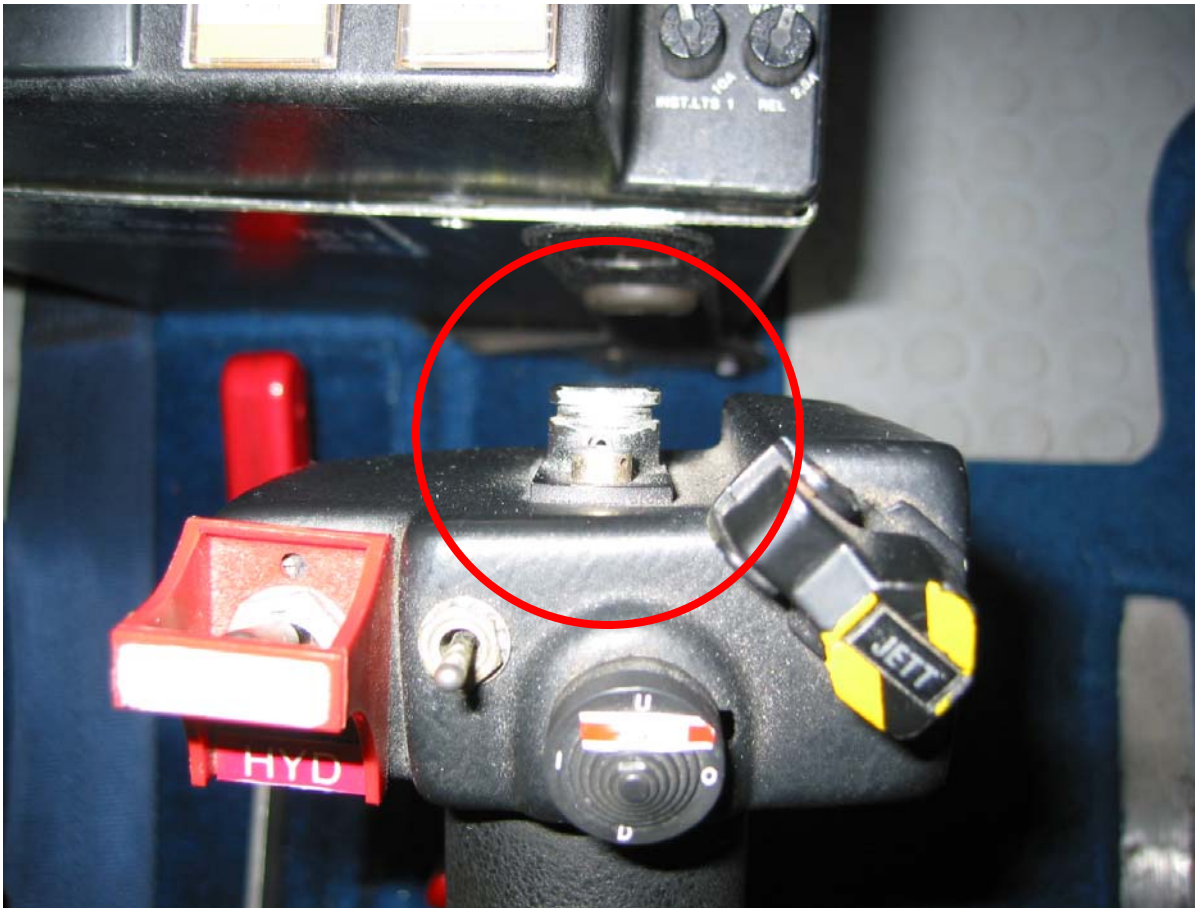


hyd press isolation switch, collective with the locking plate,
pushbutton hyd test and pushbutton horn

The hydraulic accumulator test (console pushbutton) and above all the hydraulic pressure isolation check (collective switch) generate pressure surges in the control system. In association with the general vibration of the helicopter, this may lead to an unnoticed release of the collective if the locking device is worn or not completely engaged respectively it may lead to a rapid, unnoticed increase of the pitch if the collective is not locked. If, during the hydraulic accumulator test, the accumulators are fully emptied as a result of too many major control movements, or if, during the hydraulic pressure isolation check, the collective is not additionally secured with the hand, this may cause an unintentional lift off.

The hyd test pushbutton is positioned on the console in the vicinity of the horn pushbutton of the aural warning system, which must be switched on at the latest before every take-off.

The dimensions of the engagement groove on the collective locking head and of the locking plate as a counter-piece were within the specified tolerances.



Engagement groove of the collective locking head

Inspection of the engine revealed no indication of possible overspeed. According to his own statement, the pilot first had to release the detent from the flight idle detent when he wished to throttle back.

The peculiar delayed acceleration behaviour noted by the pilot and mentioned verbally but never entered in the logbook is clearly explained, according to the manufacturer, by the defective FCU, i.e. the leak from the non-return valve. According to information from the engine manufacturer, the periodic checks according to the FCU Characteristics section of the maintenance instructions would have allowed these faults to be discovered. Evidence of these specific checks was absent from the engine log.

Checking of the conditions and expiry dates of individual components was made more difficult because of three maintenance sites and the involvement of two maintenance companies.

The investigation with reference to the initial statements about the possible technical cause of the accident would have been much simpler and more efficient if there had been a simple recording device for engine data.

2.2 Human and operational aspects

Locking of the collective is mentioned twice in the AFM checklist: the first time before start up, in the checks before starting the engine, and the second time at the start of the hydraulic accumulator test.

Verbal transmission of experiences and the peculiarities of an aircraft is important but cannot replace entries in the logbook, with the necessary consequences.

Existing technical malfunctions may demand extraordinary attention from the pilot, may restrict general perception and thereby increase the probability of errors.

The manipulations in the area of the hydraulic system, hydraulic test pushbutton and hydraulic isolation switch demand a deliberate, controlled procedure in connection with the operation and control of the cyclic and collective.

3 Conclusions

3.1 Findings

- The pilot was in possession of a commercial pilot's licence, helicopter CPL(H).
- The helicopter was rated for commercial transport, VFR, by day.
- The last 200 h check on the airframe and the last 300 h engine check were carried out on 27.03.2002.
- After the last flight on 29.04.02, no complaints were entered in the log-book.
- The dimensions of the engagement groove on the collective locking head and of the locking plate as a counter-piece were within the specified tolerances.
- Eye witnesses heard a howling noise.
- Inspection of the turbine provided no sign of a possible overspeed.
- The technical condition of the aircraft did not meet the required standard:
 - The fuel control unit – FCU – exhibited various functional deficiencies in the test run.
 - The seal on the NG max stop was missing. The corresponding entry in the logbook was not present.
 - The calendar limit for the use of the FCU had been exceeded by two years.
 - The drain valve assembly had exceeded the calendar limit.

3.2 Cause

The accident is attributable to uncontrolled lifting of the collective in the course of the acceleration process. It must remain an open question why the collective did not remain locked or was not locked.

The following circumstances contributed to the accident:

The technical defects of the turbine caused a particular start up behaviour and demanded increased attention on the part of the pilot.

Berne, 19 May 2006

Aircraft Accident Investigation Bureau

This report has been prepared solely for the purpose of accident/incident prevention. The legal assessment of accident/incident causes and circumstances is no concern of the incident investigation (Art. 24 of the Air Navigation Law).