ÚZPLN

AIR ACCIDENTS INVESTIGATION INSTITUTE
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CZ - 15 - 087

FINAL REPORT

Investigation of causes of an accident of helicopter Robinson R 44 Raven II, registration mark OK-RRJ, in the forest near Filipova Huť, on 29 March 2015

Prague
February 2016

Glossary of Abbreviations Used in this Report

°C	Temperature in degrees Celsius
ABV	Above
ACC	Air Control Centre
AGL	Above ground level
AMSL	Above mean sea level
AS	Altostratus
BKN	Broken
cm	Centimetre
CU	Cumulus
CHMI	Czech Hydrometeorological Institute
CR	Czech Republic
DZRA	Drizzle and rain
E	East
FIR	Flight information region
ft	Foot (unit of length – 0.3048 m)
GPS	Global positioning system
h	Hour
FRS	Fire rescue service
kg	Kilogram (unit of weight)
km	Kilometre
kt	Knot (unit of speed – 1.852 $km.h^{-1}$)
LKKO	Kolín public domestic airport
m	Metre
MAG	Magnetic
mb	Millibar
min	Minute
MSL	Mean sea level
N	North
NIL	None
OVC	Overcast
PPL (H)	Private helicopter pilot licence
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)
CET	Central European Time
CEST	Central European Summer Time
ST	Stratus
SYNOP	Report on surface synoptic observations made by weather stations
TCU	Towering cumulus
UTC	Coordinated Universal Time
CAA	Civil Aviation Authority
AAII	Air Accidents Investigation Institute
VFR	Visual Flight Rules
VMC	Visual meteorological conditions
MIFM	Military Institute of Forensic Medicine

A) Introduction

Operator:	HELITOM, s.r.o.
Aircraft Manufacturer and Type:	ROBINSON HELICOPTER COMPANY, R 44 Raven II
Registration/license plate:	OK-RRJ
Location:	Forest located 0.4 km west of Filipova Huť
Date and time:	29 March 2015, 08:11 (all times are UTC)

B) Synopsis

In the afternoon on the preceding day, the pilot landed the helicopter on a private land near the village of Modrava in the Šumava National Park. He spent the night in a nearby guest house. On the next day, in spite of unfavourable meteorological conditions and insistence of his relatives on postponement of the flight the pilot decided to fly to LKKO. The pilot departed the area without being noticed by anybody. Nearly three hours later, the manager of the guest house found the helicopter wreckage in the forest, approx. 650 m from the place of the take-off. The helicopter was entirely destroyed by a crash against full-grown trees and the subsequent fall to the ground. The pilot succumbed to his injuries on the spot.

The guest house manager reported the accident to the operator at the emergency number 158. The Police of the Czech Republic, the FRS, and the AAII inspectors arrived at the location of the air accident and the inspectors performed inspection of the location and of the helicopter wreckage.

The cause of the accident was investigated by the AAII commission. The investigation team comprised:

Investigator-in-charge:	Ing. Josef BEJDÁK
Commission members:	Ing. Viktor HODAŇ
	Col. MUDr. Miloš SOKOL, Ph.D., MIFM Prague

The Final Report was issued by:

AIR ACCIDENTS INVESTIGATION INSTITUTE
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on 8 February 2016.

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's next of kin described pilot's activities from the time of his landing on the private land belonging to the guest house owner until the moment when the pilot was seen for the last time. This person further described his own activities when uncertain about the pilot's whereabouts and his own search for the lost helicopter. The history of the event flight has been documented in detail based on the GPS device records.

1.1.1 Circumstances preceding the accident

The pilot finished a series of flights performed on Saturday by landing on a private land located approx. 100 m north-east of the guest house where pilot's relative stayed for a weekend with his family. When approaching the area, he made a left turn above the open area at the southern edge of Modrava and continued towards the landing place over the KLOSTER (Klostermann's chalet) point. The helicopter landed on 28 March 2015 at 17:02 on a private land on the basis of a written permission granted by the land owner. The pilot checked in at the guest house, had dinner with the family and all of them spent the rest of the evening together. He went to bed at about 21:00 (22:00 CET).

On Sunday morning, the pilot met with the family for breakfast. During the meal he announced to the family that he would fly back to Prague after breakfast. The witness stated specifically: *"My wife and me, we were discouraging him from his intention because there was fog and rain, treetops were not visible and a strong gusty wind was blowing. Father said he just wanted to have a look at the helicopter. When he was not coming back, my wife went out to look for him, but the helicopter was gone."* The family estimated that the helicopter must have departed at about 08:00 (10:00 CEST). Neither any family member nor any guest house staff member heard the helicopter departing.

1.1.2 Description of the event flight

The history of the event flight was derived from the analysis of data from the GPS device. After starting the engine before taking off, the pilot of the helicopter switched on the GPS GARMIN Aera 500 navigation device at 08:08:03 and set the GoTo active navigation to the route to LKKO.

At 08:09:36 the pilot performed take-off from a hover in the heading of 114 degrees MAG, and immediately made a left turn to the planned course to LKKO. After the take-off, the helicopter was smoothly ascending at the vertical speed of 2 $m \cdot s^{-1}$ to the altitude of 1,083 m, gradually reached the flight speed of 76 $km \cdot h^{-1}$ and took a direction slightly to the right.

At 08:10:05, at the distance of approx. 450 m from the place of the take-off, the helicopter was located approx. 150 m right of the planned route. At this point, the smooth ascending was interrupted, flight speed decreased to 36 $km \cdot h^{-1}$ and the direction turned left to the heading of the planned route. The helicopter flew approx. 150 m in the said direction and increased its speed up to 112 $km \cdot h^{-1}$ while moderately ascending.

At 08:10:17 the helicopter changed heading by nearly 90 degrees to the right. While making this turn, the helicopter first ascended to 1,166 m and then started descending down to the altitude of 1,160 m. Having flown approx. 300 m, the helicopter

sharply turned left by 180 degrees and was following practically the same route back for some 319 m.

At 08:10:51 the flight parameters changed abruptly. The GPS device recorded the last position and stopped recording the speed and direction data. The helicopter crashed down into the forest. The pilot succumbed to his injuries on the spot.

1.2 Injuries to persons

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

1.3 Damage to helicopter

Due to the collision with treetops and subsequent fall to the ground the helicopter was completely destroyed. Because the helicopter was moving among tree trunks, the cabin was entirely demolished and the instrument board was extensively damaged. The engine with the change gear box for the main rotor drive was deflected backwards and wedged into the deformed engine bed. Main rotor blades were bent and broken. The tail beam was deformed, the tail rotor change gear box was separated from the tail beam. No fire broke out during the accident.

Fig. 1: R-44 helicopter after a fall into the forest

1.4 Other damage

The damage sustained by the forest at the place of the helicopter fall and subsequent wreckage handling was minimum.

1.5 Personnel information

1.5.1 The pilot

Personal data:

- male, aged 60 years,
- valid Private Pilot Licence – Helicopters (PPL – H)
- valid rating for the type R 44 until 30 September 2015,
- valid class 2 medical certificate,
- valid limited licence of the aeronautical mobile service radio operator.

1.5.2 Flying Experience

The pilot started his practice flight training on the R 44 type in May 2012. Having flown 32 hours, he performed his first solo flight on the R 44 type on 31 October 2012 and continued the training in order to acquire the PPL (H). On 11 September 2013, he passed a skill test and a type rating for the Robinson R 44 helicopter with the following assessment: "qualified for PPL (H) under DAY VFR". Prior to the test day, he had already flown 142 h 18 min and had conducted 532 landings. As part of his training, he carried out a series of practice flights with an instructor at the Vrchlabí airfield in March 2013. On 23 June 2014 he was granted the "NIGHT" qualification. The last proficiency check on the given type took place on 4 September 2014 with assessment "passed" and the validity of R 44 type rating was renowed until 30 September 2015. In 2015, he reached the total of 28 h 36 min flown on the given type. He had performed the last flights before the event flight on 28 March 2015. The pilot had flown 2 h 48 min and performed 7 landings.

Hours flown over:	24 h	90 days	Total
This type of helicopter:	00:06	28:36	391:48
All helicopter types:	00:06	28:36	391:48

1.5.3 Other flying experience

Since 2014 the pilot had held a student licence with type rating for the Zlín Z-43 aircraft on which he flew 6 h 55 min in 2014.

1.6 Aircraft information

1.6.1 General specifications of the aircraft

The Robinson R 44 Raven II helicopter, registration mark OK-RRJ, was a light single-engine, four-seat, all-metal helicopter with a traditional structure and fixed skid landing gear. The helicopter was powered by a piston engine of the Lycoming type (IO-540-AE1A5). Prior to the departure from the LKKO, fuel tanks with the volume of 176 l were filled with the AVGAS 100 LL fuel up to the amount of approx. 120 l, which represents 65 per cent of the full tank volume.

Type:	R 44 Raven II
Registration:	OK-RRJ
Manufactured by:	Robinson Helicopter Company, USA
Year of manufacture:	2008
Serial number:	12464
Certificate of Airworthiness:	Valid
Total hours flown:	1207 h 54 min
Liability insurance:	Valid

1.6.2 Propulsion unit:

Type:	Lycoming IO-540-AE1A5
Manufactured by:	Lycoming Engines, USA
Serial number:	L-33082-48E
Year of manufacture:	2008
Total hours flown:	1207 h 54 min

1.6.3 Helicopter operation

Until 2014, the helicopter had been operated by a foreign operator. It was recorded in the aircraft register of the Czech Republic on 27 June 2014. As of that date it was operated by HELITOM, s.r.o. at the Kolín airfield. The operator used the helicopter for aerial work performance.

No logs regarding the defects in the helicopter operation were recorded in the board logbook or aircraft logbook. The last 100-hour inspection was performed on 14 November 2014 with the conclusion “Aircraft considered capable to be released into service”. Since that time, the helicopter flew 52 h 30 min and performed 165 flights.

On the day of the accident, only the event flight was carried out with the helicopter; the flight lasted 0 h 06 min.

1.6.4 Conclusions of the technical inspection of the helicopter

A) Helicopter fuselage and cockpit:

In the direction from the fireproof bulkhead towards the tail the fuselage was compact, severely deformed. The cockpit door, surface panelling and the engine covers were significantly deformed and separated from their hinges. The mechanical passageways for the controls of the main and the tail rotors were deformed. The attachment of the tail beam to the fuselage was deformed but compact, the hinges were secured in the prescribed manner. Both the fuel tanks were perforated, the remaining

amount of fuel in the main tank was approx. 40 litres. The interior of the cockpit was significantly damaged, the cockpit and door frame was flattened, the glazing of the cockpit and the door was totally shattered. The pilot seat and the passenger seats were torn and separated. The helicopter steering parts in the cockpit were damaged and some of the handles and control levers were detached from the steering mechanism. The cockpit board and the control panel were divided into several parts and were damaged significantly.

B) Engine, transmission, and the main rotor:

The main rotor hub was damaged, the drag links were deformed, one of them broken. The main rotor blades were broken in the distance of approx. 1.07 m and 0.8 m from the centre, one of the blades was broken off completely from the structure. The main rotor shaft extension was deflected by approx. 45 degrees backwards, the aerodynamic cover of the shaft was significantly deformed in the frontal part due to the previous contact with a tree trunk. The engine remained attached in the engine bed whose individual parts of the tubular construction were bent and, in numerous places, broken. The most significant damage to the engine was concentrated in its left lower part where the direct contact with the tree trunk had taken place. The drive belts were slipped off from the sheaves grooves. The mechanical systems for the engine controls and the main rotor were deformed and, in the locations of the direct contact with the tree trunks, broken. The piping and hosing of the fuel, oil and hydraulic systems were severely damaged and, in many places, broken. The electrical wiring leading into the cockpit was also cut and broken in many places.

C) Tail beam and tail propeller:

The tail beam was deformed in the length of approx. 1.30 m from the end due to the collision with the blades of the main rotor. The horizontal and vertical stabilisers were damaged in several places. It was detached from the tail beam after the contact with the tree trunk, when the connecting hinge was broken. The anti-torque rotor transmission together with the rotor were broken off from the tail beam, the blades of the anti-torque rotor were deformed, not separated from the transmission shaft however.

D) Conclusion:

The identified damage can be ascribed to the mechanism of collision of the helicopter with the treetops and the consequent fall to the ground. From the completely destroyed front part of the fuselage and the cockpit, and from the deformation of the shaft extension of the main rotor towards the rear, it can be deduced that the collision into the trees took place at a high speed. The fall from the height of tree tops together with a contact with tree trunks caused significant damage to the structure of the helicopter.

1.7 Meteorological information

1.7.1 CHMI weather report

According to the Aeronautical Meteorological Service of the CHMI, a frontal wave was advancing over western Europe in fresh zonal flow being preceded by high-level and middle-level clouds. This situation started affecting the area of the Czech Republic from

the west. According to an expert estimate the meteorological situation at the place of air accident was as follows:

Ground wind:	240–230° / 10–17 kt, gusts 22–32 kt
Upper wind:	5000 ft AMSL 250° / 30 kt, MS03 DEG
Weather:	Overcast, drizzle and rain
Visibility:	1–2 km, temporarily 0–200 m fog in clouds of ST type
Cloudiness:	BKN / OVC ST base / top 000-090/4000 ft AGL, BKN AS 4000-5000 / ABV 10000 ft AGL
Turbulence:	Weak to moderate mechanical
Zero isotherm level:	7,000 ft AMSL
Ice:	NIL

Extract from the METAR report from the Prague Ruzyně weather station:

Time	Air pressure QNH	Wind direction/ Wind speed	Visibility	Cloudiness/ Cloud base height	Regional QNH:	Temperature/Dew point
08:00	1,007 hPa	230° / 16 kt	Over 10 km	STC / 1,800 ft	1,003 hPa	10 / 06 °C

An extract from SYNOP reports from the Churáňov weather station:

Time	Total cloud cover	Wind direction/ Wind speed	Visibility	Weather/ Phenomena in the last hour	Cloudiness/ Cloud base height	Temperature
08:00	8	240° / 14–28 kt	7,000 m	58 DZRA	8 ST / 0090 ft AGL	4.1 °C
09:00	8	250° / 12–28 kt	3,400 m	58 DZRA	8 ST / 0030 ft AGL	4.1 °C
10:00	8	250° / 16–32 kt	5,000 m	59 DZRA	8 ST / 0090 ft AGL	4.4 °C

An extract from SYNOP reports from the Temelín weather station:

Time	Total cloud cover	Wind direction/ Wind speed	Visibility	Weather/ Phenomena in the last hour	Cloudiness/ Cloud base height	Temperature
08:00	7	230° / 10 kt	50 km	NIL	7 SC / 3,000 ft AGL	9.5 °C
09:00	6	250° / 19 kt	50 km	NIL	4 SC / 2,500 ft AGL	11.6 °C
10:00	8	260° / 10 kt	50 km	NIL	8 SC / 2,900 ft AGL	10.4 °C

At the time of the accident, a rather strong wind was blowing in the east-west to west direction at the speed of 10–17 kt with gusts up to 32 kt in the area of Modrava-Filipova Huť. The local terrain profile, inclining to Filipova Huť, together with the strong wind had blown low clouds (BKN / OVC 000–090 ft AGL) from the valley, which resulted

in fast reduction in visibility to 0–200 m. Because of the gusty wind there was moderate mechanical turbulence too.

1.7.2 Photograph of the on-site situation

Footage of the web camera located on the Korýtko guest house (1,118 m AMSL) has been found in the operating records of the Šumava National Park. The camera was recording a view with the shooting angle in the south-west direction towards Modrava in five-minute intervals and was located approx. 900 m east of the accident site. On 29 March 2015 from 10:00:04 to 10:15:04 CEST, the following meteorological conditions were captured:

Fig. 2: Photograph depicting the weather situation in the area of Filipova Huť from 10:00 to 10:15 CEST

1.8 Radio navigational and visual aids

NIL

1.9 Communications

NIL

1.10 Aerodrome information

The stopover was planned for the area of the Šumava National Park, at the forest edge approx. 100 m north-east of the guest house as permitted in writing by the land owner. The grass area was surrounded by a mature spruce forest on three sides and there was a telephone line leading over the open south-east edge. The ASL was 1,040 m. The helicopter was parked all night in this open and freely accessible area.

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 GPS Garmin Aera 500 device was used for navigation of the helicopter. The device was found at the accident site outside the helicopter and was not mechanically damaged. A specialised centre succeeded in starting the device and investigated the GPS navigation values and internal settings with parameter records.

The ACC summary display records did not show any indication of the position of the helicopter at the given place at that time.

1.12 Wreckage and impact information

The helicopter, after the contact of the main rotor blades with the fully grown spruce trees, was continuing to move vertically along one of the tree trunks and eventually crashed into the ground with its nose. The distance of the impact site from the cart track was approx. 37 metres. The surface of the helicopter crash site was overgrown with billberry shrubs and an unspecified number of freshly broken off spruce branches and patches of slushy snow could be found on the ground.

The helicopter was lying on the ground on its starboard side, wedged between tree trunks. Its longitudinal axis was heading in approx. 326 degrees MAG direction.

Geographical coordinates:	N 49°01´41.0´´
	E 013°30´40.6´´
Altitude:	1,099 m above sea level

Due to the crash, the cockpit was deformed, the windows, were shattered, the mounting of the main rotor transmission was damaged, and the individual components of the drive mechanism were destroyed.

The cockpit seats were furnished with safety seatbelts which were buckled up. The controls for operating the helicopter were fitted to enable the piloting from the right piloting seat. The emergency locator beacon ELT was not activated after the crash.

The instruments placed on the control board in the cockpit were severely damaged. The pressure value set on the altimeter was 1,012 mb. The ignition and the main switch of the accumulator were switched off by the FRS team who disconnected the conductor from the negative terminal. The fuel gauge was in the "open" position. A partial leakage of the working fluids took place on the site. Traces of petrol leakage from the helicopter fuel tanks were discovered in the immediate vicinity around and under the helicopter. The tank fuel fillers were closed off by caps.

After the investigation performed on site of the accident, an intentional mechanical separation of the tail beam from the fuselage was carried out in order for the helicopter to be transported into the AAII hangar where a more detail technical inspection was to be performed.

1.13 Medical and pathological information

Polytrauma, i.e. multiple injuries to several organ systems, was the immediate cause of pilot's death. Death occurred immediately after the injury had been caused by the crash of the helicopter into the wooded terrain.

The autopsy protocol implies that the pilot suffered multiple injuries, in particular, to his head, trunk and limbs. From the forensic medical point of view it is possible to state that blunt violent force of great intensity, mostly from the front and slightly from below, impacted the pilot's body. The origin of the injury may be easily explained by the mechanism of the given air accident by a crash of the helicopter against full-grown trees and subsequent fall of the air vehicle to the ground.

The pilot had his left upper limb bent in the elbow, placed before his body, most probably clutching a small cylindrical item, a part of the collective control. Injuries to his right hand were atypical of the interpretation of the findings. His lower limbs were placed under the control panel, stretched and propped against a solid cockpit component.

The autopsy has detected no traumatic alterations which could not have been explained by the mechanism of the said accident, such as a projectile wound, an explosion, etc.

The autopsy has disclosed no pathological changes that might have been involved in the causes of the accident, or that could have been considered as a casual link with the pilot's death.

No trace of alcohol or other substance prohibited for aviation duty was proven in the pilot's body by the toxicological examination.

The biochemical examination of tissue samples collected during autopsy has been performed to determine the pilot's somatopsychic condition. Based on the laboratory examination results, statistical processing for evaluation, and within the context of available data, it may be deduced that the pilot's energy metabolism was considerably activated over several last seconds before his death, drawing on the reserve sugar from his liver and muscles, without raising the level of lactic acid. The examination results may be interpreted, for instance, as pilot's perceiving the said flight in the last dozens of seconds before his death with significantly increased mental strain, which gradually grew into stress response while apprehending some critical flight situation.

1.14 Fire

After the helicopter crashed against the treetops and then fell down to the ground, no fire was ignited. At the moment of the air accident there were 60 l of fuel in the helicopter tanks.

1.15 Survival aspects

The pilot's next of kin tried to contact the pilot first over the mobile telephone at 08:45 and then half an hour later, but always with a negative outcome.

Search was organised at the moment when the relative failed to contact the pilot for the third time although he was supposed to have landed at LKKO a long time before that. At 11:00, the relative contacted the helicopter operator who found out from the data recorded by the GPS/GSM on-line tracker that the helicopter was located on the territory of the Šumava National Park near Filipova Huť. GPS coordinates were communicated to the guest house owner who went to the given place and after several minutes discovered the helicopter wreckage in the forest ground cover and reported the situation to the emergency line 158.

Pilot's body was found in the wreckage of the deformed helicopter cockpit without any signs of life.

1.15.1 Emergency locator beacon (ELT)

The ELT KANNAD 406 AF COMPACT emergency locator beacon installed in the helicopter was not located by the rescue operation forces, which extended the time of search considerably. It was found in the helicopter wreckage during the examination of the debris at the accident location. The unit was found with no visible mechanical damage with some residues of soil and working fluids.
The "ON/OFF/ARM" switch No. 17 was in the ARM position. The green signalling light was on. After it had been collected from the debris and its state had been documented, the switch was put to the "OFF" position. There was a remainder of the linking connector with visibly torn out conductors in the "REMOTE" connector socket. Remainder of the BNC connector without the middle conductor was connected to the antenna connector.

1.16 Tests and research

1.16.1 ELT Emergency locator beacon

The emergency locator beacon was handed over for examination to a specialised site of the organisation approved for maintenance so as to verify the authenticity of an ID code and the functionality by a serial line self-test.

The above stated emergency locator beacon did not show any signs of mechanical damage during the initial inspection. The function switch was in the "OFF" position, the connector for the remote contact and the connector for the aerial remained intact. The internal battery expiry date was October 2017. The safety seal remained intact.

Before the disassembly of the emergency locator beacon, the self-test check had been carried out with a positive result. Subsequently, function simulations were performed in the real-life settings, i.e. the emergency locator beacon was connected to the connector of the pulled out aerial and utilising the tester a test with a positive result was carried out. After the disassembly, a check of the "G" switch, found in a switched off position, was performed. Upon the impact on the ground the above mentioned switch did not switch on, that is the emergency locator beacon was not switched on. The rest of the components after the disassembly of the beacon did not show any signs of mechanical damage.

The cause of the emergency locator beacon not being switched on was a very low long-term g-load effect. Minimum g-load required for the beacon to be switched on is 6.

1.17 Operator

The helicopter had been used mostly for training and recreational flights.

1.18 Supplementary information

1.18.1 Requirements of the rules

The regulatory requirements for preflight preparation are stipulated, on the basis of ICAO standards, Annex 2, Rules of the Air, by Regulation L 2 Applicability of the Rules of the Air, Chapter 2(2.3.2):

Before beginning a flight, the pilot-in-command of an aircraft shall become familiar with all available information appropriate to the intended operation. Pre-flight action for flights away from the vicinity of an aerodrome, and for all IFR flights, shall include a careful study of available current weather reports and forecasts, taking into consideration fuel requirements and an alternative course of action if the flight cannot be completed as planned.

The pilot intended to perform the flight in compliance with the visual flight rules. The minima depend on the level and speed of a given flight and the class of airspace in which the aircraft is operating.

Based on the ICAO standards, Annex 2, Rules of the Air, Chapter 3 3.9 stipulates the Visual Meteorological Conditions (VMC) Visibility and Distance from Cloud Minima and Chapter 4 4. 11 in Regulation L 2 stipulates the Rules of the Air 6):

3.9 The VMC visibility and distance from cloud minima are specified in Table 3-1 below.

Airspace class	*G*
Flight visibility *Distance from cloud*	*5 km** *Clear of cloud and with the surface in sight*
**a) flight visibilities reduced to less than 5 km, but not less than 1 500 m may be permitted for flights operating:* *1) at speeds that, in the prevailing visibility, will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision; or* *2) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low volume traffic and for aerial work at low levels.* *3) HELICOPTERS may be permitted to operate in less than 1 500 m flight visibility, but no less than 800 m, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision. Flight visibilities lower than 800 m may be permitted for special cases, such as medical flights, search and rescue operations and fire-fighting.*	

4.11 *The flights of VFR aircraft which are not equipped for IFR flights or are equipped for IFR flights, but the pilot is not qualified for IFR flights, must be conducted in constant visibility of the ground at all times. Flights above clouds may be performed if the coverage of the sky with clouds under the aircraft is not more than 4/8 and it is feasible to carry out the flight according to map matching.*

1.18.2 Data from the GPS Garmin Aera 500 satellite navigation system

An expert inspection of the navigation device Garmin Aera 500 was performed at a specialised facility. Original set of data was secured from the GPS navigation device records in the Garmin software format. A backup of the file of the data values was made and saved for further analysis and processing. From the extensive data record data files were identified, then separated and processed in an analysis; the said files were linked to the air accident on 29 March 2015, and also files from the flights performed on the day before when the pilot had been flying for 2 hours and 48 minutes and performed altogether 7 flights.

1.18.2 Flight records made on 28 March 2015

From the GPS data records the files from the day before the accident day were processed and separated and the data concerning several flights up to the arrival to Modrava were identified.

List of performed flights:

1. Modletice u Doubravic – Divišov
2. Divišov – Blatná
3. Blatná – Divišov
4. Divišov – Kolín (at LKKO the fuel tanks refuelled to the amount of approx. 140 l)
5. Kolín – Divišov
6. Divišov – Divišov (local flight)
7. Divišov – Modrava

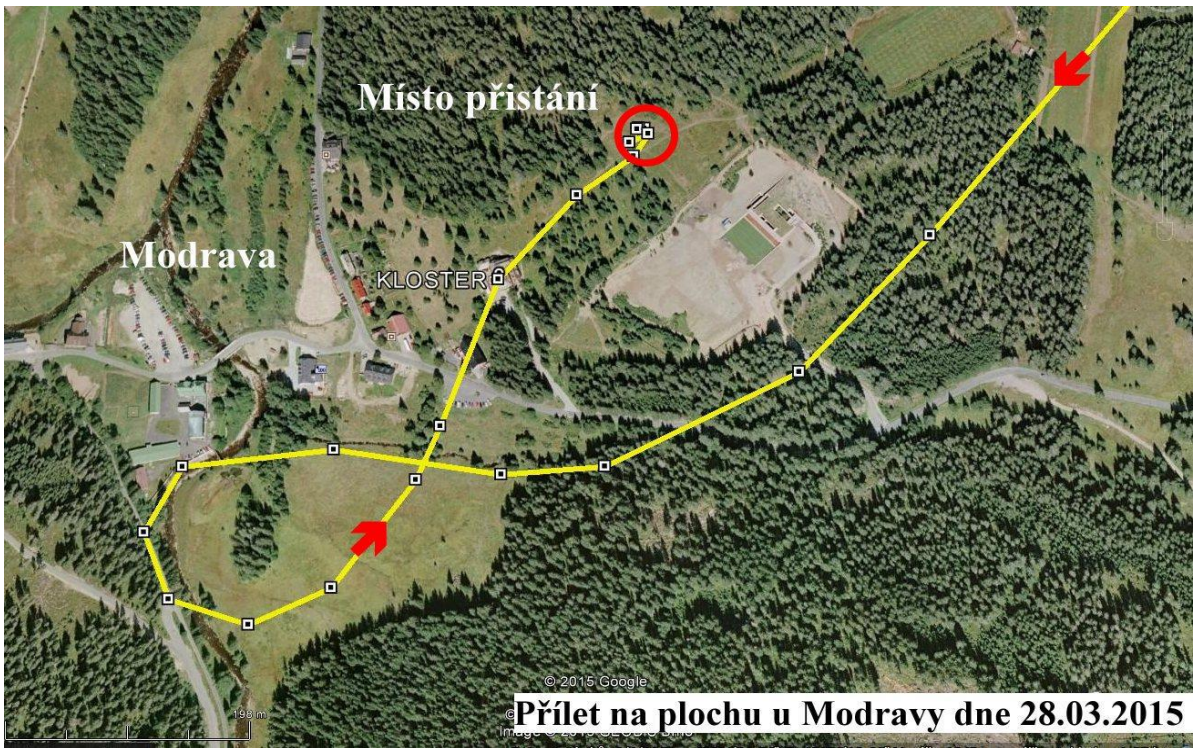

Fig. 3: Arrival and the landing site at the north-east edge of the village Modrava

1.18.4 The flight records made on 29 March 2015

The last event flight was recorded in the data form and processed from the time of lift from the take-off surface near the village of Modrava until the end of the flight in the vicinity of Filipova Huť.

Point No.	Time [h:min:s]	GPS height [m]	AGL height [m]	Section length [m]	Time of flight [s]	Speed [km·h^{-1}]	Direction [°MAG]	GPS position
1	08:08:03	1038	0	0	93	0.1	045	N 49 01 32,5 E 013 30 09,6
2	08:09:36	1042	2	24	6	14	114	N 49 01 32,6 E 013 30 09,6
3	08:09:42	1046	6	54	6	32	065	N 49 01 32,2 E 013 30 10,7
4	08:09:48	1060	10	102	5	73	051	N 49 01 32,9 E 013 30 13,1
5	08:09:53	1083	28	106	5	76	067	N 49 01 34,9 E 013 30 17,2
6	08:09:58	1113	45	70	7	36	075	N 49 01 36,1 E 013 30 22,0
7	08:10:05	1132	58	96	4	86	041	N 49 01 36,6 E 013 30 25,4
8	08:10:09	1133	58	94	3	112	052	N 49 01 38,9 E 013 30 28,6
9	08:10:12	1142	57	112	5	80	079	N 49 01 40,7 E 013 30 32,3
10	08:10:17	1166	71	62	3	74	112	N 49 01 41,2 E 013 30 37,8
11	08:10:20	1160	65	275	15	66	112	N 49 01 40,4 E 013 30 40,6
12	08:10:35	1137	42	319	16	72	296	N 49 01 36,8 E 013 30 52,9
13	08:10:51	1147	52	-	-	-	-	N 49 01 41,6 E 013 30 39,1

Fig. 4: Horizontal projection record of the event flight

The GPS speed is the speed measured by the GPS satellite system in a given section of the record and stands for the average Ground Speed.

The GPS altitude is the altitude given in metres measured by the GPS satellite system and it can be roughly equated to the MSL altitude. The variance between those two values can be corrected at the points which are known.

1.19 Useful or effective investigation techniques

The accident investigation was carried out in compliance with Regulation L13.

2 Analyses

Majority of facts pointing to the determining of the causes of the accident arise from the evidence found in the wrecked helicopter, from the findings from the detailed inspection of the accident site, from the information provided by the witnesses and the records of the last stage of the event flight captured by the GPS device.

2.1 Pilot's qualifications

The pilot was a holder of adequate qualifications for performing flights with the R 44 Raven II helicopter on which type he had in total 391 flight hours 48 minutes since 22 May 2012. He performed flights on regular basis with no lengthy breaks between the flights. The last proficiency check on the type was performed on 4 September 2014 with the qualification "passed". From this perspective it can be assumed that the pilot had sufficient experience in flying and was also well acquainted with the given type of helicopters. The pilot did not have experience with flying in mountainous regions.

2.2 Flight performance

No witness or evidence acquired by the commission did prove that the pilot had performed the pre-flight preparation for the specific flight in the proper and appropriate extent and quality. The pilot had not performed the navigational preparation with paper or electronic formats of maps, and neither, most likely, had studied the situation at FIR Prague. He was navigating using the GPS Garmin Aera 500 device, which he had, after switching on, set on the active GoTo navigation for the flight route to LKKO. The commission was also unable to ascertain with whom and to what extent the pilot consulted the situation and development of the meteorological situation on the planned flight route and in the location of intended landing.

It was not feasible to ascertain in what extent and quality level the pilot was performing the pre-flight inspection of the helicopter. From the GPS device record and from the inspection of the barometric altimeter it is evident that the pilot had performed even the pre-flight operation within the framework of the standard procedures in a negligent manner and in a considerable haste. It is corroborated by the fact that prior to the take-off the pressure on the barometric altimeter had been set on the value of 1,012 mb which differs significantly from the then valid values of current local QNH. Also, the timespan of 93 seconds from the GPS device activation to the take-off performance confirms the haste with which all of the steps were being taken.

After the take-off in the south-east direction and passing the telephone line, the pilot was turning left in the north-east heading, approximately in the course of the LKKO. Having completed the left turn, the helicopter was located slightly to the right from the set and displayed flight route into the destination location. The ascent profile is initially smooth, continuous; the speed according to the GPS gradually reached the calculated value of 76 $km \cdot h^{-1}$. Within the first 300 metres of flight the values of climbing, altitude, and the gradual increase in speed seemed to indicate a smooth flight carried out at the beginning over the clearing in the forest, above the telephone utility poles, and further continued above the area of forest nursery.

2.3 Event situation

The event situation occurred apparently as a consequence of the pilot's response to the significant deterioration of the flight visibility conditions after having flown for about 450 metres from the take-off point. At this point, a significant deceleration of the helicopter took place to the level of 36 $km \cdot h^{-1}$. The pilot interrupted the ascent and simultaneously changed the course slightly to the left. In this stage of flight, about 350 metres in length, the helicopter was moving over an ascending terrain with a fully grown spruce forest parallel to the right from the planned flight route. The pilot accelerated moderately up to 112 $km \cdot h^{-1}$ and climbing also moderately kept the vertical distance of approx. 25 metres from the treetops of the fully grown trees. At the end of this section, the helicopter was located 1,090 m AMSL. The further rising terrain ahead of the helicopter was very likely already covered by the clouds. The pilot performed a right turn by almost 90 degrees and continued in the flight in the south-east heading to the edge of the forest. At this stage, the pilot maintained an average speed of 70 $km \cdot h^{-1}$ and was descending gradually all the way down to 42 m AGL when he was located above the meadow by the road at the south edge of Filipova Huť. Here, at that moment, the meteorological conditions very likely prevented the pilot from continuing the flight in the given heading and the pilot lost visual contact with the ground. Therefore he, probably already in the clouds at that moment,

made an abrupt turn by 180 degrees in an attempt to fly out of the clouds as soon as possible and to return to the area above which he had been flying and, presumably had had at least some visual contact with the treetops. With a great probability, he was not able to re-establish the visual contact with the ground again and after having flown approx. 300 metres in the clouds he lost the spatial orientation and with it also the ability to pilot the helicopter safely.

2.4 Helicopter

The helicopter was operated 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.

Substantial damage to both, the external and internal, parts of the cockpit, the landing gear, the tail beam, the main and anti-torque rotors, was caused as a result of the contact of the rotating surfaces with a solid obstacle and a consequent crash into the ground.

2.5 Weather effects

The meteorological conditions did have an immediate effect on the course of the flight and the event history development. At the time of the accident, a rather strong wind was blowing in the east-west to west direction at the speed of 10–17 kt with gusts up to 32 kt in the area of Modrava-Filipova Huť. As a consequence of the mountainous terrain configuration due to the strong breeze low clouds drifted from the valley causing the flight visibility to drop down to levels of 0– 200 m. Moreover, considering the gust wind a mild mechanical turbulence occurred. The reduction in visibility to the levels in which it was not feasible to perform flights in VMC is evident from the pictures provided by the webcam.

3 Conclusions

3.1 The AAII Commission concludes the following:

3.1.1 Pilot

- held the required and valid licence and was medically fit for performing the given flight,
- held a valid limited 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,
- had not performed the pre-flight preparation in accordance with the Regulation L 2,

- had selected completely unsuitable route of flight with a single engine helicopter over the overgrown area,
- had overestimated his abilities to pilot a helicopter under the meteorological conditions that do not permit a flight in safe altitudes above terrain away from clouds and in constant visual contact with the ground,
- performed the flight despite the fact that it was absolutely evident at the site of take-off that at least part of the flight route would not be suitable for a flight in meteorological conditions allowing for a visual flight,
- had no sufficient experience with flying in mountainous terrain with chances of sudden weather changes,
- immediately after the take-off, when the flight visibility was with a great probability unsuitable for a safe continuation in the flight, did not carry out a prompt precautionary landing in the terrain but continued in the flight with regards to the cloud height and the flight visibility at the altitude of approx. 20 m above the treetops,
- in the last stage of the event flight piloted the helicopter under considerable strain, and, after partial or full loss of the visual contact with the ground, decided to return to the take-off site,
- having taken-off into the clouds lost spatial orientation and consequently the control over the helicopter.

3.1.2 Helicopter

- had a valid certificate of airworthiness and was airworthy,
- had a valid liability insurance,
- the described damage to the structure of the helicopter was caused only after the crash into the ground,
- the engine 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,
- was completely destroyed due to the forces affecting it after the contact of the rotating surfaces and the fuselage with the tree trunks and by the consequent crash into the ground.

3.1.3 Weather Impacts

- the weather conditions in the given mountainous region had a fundamental effect on the course of the event flight,
- the visibility together with the surrounding hilltops covered by low clouds eliminated the planning and subsequent performance of a VFR flight into the intended destination,
- regarding the abrupt deterioration of the weather conditions, typical of mountainous regions, when the visibility decreased within a few minutes practically to zero, the performance of the flight was unfeasible,

- the gust wind and the mechanical turbulence negatively affected the piloting of a light helicopter.

3.2 Causes

The accident was caused by performing the take-off and subsequent continuation in the flight in weather conditions not complying with the stipulated minima for the VFR flight performance in which it was not feasible to pilot the helicopter safely.

4. Safety recommendations

Continuous data transfer between an aircraft and the Flight Track system provides the user with an online access to monitoring of the location of the given aircraft via an account on the web site Ftrack.eu. In accident situations, it can be a source of data in search and rescue operations for the aircraft or its crew in conditions where all the other on-board devices failed, and thus be an asset in saving lives.

4.1 Safety recommendation CZ-2016-001:

The AAII recommends to the CAA in regards to EASA RMT.0271 & 0272 to conduct a study in order to verify the benefits and specifications of conditions of the use of on-line recording devices based on the current information and communication technology and of the software enabling downloads of the recordings of locations of aircraft used for sporting and recreational purposes.

5. Appendices

5.1 Event flight animation

The animation of the event flight was processed based on the data gained from the analysis of the data from the GPS device and the webcam footage.