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**Swiss Accident Investigation Board SAIB**

Aviation Division

# Final Report No. 2137 by the Swiss Accident Investigation Board SAIB

concerning the accident involving the Robinson R22 Beta II helicopter, registration HB-ZGR

on 9 April 2009

Bern-Belp airport (LSZB)

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### Ursachen

Der Unfall ist darauf zurückzuführen, dass der Helikopter im Rahmen einer misslungenen Demonstration einer Autorotation hart auf der Graspiste aufschlug.

Zum Unfall beigetragen haben:

- Fehlende Planung einer Sicherheitshöhe
- Fehlender Abbruch der Demonstration

# General information on this report

This report contains the Swiss Accident Investigation Board's (SAIB) conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Art 3.1 of the 10th edition, applicable from 18th November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All times in this report, unless otherwise indicated, are stated in local time (LT). At the time of the accident, Central European Summer Time (CEST) applied as local time in Switzerland. The relation between LT, CEST and UTC is: LT = CEST = UTC + 2 hours.

# Final Report

| | | |
|---|---|---|
| **Aircraft type** | Robinson R22 Beta II | HB-ZGR |
| **Operator** | Mountain Flyers 80 Ltd., Flugplatz/Hangar 7, CH-3123 Belp | |
| **Owner** | MR Flugbetriebs AG, Achereggstrasse 6A, CH-6362 Stansstad | |

| | | | | |
|---|---|---|---|---|
| **Flight instructor** | Swiss citizen, born 1975 | | | |
| **Licence** | Commercial pilot licence helicopter (CPL (H)), according to joint aviation requirements (JAR), issued by the Federal Office for Civil Aviation (FOCA), valid till 3 July 2013. | | | |
| **Ratings** | AS350, Bell206, R22, R44, FI (H), FI (H) MOU limited to 2000 m AMSL, NIT (H), MOU (H) | | | |
| **Medical certificate** | Class 1, valid until 11 September 2009, no restrictions | | | |
| **Flying hours** | **total** | 1904 h | **during the last 90 days** | 112 h |
| | **on the accident type** | 1000 h | **during the last 90 days** | 53 h |

| | | | | |
|---|---|---|---|---|
| **Student pilot** | Swiss citizen, born 1958 | | | |
| **Licence** | Helicopter licence trainee (H), issued on 1 September 2008 by the FOCA, valid till 1 September 2010 | | | |
| **Ratings** | None | | | |
| **Medical certificate** | Class 2, valid till 1 September 2009.<br>Restrictions: shall wear corrective lenses (VDL) | | | |
| **Flying hours** | **total** | 19 h | **during the last 90 days** | 12 h |
| | **on the accident type** | 19 h | **during the last 90 days** | 12 h |

| | | | |
|---|---|---|---|
| **Location** | Bern-Belp airport, glider runway | | |
| **Coordinates** | --- | **Elevation** | 1675 ft AMSL |
| **Date and time** | 9 April 2009, 11:09 | | |

| | |
|---|---|
| **Type of operation** | VFR training |
| **Flight phase** | Autorotation |
| **Accident type** | Loss of control |

**Injuries to persons**

| Injuries | Crew | Passen-gers | Total number of occupants | Others |
|---|---|---|---|---|
| Fatal | 0 | 0 | 0 | 0 |
| Serious | 0 | 0 | 0 | 0 |
| Minor | 1 | 0 | 1 | 0 |
| None | 1 | 0 | 1 | Not applicable |
| Total | 2 | 0 | 2 | 0 |

| | |
|---|---|
| **Damage to aircraft** | Destroyed |
| **Other damage** | Minor damage to turf on the glider runway |

# 1 Factual information

## 1.1 History of the flight

### 1.1.1 General

The statements of the flight instructor and the student pilot and the recordings of the GPS data were used for the following description of the pre-flight history and history.

### 1.1.2 Previous history

After the flight instructor had Sunday 5 April 2009 and Monday off, he was busy as usual with flight duty and office work on the Tuesday and Wednesday. After a rest time of more than 8 hours, he began his flight duty on Thursday, 9 April 2009, at about 07:30. The flight instructor felt fit for flight duty on that day. He met the student pilot within the framework of the private pilot training for a briefing in the flight school's office.

They had already flown together in July 2008 on a one-hour introductory flight for the student pilot and for a little over one hour for autorotation exercises on 13 March 2009. There were no notable incidents or special events on those flights.

The subject of the training flight, in addition to regular circuits, was the practising of emergency procedures, especially autorotation. During the briefing, which lasted 30 to 40 minutes, the autorotation exercises which were to be flown were discussed in detail, among other things.

Various possible autorotations with their detailed flight procedures were explained by the flight instructor; the emphasis was placed on initiating the autorotation through to stabilised gliding.

At the end of the exercise, the flight instructor intended to demonstrate a special autorotation exercise. After the accident, he stated the following regarding carrying out this exercise: *"I flew these exercises despite the inexperience of the student pilot, because he has an above-average talent for flying."*

This special autorotation exercise was discussed as follows as part of the briefing: *"...I addressed energy loss during the last autorotation manoeuvre which was carried out. The last* [exercise] *was the following: we reduce speed to 0, rotate around the vertical axis using the right pedal, then speed is increased again and after the speed has built up a normal transition to flare with subsequent reestablishment of level attitude, then simultaneous re-establishment of engine speed, throttle open. For this manoeuvre we discussed the loss of rpm on turning left or right around the vertical axis, what percentage we lose in each case. So we discussed in advance that we would rotate right, because the rpm loss is less.*

According to the flight instructor, the characteristics of the R22 in the event of an impact were also explicitly discussed in this briefing. After this briefing, the helicopter was refuelled to a fuel level of 18 USG and the pre-flight check was carried out.

The student pilot was responsible for calculating the load (weight and balance) and performance. He also signed the flight notification on behalf of the flight instructor.

1.1.3 History of the flight

At 10:10, the crew requested take-off clearance from helipad 1 at Bern-Belp airport. After flying over the grass glider runway west of the main runway, the circuit training began at 10:14. Four circuits and approaches from approximately 2100 ft AMSL were followed by nine normal autorotations “straight in” with initial altitudes of approximately 2400 ft AMSL or approximately 700 ft AGL. According to the flight instructor, the flight was characterised by the usual coordination problems at this level of training between excessively high or low rotor speed and forward speed.

The fourteenth and final exercise involved a demonstration by the flight instructor. According to the flight instructor’s assessment, the student pilot had showed “quite a lot of respect” for the normal straight-in autorotations and had therefore inhibited himself from achieving the training objective.

After the student pilot initiated the autorotation at approximately 2800 to 2900 ft AMSL, the flight instructor closed the throttle to an engine speed below 80% and took control of the helicopter. The student pilot sensed the flight instructor’s operation of the controls. The flight instructor continuously commented on what he was doing at the time and which factors had to be taken into consideration.

First the forward speed was reduced to zero by flaring while maintaining the required rotor speed. Almost no loss of altitude was noted in this phase. Then the helicopter was autorotated vertically, slightly rearwards, before building up speed again. In this phase the rotor speed was always above 102% RRPM[1] and the helicopter reached approximately 2500 ft AMSL (approx. 800 ft AGL). Then the flight instructor accelerated the helicopter to approximately 60 kt.

At approximately 2000 ft AMSL the turning manoeuvre followed, as discussed in the briefing. The helicopter was again brought to a 15° attitude nose up (ANU). At the same time, the flight instructor pulled the collective to maintain engine speed and height. At a forward speed of approximately 15 kt he turned the helicopter around its vertical axis using the right pedal. Because of an impending loss of engine speed during the turn, he returned the collective to the full-down position. According to the flight instructor, the engine speed was above 102% RRPM after the 180° right turn. The collective remained at the lower stop.

At this moment, when the helicopter was at approximately 2000 ft AMSL or about 300 ft above ground, the flight instructor became consciously aware of his altitude: *“I wasn’t surprised; after the turn I noticed that we were at the lower altitude limit to be able to fly this manoeuvre.”*

The student pilot was surprised *"that after the successful reduction and subsequent increase in speed* [name of the flight instructor] *wanted to perform another 360° turn, as we were already fairly close to the ground*.” According to the flight instructor, a 360° turn was not intended.

During the acceleration for the subsequent flare, the rotor speed dropped back to approximately 95% RRPM. The warning tone, which is activated below 97% RRPM, was heard. The flight instructor was surprised by the relatively high rate of descent in this phase. In view of the current engine speed he had the feeling that the build-up of speed and the remaining altitude would be sufficient to end the manoeuvre with a flare. He estimated the forward speed before the flare to be approximately 50 kt. The flight instructor estimated his height above ground to be approximately 10 m when he made the transition to the flare and at the same time fully opened the throttle. In this phase he realised that there will be a ground

[1] Rotor speed: rotor revolutions per minute (RRPM)

contact. He said to the student that it would "not be sufficient". He therefore kept the helicopter level, in order to use any ground effect if possible. Shortly before impact, he pulled the collective to the upper stop. The helicopter hit the grass runway, as the flight instructor described: *"...Exactly level, well cushioned by the skids."*

The helicopter bounced back up from the ground. The engine revved up and the helicopter began to rotate clockwise around its vertical axis. The flight instructor estimated that the helicopter completed two or three rotations. The main rotor seemed to be driven normally, according to information from the flight instructor; the engine was developing high power. Then the occupants felt a sideways tipping motion, until the rotor blades contacted the ground and the helicopter tilted aft and finally came to rest on the deformed skids. The engine was still running at full speed.

The flight instructor switched off all electrical switches from right to left on the panel. The flight instructor or the student pilot pulled the mixture control. The engine then stopped. Both occupants were able to vacate the wreckage of the helicopter through the open cockpit without outside help. The flight instructor was slightly injured. The student pilot was not injured.

Another flight instructor, who rushed up shortly afterwards, shut off the fuel valve. The emergency locator beacon aircraft (ELBA) was shut off approximately 15 minutes after the accident by a helicopter mechanic.

Tarmac runway 14/32 remained closed to air traffic from 11:09 to 11:46. The grass runway remained closed to air traffic from 11:09 for the rest of the day.


**Picture 1** – Witness marks of the first impact

**Picture 2** – Final position of the wreckage

## 1.2 Meteorological information

### 1.2.1 General

The information in sections 1.2.2 to 1.2.3 was provided by MeteoSwiss.

### 1.2.2 General meteorological situation

*A flat high-pressure area lay over central Europe. It was moving slowly eastward but still determined the weather in the Alpine area. With slightly higher air pressure south of the Alps, a Föhn wind situation was developing.*

### 1.2.3 Weather at the time and location of the accident

The following weather information at the time and location of the accident is based on the aerodrome routine meteorological report (METAR) of 08:50 UTC.

| | |
|---|---|
| *Cloud* | *No significant clouds* |
| *Weather* | *-* |
| *Visibility* | *Around 8 km* |
| *Wind* | *Variable 2 kt* |
| *Temperature/dewpoint* | *14 °C / 07 °C* |
| *Atmospheric pressure* | *QNH LSZB 1017 hPa, LSZH 1018 hPa, LSZA 1019 hPa* |
| *Position of the sun* | *Azimuth 131°, elevation 41°* |
| *Hazards* | *None detectable* |

## 1.3 Aircraft information

### 1.3.1 General

The Robinson R22 helicopter is a lightweight two-seater helicopter of composite construction consisting of a tubular steel frame, glass-fibre composite parts and an aluminium sheet structure. The dynamic system, which consists of a twin-blade main rotor and a twin-blade tail rotor, is driven by a four-cylinder piston engine. The power and control system consist of purely mechanical components.

### 1.3.2 Fuel

The helicopter HB-ZGR was being operated with AVGAS 100 LL grade fuel. The crew stated that before the flight commenced there were approximately 18 US gallons of fuel on board. According to the flight instructor, there were still 8-10 US gallons available at the time of the accident.

### 1.3.3 Weight calculation

The student pilot completed the flight notification. Under the flight plan heading, the take-off mass was noted as 1320 lb, the HOGE performance calculation as 7000 ft and the block fuel as 17 US gallons. Under the weather heading, a visibility of 5000 m was specified, with wind at 5000 ft as 100/10 kt and temperature as ISA + 2˚ Celsius.

According to the flight instructor, the take-off mass before departure was approximately 1340-1350 lb, including approximately 18 US gallons of fuel.

A recalculation of the mass showed that the helicopter was at the maximum permitted take-off mass on take-off.

The maximum take-off mass for the R22 Beta II helicopter is 1370 lb.

After the accident, it was possible to drain approximately 30 l from the tanks, corresponding to approximately 8 US gallons of AVGAS.

The helicopter's mass at the time of the accident was approximately 1310 lbs.

### 1.3.4 Wreckage and impact information

The helicopter's landing skid structure had been deformed outwards by the impact. The witness marks on the underside of the airframe and the engine area indicate a heavy impact with the turf. The tail rotor bracket was bent and the tail rotor shaft was torn out. When the main rotor blades made contact with the ground, the engine was delivering power, because although the drive belt was intact, it was separated from the drive shaft and the cooling fan was twisted in the direction of rotation of the engine. The lower structure of both pilots' seats was deformed.

## 1.4 Information concerning the training syllabus and the student pilot's training status

After the introductory flight with the flight instructor in July 2008, the student pilot took eleven flying lessons with a different flight instructor up to February 2009. In March 2009, he made another flight with the first flight instructor. Two further training flights were then made with different flight instructors. He had not yet completed a solo flight. During training up to this point approximately 20-25 autorotation exercises had been carried out.

The exercise which was being demonstrated by the flight instructor when the impact occurred was unknown to the student pilot until the briefing prior to the accident flight. The flight school's training syllabus did not specify this type of autorotation exercise for the student.

The student pilot considered that his training status after approximately 18 hours flying time since starting training in October 2008 was generally good.

## 1.5 Information concerning the flight instructor's flying experience

In 2002, the flight instructor completed an initial flight safety course for pilots of the R22 type involved in the accident at the helicopter manufacturer's premises. At the time he held a private pilot's licence and had a total flying time of 112 hours, of which 90 hours on the R22.

In 2004, the flight instructor participated in a helicopter flight instructor course provided by the Federal Office of Civil Aviation. Regarding autorotation, the syllabus for this course lists in the "Flight Training follow up" document the following exercise which is not specified in more detail: "- straight in autorotation with power recovery – 180° autorotation – simulated engine failure – hovering autorotation".

In 2005, with a flight instructor's licence and a total flying time of 430 hours, of which 150 hours on the R22 and 90 hours on the R44, he participated in the second part of the safety course from the manufacturer Robinson.

Since 2005, the flight instructor had provided approximately 400 hours of instruction annually. According to his statements he had performed several hundred autorotation exercises during this period. In particular he had performed 50 to 60 exercises like the one which resulted in the accident since 2002.

## 1.6 Medical findings

The flight instructor suffered a laceration to the forehead and had a slight headache after the accident. The results of the toxicological investigation were negative.

The student pilot was not injured in the accident.

## 1.7 Survival aspects

The helicopter's landing gear and the two pilot seats absorbed a large part of the impact energy through the deformation caused by the accident.

The pilots did not wear helmets.

## 1.8 Information from the manufacturer of the Robinson R22 helicopter

### 1.8.1 Emergency Prodedures

The Rotorcraft Flight Manual (RFM), Section 3 Emergency Procedures for the helicopter R22 prescribes the following procedure:

*‚Power failure above 500 feet AGL'*

1. *Lower collective immediately to maintain RPM and enter normal autorotation.*
2. *Establish a steady glide at approximately 65 KIAS (see 'Maximum Glide Distance Configuration', page 3-3).*
3. *Adjust collective to keep RPM in green arc or apply full down collective if light weight prevents attaining above 97%.*

4. *Select landing spot and, if altitude permits, maneuver so landing will be into wind.*
5. *A restart may be attempted at pilot's discretion if sufficient time is available (see airstart procedure, page 3-3).*
6. *If unable to restart, turn off unnecessary switches and shut off fuel.*
7. *At about 40 feet AGL, begin cyclic flare to reduce rate of descent and forward speed.*
8. *At about 8 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown in level attitude with nose straight ahead.*

1.8.2 Safety notice - SN-38 Oct 2004

*<u>Practice Autorotation cause many training accidents</u>*

*Each year many helicopters are destroyed practicing for the engine failure that very rarely occurs.*

*Many practice autorotation accidents occur when the helicopter descends below 100 ft AGL without all the proper conditions having been met. As the aircraft descends through 100 ft AGL, make an immediate power recovery unless all of the following conditions exist:*

1) *Rotor RPM in middle of green arc*
2) *Airspeed stabilized between 60 and 70 KIAS*
3) *A normal rate of descent, usually less than 1500 ft/min*
4) *Turns (if any) completed*

*Instructors may find it helpful to call out "RPM, airspeed, rate of descent" prior to passing through 100 feet. At density altitudes above 4000 feet, increase the decision point to 200 feet AGL or higher.*

*(...)"*

1.8.3 Extract from the manufacturer's safety course

<u>Robinson Safety Awareness Course</u>

Frank Robinson:

*"One of the most common causes of accident: The situation where the pilot has allowed his RPM to get low and has allowed his airspeed to get low. As a matter of fact in a study done by the NTSB for the years 1977-1979; The conclusion of that study was that the primary cause of the accidents in all helicopters was failure to maintain RPM and airspeed.*

*When you allow that RPM to get low, the power available from that engine will also be low. Just remember: the power that that engine can produce is almost directly proportional to its RPM.*

*When that RPM is low, the amount of energy that you'll have stored in your RPM will also be very low.*

*When the airspeed is low, you'll have gone on the backside of the power curve that is you affecting your translational lift and the power being required by the rotor will have gone way up.*

*And when your airspeed is low, the amount of energy that you have stored in your airspeed that you can recover will also be low.*

1.8.4 Origin of the exercise

Since the origin of the special autorotation exercise performed could not be found in the available training documentation, enquiries were made of the manufacturer during the investigation.

A flight instructor from the manufacturer provided the following information:

"It is a maneuver used to demonstrate how usable rotor energy can be gained and used during autorotations. Many pilots are only exposed to the method of converting airspeed into rotor speed. This demonstrates that a controlled rate of descent with zero airspeed can also provide rotor speed and at the same time allow you to maneuver the aircraft for a more suitable landing area. This maneuver should only be practiced at an altitude that allows the pilot amble time to transition back into the required airspeed needed to perform a proper autorotation to the surface. For example, the pilot will enter the auto at or above 1500 ft AGL, slow to zero airspeed while maintaining rotor RPM within the green arc, perform 180 degree pedal turns and then nose over to increase airspeed to 65 knots prior to descending below 500 ft AGL."

## 1.9 Aspects of the autorotation

Two forms of stored energy are available on the helicopter for the execution of an autorotation. These are:

- Kinetic energy in the main rotor, depending on the mass and rotational speed of the main rotor blades, and the kinetic energy from the airspeed of the helicopter
- Potential energy in the form of height above ground.

The pilot controls a successful autorotation by using the three factors of rotor speed, airspeed and height above ground in different combinations.

The R22 is considered to have a "low-inertia rotor system" due to the small mass of the two rotor blades. At a normal main rotor speed in flight, relatively little energy is stored in it compared to other helicopters. This means that the loss of rotational speed in the event of an engine failure or of an increase of the collective in the autorotation on the one hand occurs quickly and on the other hand can also be corrected within a short time.

The energy stored in the rotor system is important at the end of the autorotation, when it is used to reduce the rate of descent prior to touchdown once all the height and airspeed have been exhausted.

Since a sufficiently high rotor speed is crucial for flight and the successful completion of the autorotation it must be continuously kept in the required range by a careful management of the available energies.

The manufacturer Robinson lists three types of autorotation in the RFM:

- *Power failure above 500 ft AGL*
- *Power failure between 8 ft and 500 ft AGL*
- *Power failure below 8 ft AGL.*

# 2 Analysis

## 2.1 Technical aspects

There are no indications that technical faults or limitations were present which might have caused or influenced the accident.

## 2.2 Human and operational aspects

### 2.2.1 General

There may be phases during flight training where it makes sense to demonstrate to a student, within clearly defined boundaries, that the practiced manoeuvres still have a tolerance before the physical limitations are reached.

However, such demonstrations must be performed with sufficient margins and the demonstrating pilot/flight instructor must have a level of competence which will allow the demonstration flight to be performed with the required safety margins.

In the *present case the following issues must be noted:*

- *A suitable planning for safety altitudes did not take place*
- *No decision height was defined*
- *The exercise did not correspond with the level of experience of the student pilot.*

The practicing of the procedures for the three cases as described in the RFM

- *Power failure above 500 ft AGL*
- *Power failure between 8 ft and 500 ft AGL*
- *Power failure below 8 ft AGL.*

is very challenging for a helicopter student pilot. Practicing these conditions requires a coordinated reaction by the student pilot with all three flight controls within one second after initiating the simulated engine failure. For the exercise “power failure above 500 ft AGL” there are several options to control the approach the approach to the landing site, e.g. by intentionally varying the rotor speed within the permissible range, combined with a reduction or increase of the airspeed, executing turns, intermediate flares followed by increasing the speed again, etc. These types of exercises usually are the most demanding parts of the pilot training. Student pilots generally tend to be apprehensive due to the awareness that the operations are performed close to the physical limitations of the helicopter and that accidents are relatively frequent during such emergency procedures training. The purpose during the basic training is to enable the student pilot to demonstrate in these standard situations the appropriate reactions within the required time and to manipulate the controls in a relaxed, i.e. inapprehensive manner.

However, there are no conceivable reasons to incorporate in the student training such demanding exercises as have led to this accident.

### 2.2.2 Safety altitudes and piloting actions

During the first part of the demonstration, HB-ZGR used up approximately 400 ft of height from the initial height of approximately 2900 ft AMSL, i.e. the initial altitude for the second part was approximately 2500 ft AMSL. It was only then that the airspeed was increased in preparation for the second part of the special autorotation exercise, which was discussed in detail in the briefing. The loss of height in this acceleration phase was approximately 500 ft, from 2500 ft AMSL to 2000 ft AMSL. The flight instructor therefore initiated the special autorotation at approximately 2000 ft AMSL, i.e. approximately 300 ft AGL.

The flight instructor underestimated the height required for the build-up of airspeed. After the first exercise in speed reduction and increase, at the resulting approximate 300 ft AGL, he had already descended below the manufacturer's recommended decision height of 500 ft AGL. He did not initiate the second speed reduction until the decision height of 300 ft AGL. At this minimal decision height, only a go-around will result in a successful continuation of the flight if the airspeed and RPM parameters are not as required.

The above findings permit the conclusion that an appropriate allocation of height for the performance of the part of the demonstration, which consisted of a combination of two exercises, was lacking.

According to his statement, the flight instructor did not realise even after the 180° turn under 300 ft AGL that neither kinetic energy in the form of forward airspeed and rotor speed nor potential energy in the form of height were sufficient for a safe continuation of the autorotation exercise.

The flight instructor did not recognise sufficiently early the critical situation he had manoeuvred himself into regarding the management of the remaining energy, otherwise he would have aborted the exercise.

The unexpectedly low rotor speed of 95% detected by the flight instructor and the acoustic warning for an rpm below 97%, together with the rapid loss of height are explained by the accentuated operation of the forward cyclic input after detection of the low height. The energy for the rapid build-up of speed from approximately 15 kt to just below 50 kt originated on the one hand from the reduction in height and on the other from the reduction in rotor speed.

Given the lack of airspeed and height, the power required to increase the rotor speed would have had to be provided by engine power, which was not possible because of the low rpm at this time.

Shortly before impact the flight instructor reacted appropriately by warning the student pilot, maintaining the helicopter in a horizontal attitude and increasing the collective up to the stop at the right moment.

It is due to lucky circumstances and the low centre of gravity resulting from the deformation of the landing skid that the helicopter, which was no longer controllable, did not roll onto its side in the final phase after the turns without tail rotor drive.

The safety courses provided by the manufacturer include an exercise similar to the one which led to the accident. However, this exercise in which the airspeed is first reduced to zero and the helicopter is yawed prior to initiating the normal autorotation, is initiated at an initial height of approximately 1500 ft. Such an exercise only makes sense for students at an advanced level but not in basic pilot training.

### 2.2.3 Perception

The flight instructor wanted to point out to the student as many aeronautical elements as possible. This is why he commented on his own piloting demonstration.

Monitoring of the drop in height during this challenging exercise, indispensable for safe execution, demands maximum and focused attention from the pilot. This was very probably adversely affected by the demanding commenting provided by the flight instructor for the purposes of instruction.

### 2.2.4 Motivation

In the present case, the flight instructor had already discussed the special autorotation exercise with a 180˚ turn around the vertical axis with the student. According to his own statement it was *“a demonstration, a presentation of how to recover from an extraordinary flying situation.”* The flight instructor also justified his plan by the “*great respect*” of the student pilot during the normal straight-in autorotation. According to his statement, the flight instructor flew this exercise despite the inexperience of the student pilot, because the latter *“is a student with an above-average talent for flying*.” Just how much the student pilot understood about the exercise in the briefing and demonstration must be questioned with regard to his statement about the anticipated 360˚ turn, as this was not envisaged.

The flight instructor underestimated this task.

# 3 Conclusions

## 3.1 Findings

### 3.1.1 Technical aspects

- There are no indications of any pre-existing technical defects which may have caused or contributed to the accident.
- One occupant was only slightly injured and the other occupant was uninjured because the design of the landing skid and seats absorbed a large part of the energy of the impact.

### 3.1.2 Crew

- The flight instructor held the required licences for the flight.
- There are no indications of the flight instructor suffering health problems during the accident flight.
- The flight instructor underestimated the task.

### 3.1.3 General conditions

- The demonstration for the student pilot took place within the framework of his training to become a private pilot.
- The flight instructor and the student pilot had already flown together on the one-hour introductory flight in July 2008 and for just over an hour on 13 March 2009 on autorotation exercises. There were no notable incidents or special events on those flights.
- In addition to practicing normal circuits4, the subject of the training flight was the practising of emergency procedures, especially autorotation.
- Safe execution of the combined exercises was not possible from a height of 1200 ft AGL.
- The flight instructor briefed the student pilot on the envisaged special autorotation.
- The flight instructor neglected appropriate height planning for the combination of the two parts of the exercise.
- The helicopter’s mass at the time of the accident was approximately 1310 lbs.
- The weather had no influence on the accident sequence.

3.1.4 History of the flight

- The flight instructor underestimated the height required for the build-up of airspeed. After the first exercise in speed reduction and increase, at the resulting approximate 300 ft AGL, he had already descended below the manufacturer's recommended decision height of 500 ft AGL. He did not initiate the second speed reduction until the decision height of 300 ft AGL.
- Despite unstabilised flight parameters the flight instructor did not abort the exercise.
- Shortly before impact the flight instructor reacted appropriately by warning the student pilot, maintaining the helicopter in a horizontal attitude and increasing the collective up to the stop at the right moment.
- Both occupants were able to vacate the wreck of the helicopter through the open cockpit without outside help.

## 3.2 Causes

The accident is due to a forceful impact of the helicopter on the grass runway during an unsuccessful demonstration of an autorotation.

The following factors contributed to the accident:

- lack of planning for a safety height
- the demonstration was not aborted

Payerne, 16 April 2012 Swiss Accident Investigation Board

*This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).*

*Berne, 10 May 2012*