



AIR ACCIDENTS
INVESTIGATION INSTITUTE
Beranových 130
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CZ - 14 - 314

FINAL REPORT

**Investigation of causes of an air accident
of helicopter Robinson R 22 BETA II, registration mark OK-LPS,
on the field near Hlavenec,
20 June 2014**

Prague
November 2014

This investigation was carried pursuant to Regulation (EU) of the European Parliament and of the Council No. 996/2010, Act No. 49/1997 Coll., on civil aviation, and Annex 13 to the Convention on International Civil Aviation. The sole and only objective of this report is the prevention of potential future accidents and incidents free of determining the guilt and responsibility. The final report, findings and conclusions stated therein pertaining to aircraft accidents and incidents, or possible system deficiencies endangering operational safety shall be solely of informative nature and cannot be used in any other form than advisory material for bringing about steps that would prevent further aircraft accidents and incidents with similar causes. The author of the present Final Report states explicitly that the said Final Report cannot be used as grounds for holding anybody liable or responsible as regards the causes of the air accident or incident or for filing insurance claims.

Glossary of Abbreviations Used in this Report

°C	Temperature in degrees Celsius
ACC	Air Control Centre
AGL	Above ground level
AMSL	Above mean sea level
PPL (H)	Commercial Helicopter Pilot Licence
BKN	Broken
CU	Cumulus
CHMI	Czech Hydrometeorological Institute
CR	Czech Republic
E	East
FI (H)	Flight Instructor (H)
ft	Foot (unit of length = 0.3048 m)
FRS	Fire Rescue Service
h	Hour
hPa	Hectopascal
l	Litre
kg	Kilogram (unit of weight)
km	Kilometre
kt	Knot (unit of speed = 1.852 km.h ⁻¹)
LKRO	Public Domestic Aerodrome Roudnice
LKSK	Public Domestic Aerodrome Skuteč
AF	Air Fuel
m	Metre
METAR	Aviation Routine Weather Report
min	Minute
N	North
NIL	None
ERS	Emergency Rescue Service
QNH	Atmospheric pressure (reduced at mean sea level according to the standard atmosphere conditions, used for altimeter subscale setting to obtain elevation reading when on the ground)
RWY	Runway
SC	Stratocumulus
SE	Single Engine
UTC	Co-ordinated Universal Time
CAA	Civil Aviation Authority
AAIL	Air Accidents Investigation Institute

A) Introduction

Operator: LPS, Letecké práce a služby s.r.o.
Aircraft Manufacturer and Type: ROBINSON HELICOPTER COMPANY, R 22 Beta II
Registration mark: OK-LPS
Location: Field at the south end of the village of Hlavenec
Date and time: 20 June 2014 06:48 (all times are UTC)

B) Synopsis

The pilot of the helicopter together with another person on board were planning a business flight from LKRO to LKSK. Having flown for sixteen minutes, the helicopter crew heard a bang from the engine compartment. The pilot switched the helicopter to the autorotation mode and conducted emergency landing on a grassland. The rough landing resulted in considerable damage to the helicopter and serious injuries to both persons on board.

The pilot reported the air accident on emergency line 158. The Police Force of the Czech Republic, the FRS, the ERS and AAll inspectors arrived at the location of the air accident and the inspectors performed professional investigation of the location and of the damaged helicopter.

The cause of the incident was investigated by an AAll commission. The investigation team comprised:

Investigator-in-charge: Ing. Josef BEJDÁK
Commission member: Ing. Viktor HODAŇ

The Final Report was issued by:

AIR ACCIDENTS INVESTIGATION INSTITUTE
Beranových 130
199 01 PRAGUE 99
on 24 November 2014.

C) This Final Report consists of the following main parts:

- 1) Factual Information
- 2) Analysis
- 3) Conclusions
- 4) Safety Recommendations
- 5) Appendices

1 Factual information

1.1 History of the Flight

The pilot of the helicopter and the person sitting on the left seat provided the following information about the history of the flight.

Having arrived at the aerodrome, the pilot of the helicopter carried out pre-flight preparation during which he was focusing on information about the current weather condition and activation of areas on the route of the planned flight. The pre-flight preparation was performed by a technical engineer, employee of the operator.

The pilot completed pre-flight preparation of the helicopter and together with another person embarked the cabin. The pilot executed pre-start engine checks and after starting he carried out an engine check followed by the mandatory pre-take-off checks. All was in compliance with the flight manual and all the systems were free of defects. The helicopter took off at 06:32 in the direction of RWY 13 LKRO and continued in the VFR flight directly to LKSK. The flight was proceeding in a standard manner, however, approximately 16 minutes after take-off a strong bang was heard from the engine compartment while the helicopter was overflying the north-west edge of the village of Hlavenec. The acoustic and light signal started indicating low RPM of the main rotor. At the same moment the rotations of the main rotor and the engine dropped to 90 per cent. Both of the said facts were not accompanied by the characteristic turning of the nose of the helicopter.

The pilot responded to the situation by a forceful lowering of the collective pitch control with the aim to bring the helicopter flight regime into autorotation. At the same time, he was pulling the cyclic pitch control in order to increase the critical RPM of the main rotor. The main rotor RPM were increasing only gradually and the helicopter continued descending while still in the autorotation mode of the main rotor. While continuously descending, the pilot was negotiating the trajectory in order to avoid the village and forest. In the altitude of approx. 3 m above the place of landing, an abrupt loss of altitude and subsequent rough landing occurred. The vertical descent moderation before the landing had not been achieved even after forceful pull of the collective pitch control.

After the forced landing, the pilot shut the engine down, called for help by telephone and notified the authorities of an air accident. With regard to the spinal injury caused by the rough landing the pilot together with the other person on board remained seated in their seats, and, in this position, waited for arrival of the FRS and the ERS.

1.2 Injuries to Persons

Injury	Crew	Passengers	Others (inhabitants, etc.)
Fatal	0	0	0
Serious	1	1	0
Light/No injury	0/0	0/0	0/0

1.3 Damage to Helicopter

The helicopter was damaged heavily during rough landing. The skin on both sides of the fuselage was undulated, especially in the tail lower part. By the displacement of the control board a contact of the same board with the acrylic window panel on the left side of the cockpit, the panel cracked along its full length. The vertical partition was deformed in its lower part. The tail beam was partially broken in the place behind the joining with the fuselage due to the impact, the undulation of the skin took place and in some places visible fissures emerged. The door frame on the right side was deformed in its lower part. The impact caused the vertical displacement of the left fuel tank and breaking of the rear horizontal landing gear strut. Landing gear skids were open to the maximum in the direction of the collision of the helicopter impact on the ground whilst contact between the lower part of the helicopter fuselage and the engine with the ground took place. The vertical stabilizer skid was broken off.

The power unit was mechanically damaged, especially in the lower part. The rod structure of the engine bed was, in many places, bent and broken. The said damage caused deformation of the exhaust piping at the same time. The impact also caused slight turning of the ventilator in the direction of the flight by approx. 10 degrees.



Fig.1: R 22 helicopter after rough landing

1.4 Other Damage

Not reported.

1.5 Personnel Information

1.5.1 The pilot

Personal data:

- Male, aged 56 years,
- CPL (H) Pilot's Licence,
- valid rating for the type R 22 until 31 March 2015,
- further valid ratings for the types R 44 and CABRI G-2,
- valid instructor rating certificate PPL/LAPL, type ratings SE/SP, CPL, NIGHT, FI (H) until 31 March 2017,
- valid class 1 medical certificate,
- valid licence of the aeronautical mobile service radio operator.

1.5.2 Flying experience

The pilot started practice flight training on the type R 22 in March 1994. He had performed the last flight before the event flight on 17 June 2014. The said flight lasted for 54 minutes and the pilot performed one landing. The pilot performed the last flight in the position of an instructor on the type R 22 on 19 June 2014.

Hours flown over:	24 hours	90 days	Total
This type of helicopter	0:18	51:27	3174:00
All helicopter types:	-	81:45	7913:13

1.5.3 Another person on board

A 63 year old man who had had experience with flying R 22 helicopters was sitting on the left seat. He is a holder of valid licences CPL (H) and of a glider pilot.

1.6 Aircraft Information

1.6.3 General Specifications of the Aircraft

The Robinson R 22 BETA II helicopter, registration mark OK-LPS, was a light single-engine, two-seat, all-metal helicopter with a traditional structure and fixed skid landing gear. The helicopter was driven by a piston engine of the Lycoming type. Fuel tanks

with the volume of 106 l were filled with the AVGAS 100 LL fuel up to the amount of approx. 80 l, which represents 75 per cent of the full tank volume.

Type:	R 22 BETA II
Registration mark:	OK-LPS
Manufactured by:	Robinson Helicopter Company, USA
Year of manufacture:	2003
Serial number:	3457
Certificate of airworthiness inspection:	valid until 16 July 2014
Total hours flown:	2,112 h 30 min
Liability insurance:	valid until 26 January 2015

1.6.4 Power plant:

Engine/Type:	Lycoming / O-360-J2A
Manufactured by:	Lycoming Engines, USA
Serial number:	L-39119-36A
Year of manufacture:	2003
Total hours flown:	2,112 h 30 min

1.6.5 Helicopter Operation

The helicopter was manufactured in 2003 and until 2005 was operated by an Austrian operator. The helicopter was registered in the Aircraft Registration Database of the Czech Republic on 3 January 2005 and licensed to conduct air work. Since this date the helicopter has been owned and operated by LPS, letecké práce a služby, s.r.o., Mělník at the Roudnice nad Labem aerodrome. The helicopter has been mostly used for air training flights and air work.

The last 100-hour inspection was performed on 29 April 2014 with the conclusion "Aircraft considered capable to be released into service". Since that time, the helicopter had in total 82 h 18 min of flown hours.

On 13 January 2014 an entry in the board logbook was made describing a defect regarding the overrunning the RPM of the engine up to the value of 110 per cent. Based upon the said entry, servicing and maintenance operations were performed on the engine in accordance with the service bulletin SB 369 J together with the exchange of the engine oil and of the oil filter on 15 January 2014. The helicopter was released back into operation.

The following entries were recorded in the aircraft logbook regarding the issues of the main rotor drive belts:

On 16 October 2006, after 803 h 18 min of aircraft hours the drive belts in the main transmission were exchanged for new ones.

On 20 August 2010 a check of the engagement of the driving belts tension was performed in accordance with the binding service bulletin SB-104.

On 19 June 2014, a repair of the cabling of the motor of turn-buckle for the driving belts was performed and the helicopter was released into operation.

On the day of the air accident, only the event flight was carried out with the helicopter; the flight lasted approx. 18 min.

1.6.6 Calculation of the Total Weight of the Helicopter

Weight of an empty helicopter:	395.70 kg
Weight of fuel:	57.60 kg
Weight of the crew:	150.00 kg
Weight of cargo:	10.00 kg
Total weight of the helicopter:	613.30 kg

The maximum take-off weight of the helicopter is 621 kg.

1.6.7 Conclusions of the Technical Inspection of the Helicopter

After the air accident, a technical inspection was performed on the helicopter with the aim of ascertaining the damage caused by the rough landing into the terrain. Each damage found on the helicopter structure and on the power unit, with the exception of both the double V-belts, was corresponding to the mechanism of the impact of the helicopter on the ground.

In the next phase, the inspection focused on the tension mechanism and the sprag clutch. In conclusion, perfect operational functionality of the inspected elements was confirmed.

Further, the Commission attended to examining the remaining parts of the V-belts. The front double V-belt was located in the engineering compartment away from the sheaves. The belt was divided along its whole circumference. The condition thereof showed substantial wear and tear without the possibility of a clear assessment of its condition before the air accident. The inner walls of the engineering compartment were coated with dry rubber dust originating from the V-belts. In the lower part of the engineering compartment there were large fragments of the rear double V-belt. The rear double V-belt, extensively devastated, fell out of the helicopter after snapping, and it was found on a road in the village of Hlavenec.



Fig. 2: The damaged rear double V-belt



Fig. 3: The damaged front double V-belt in the engineering compartment

1.7 Meteorological Information

1.7.1 CHMI Weather Report

According to the report issued by the CHMI, behind the cold front proceeding over Slovakia further to the south-east, colder air was blowing into the area over the Czech Republic from the north-west. According to expert estimate the meteorological situation at the place of air accident was as follows:

Surface wind:	250° - 290° / 8 - 12 kt
Upper wind:	1000 ft AGL 280° / 18 kt /+11°C, 2000 ft AGL 280° / 18 kt /+09 °C
Weather:	Broken, no precipitation
Visibility:	over 10 km
Cloudiness:	BKN SC, CU base/top 5000 - 8000 ft AMSL
Turbulence:	NIL
Zero isotherm level:	7000 ft AMSL
Ice:	NIL

Extract from the METAR report from the Prague-Kbely weather station (LKKB)
05-07

2006 0500 METAR LKKB 200500Z 25008KT CAVOK 12/09 Q1013 NOSIG=

2006 0600 METER LKKB 200600Z 26009KT CAVOK 12/08 Q1013

2006 0700 METAR LKKB 200700Z 27009KT CAVOK 13/08 Q1013 NOSIG=

1.8 Radio Navigational and Visual Aids

NIL

1.9 Communications

NIL

1.10 Aerodrome Information

The take-off airport was LKRO, a public domestic aerodrome. Helicopters usually take off from a reinforced manoeuvring area outside the operator's hangar. After the take-off they continue air-taxiing into the RWY area, and, with regard to the local operating conditions, they perform the lift and departure manoeuvres.

1.11 Flight Recorders and Other Means of Recording

No logger, the record of which might be used in the flight analysis, was installed on the helicopter board.

The helicopter appeared in the secondary ACC radar record shortly after the take-off from LKRO at 900 ft ALT. The last radar echo recorded in the vicinity of the village Hlavenec at 06:41:30, when the helicopter was located at 700 ft ALT at the ground speed 80 kt.

1.12 Wreckage and Impact Information

The helicopter made a rough landing into the sown field in the cadastral territory of the village of Hlavenec. The location of landing was approx. 132 m to the south-east from the built-up area.

Geographical coordinates	N 50°14'13.13''
	E 014°42'13.34''
altitude:	192 m above sea level

From the traces on the ground, the landing gear deformations, and according to the statements of the witnesses, it was ascertained that the helicopter made impact on the ground on a perpendicular trajectory from approx. 3 m AGL. After the impact the ELT locator was switched on.

The Commission was, in cooperation with the villagers, able to find part of the rear double V-belt from the crashed helicopter. Substantially damaged V-belt was found in the village on the pavement next to the road to Kostelní Hlavno.

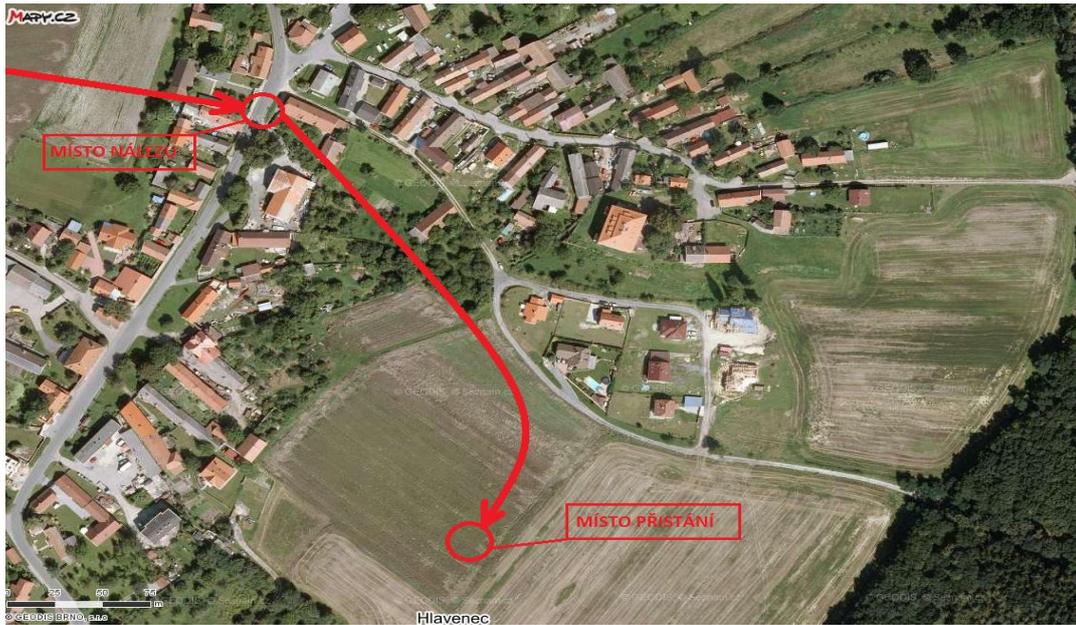


Fig. 4: Last stage of the event flight

1.13 Medical and Pathological Information

The pilot and the other person on board suffered severe injuries in the area of the spine. After the transport to the hospital, a blood sample test was performed on the pilot in order to determine the use of alcohol or toxic substances with a negative result.

1.14 Fire

No fire occurred after helicopter's rough landing.

1.15 Survival Aspects

No search and rescue procedures were organised. The pilot notified the authorities of the air accident on 158 emergency line and, together with the other person on board, remained seated in their seats in the cockpit of the helicopter due to the inability to move caused by injuries to the spine during the rough landing. They had been waiting in this position until the FRS and the ERS arrived.

1.16 Tests and Research

NIL

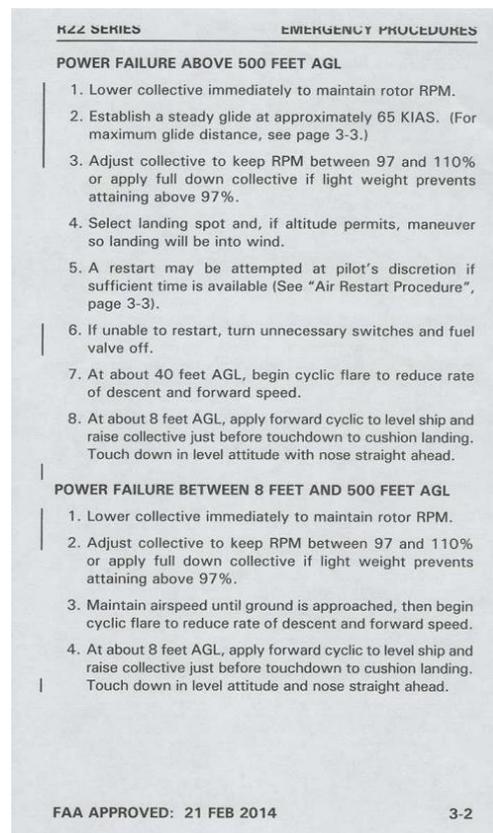
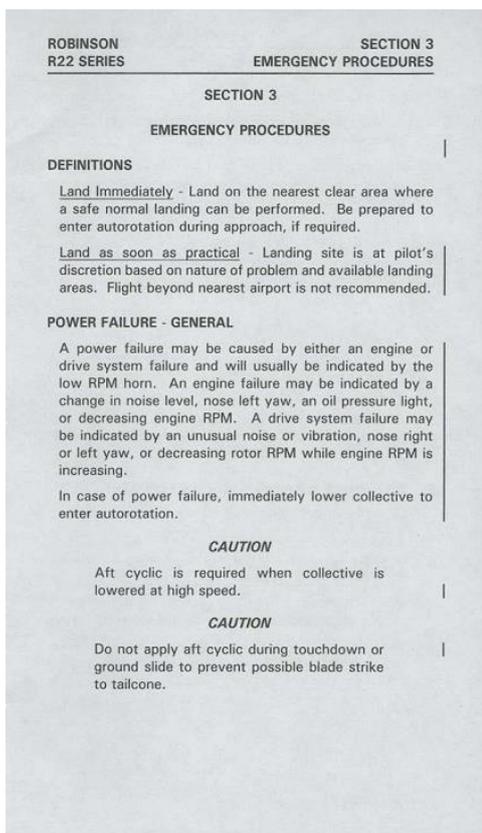
1.17 Operating Body Information

The helicopter had been used for aviation training of the helicopter pilots at the aviation school and for air work.

1.18 Additional Information

1.18.1 Flight Manual

In the flight manual of the helicopter Robinson, model R 22, serial number 3457, under Section 3, Emergency Procedures, there are, on page 3-1, descriptions of the defects and failures of the propulsion in general, and, on page 3-2, there is a description of an emergency procedure in case of defect or failure of propulsion in-flight at 8-500 ft AGL altitude.



2 Analysis

Majority of facts pointing to the determining of the causes of the air accident arise from the evidence found in the wrecked helicopter, from the findings from the detailed inspection of the air accident location, from the information provided by the pilot and the other person on board.

2.1 Pilot's Qualifications

The pilot was a holder of adequate qualifications for performing flights with the R 22 BETA II helicopters on which type he had in total 3,174 flight hours since 16 March 1994. From this perspective it can be assumed that the pilot had sufficient experience in flying and also with the given type of helicopters.

As an instructor he possessed the necessary practical experience with performing flights with a helicopter in the autorotation mode. He applied his experience fully when negotiating the non-standard emergency while in flight and his proceedings were fully in accord with the flight manual for the given helicopter type.

2.2 Flight Performance

The pilot had carried out the pre-flight preparation for the specific given flight in the required extent. After the take-off from LKRO, the helicopter was flying at 900 ft ALT all the way to the point of the critical event occurrence. The whole said flight was carried out without any defects or incidents.

2.3 Event Situation

The critical event occurred at the moment when the helicopter crew heard a strong bang from the engine compartment of the helicopter. This unusual sound was caused by the impact of the damaged V-belt on the walls of the engineering compartment. The helicopter was located before the village Hlavenec, at its north-east edge and was flying at approx. 900 ft ALT in the course of 120 degrees. At the same moment, the light and sound signal of the low RPM of the main rotor occurred, and the main rotor as well as the engine RPM dropped to 90 per cent. The pilot responded immediately to the situation by changing the mode of the helicopter to autorotation. The rotor RPM were not, however, increasing, therefore the pilot used the forward speed and by the means of moderate pulling of the cyclic control he attempted for the increase of the RPM. The main rotor RPM were increasing towards the operating values very slowly whilst the helicopter continued descending at the speed recommended for autorotation to the selected area. At this stage of flight, the pilot was attending the piloting of the helicopter with a full attention aiming at the most precise approach of the area, and to the actual landing in the autorotation mode. During the descent, the operation of the helicopter was standard. The change occurred when the pitch of the helicopter was being levelled in descent, when, in the decrease of the forward speed, the desired decrease of the vertical speed was not achieved. The pilot responded to the occurred situation by pulling the cyclic control by means of which he levelled the helicopter into landing configuration and by forceful pulling of the collective pitch control he attempted to reduce the vertical descent. After the pulling of the collective pitch control to the very end at the top position, the helicopter fell from the altitude approx. 3 m AGL with the landing gear skids to the ground.

2.4 Helicopter

The helicopter was operated before as well as during the event flight within the range of the authorised weight and centre-of-gravity position, which ensured sufficient range of control for its safe piloting. The maximum take-off weight of the helicopter was not exceeded.

During the flight the pilot did not notice any abnormality in the helicopter control, indication of V-belts tension or engine operation and its performance.

The technical inspection of the helicopter confirmed that no technical failure of the individual elements of the tension mechanism took place and that the sprag clutch operation was flawless as well.

The V-belts were installed into the helicopter eight years ago and were operated in total of 1,409 flight hours. During the operation time and at the regular inspections no damage, as listed in the service manual under item No. 2.507, was discovered on the said belts. The expected lifetime of the said belts is determined to be 12 years, or 2,200 hours.

At every regular inspection after every 100 hours, objective clutch shaft angle measurements were performed in accordance with the service manual, item No. 2.410. The values of the measured quantities were always in the range stated under item No. 7.240 of the service manual.

Upon the destruction of the rear V-belts a change in the engine power output transmission occurred at the top sheave, but very likely partially operational front V-belt prevented the total cut of power output transmission and the sprag clutch, embedded in the hub of the upper sheave, did not stop the power output transmission to the main rotor and the tail propeller. The main driving gear system defect manifested itself in the main rotor RPM decrease whilst the motor RPM were not increasing.

The damage to the outer parts of the cockpit and of the landing gear occurred in consequence of the rough landing in the autorotation mode of the main rotor.

2.5 Weather Effects

The weather conditions were fully satisfactory for flight performance under VFR. The wind direction and speed might have had a negative effect on the final stage of the flight in the autorotation mode of the main rotor.

3. Conclusions

3.1 The AAI Commission concludes the following:

3.1.1 Pilot

- held the required and valid licence and was medically fit for performing the flight,
- had a valid general licence of the aeronautical mobile service radio operator,
- had, from the skills point of view, sufficient piloting experience with flying this specific type of helicopters,
- as an instructor had considerable experience with the training for emergency situations, including flights in the autorotation mode of the main rotor,
- responded in time and in correct manner to the main rotor RPM decrease,
- with regard to the flight altitude and the necessity to pilot the helicopter towards the area of an emergency landing, he had no time to specify the defect occurred more accurately.

3.1.2 Helicopter

- had a valid certificate of airworthiness inspection and was airworthy,
- had a valid liability insurance,
- the operations carried out in connection with the defect of the V-belt tension mechanism were performed in accordance with the service manual,
- the correct operation of the V-belt tension mechanism was subjected to multiple functional checks, with no malfunction detected,
- record was made about the performed service and maintenance steps into the helicopter documents,
- was filled prior to the flight with the fuel necessary for the given flight,
- double V-belts were checked in accordance with the service regulation item No. 2.507 and did not show any signs of excessive wear and tear effects nor of any mechanical damage,
- both the belts did not exceed the lifetime and hourly TBO,
- the complete destruction of the rear double V-belt occurred probably due to the wear and tear effects,
- the front double V-belt provided partial transmission of power output, whereby a great difference between the RPM of the engine and of the main rotor values (upper and lower sheaves) did not occur in order for the disengagement of the sprag clutch to take place,
- during the decrease in the RPM of the main rotor, no increase of the RPM of the engine took place,
- the Commission was not able to determine the exact mechanism of the gradual loss of transmission of the engine power output,
- freely moving parts of the rear double V-belt were, with high probability, the cause of the destruction of the front double V-belt and the consequent slipping thereof off the sheaves,
- the individual belts of the front double V-belt were, during the critical stage of the flight, mechanically separated from each other,
- the individual V-belts were not capable of transmitting the required power output from the motor to the main rotor individually,
- the described damage to the helicopter structure was caused in consequence of the forces operating during the rough landing,
- the engine of the helicopter and its individual systems worked perfectly normally during the whole flight, and all control elements were fully functional,
- the maximum take-off weight of the helicopter was not exceeded.

3.2 Causes

The cause of the air accident was the gradual destruction of both the driving double V-belts in the powering system of the main rotor. Thus caused operational failure of the drive system influenced the RPM of the main rotor in a negative way not only in the transition into the autorotation mode of the helicopter, but primarily in the landing stage in the autorotation mode.

Ing. Josef BEJDÁK
Investigator in charge

4. Safety Recommendations

We recommend, in the course of the service and maintenance operations, to record the measured angle of the clutch shaft into the statement of operations performed.

Approved by:

In Prague on ~~November~~ 2014

~~Ing. Pavel ŠTRŮBL~~
~~Managing Director~~

5. Appendices

NIL