State Commission on Aircraft Accidents Investigation

FINAL REPORT

2023-0039

OCCURRENCE NUMBER

ACCIDENT

LOC-G: Loss of control – on the ground

The sole objective of the investigation and the final report is the prevention of future aviation accidents and incidents.

The Commission does not apportion blame or liability. The investigation is independent and separate from any judicial and administrative proceedings.

Any use of the report for any purpose other than the prevention of aviation accidents and incidents may lead to wrong conclusions and interpretations.

GSA Aviation Sp. z o. o.

Robinson Helicopter Company R44 II, OK-LUK

Warszawa Babice (EPBC) 6 July 2023

The Final Report has been issued by the State Commission on Aircraft Accidents Investigation on the basis of information known at the time of its publication.

This Report presents the circumstances of the aviation occurrence concerned, as well as its causes, contributing factors and safety recommendations.

The report was drawn up in Polish.

Warsaw, Click here to select the date of the publication

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INTRODUCTION

LEGAL BASES

The State Commission on Aircraft Accidents Investigation is the safety investigation authority referred to in Article 4(1) of Regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (Official Journal of the European Union L 295, p. 35).

The Commission conducts investigations based on the provisions of the Act of 3 July 2002 – Aviation Law (Journal of Laws 2023, item 2110, as amended) and European Union law in the field of civil aviation accidents and incidents and taking into account the standards and recommended practices contained in Annex 13 to the Convention on International Civil Aviation, drawn up in Chicago on 7 December 1944 (Journal of Laws of 1959, item 212, as amended).

BASIC INFORMATION ABOUT THE OCCURRENCE

Operator (user), flight number or type – GSA Aviation Sp. z o. o., Training flight.

Manufacturer, type, model and registration mark of the aircraft – Robinson Helicopter Company R44 II, OK-LUK.

Place and date of occurrence – Warszawa Babice (EPBC) 6 July 2023

OCCURRENCE REPORT

PKBWL was notified of the occurrence under the mandatory occurrence reporting system on 7 July 2023.

The occurrence was assigned the registration number – 2023-0039.

Based on initial information, the occurrence was classified as an accident.

In the course of the investigation, the occurrence class was not changed.

NOTIFICATION OF THE OCCURRENCE

PKBWL notified the following bodies of the occurrence:

- state of registry – Czech Republic (UZPLN);
- state of the operator – Poland;
- state of design – the United States of America (NTSB);
- state of manufacture – the United States of America (NTSB);
- EASA;
- Civil Aviation Authority.

ORGANISATION OF THE INVESTIGATION

Until 26 January 2024, the investigation was conducted by the aircraft operator under the supervision of PKBWL.

On 26 January 2024, the Chairman of PKBWL decided that the Commission would take over the investigation.

Investigator-in-Charge (IIC) – Mieczysław Wyszogrodzki.

Commission Member – Paweł Jajkowski.

Specialist groups – no specialist groups have been appointed.

Accredited Representatives (and their advisers) – NTSB appointed ACCREP: Dr David Bowling.

RECOMMENDATIONS

No recommendations were formulated.

TIME

The times in the report are given in UTC, on the day of the incident UTC=LMT-2.

If a date is given in digital format in the report, individual digits stand for DD.MM.YYYY, where DD stands for day, MM for month and YYYY for year.

DRAWINGS AND TABLES

Unless otherwise stated in the report – source: PKBWL.

SUMMARY

On 6 July 2023, training flights for the PPL(H) licence were carried out at the Warsaw-Babice aerodrome in an R44 II helicopter with the registration mark OK-LUK. The training was provided by DTO GSA Aviation Sp. z o.o. At around 15:00, a student-pilot and an instructor-pilot, after arriving at the aerodrome and preparing the helicopter for the flight, proceeded to launching it.

After launching, during the take-off attempt at around 15:17, the helicopter began to rotate to the left relative to the vertical axis. A 360° rotation of the helicopter resulted in a ‘cradle-like’ movement. Being in contact with the landing area all the time, the helicopter alternately hit it with the front and back of the skids. The instructor-pilot stopped the rotation of the helicopter and then switched off the engine. The crew suffered no injuries.

The helicopter was severely damaged.

Probable causes of the occurrence:

1. Inadequate co-ordination of the student-pilot actions during the take-off, involving inappropriate correlation of the speed of movement of the collective pitch lever relative to foot controls;

2. Late reaction of the instructor-pilot to the mistake made by the student-pilot.

SYMBOLS AND ABBREVIATIONS

SYMBOLS

' Minute

” Second

º Degree e.g. ºC (temperature) and 1º (angle)

ABBREVIATIONS

A

ACCREP Accredited representative

ABV Above

AC Altocumulus

AFT Aft

AMM	Aircraft Maintenance Manual
AMSL	Above Mean Sea Level
AMO	Aircraft Maintenance Organisation
ATO	Approved Training Organisation
ARC	Airworthiness Review Certificate
AS	Altostratus

B

BKN 5 – 7/8 Broken

C

°C	Degrees Celsius
CAMO	Continuing Airworthiness Management Organisation
CAO	Combined Airworthiness Organisation
CAE	Combined Airworthiness Exposition
CB	Cumulonimbus
CG	Centre of Gravity
CofA	Certificate of Airworthiness
CofR	Certificate of Registration
CPL(H)	Commercial Pilot Licence (Helicopters)
CRS	Certificate Release to Service
CVR	Cockpit Voice Recorder

D

DTO	Declared Training Organisation

E

E	East / Eastern longitude
EASA	European Aviation Safety Agency
ExCofA	Export Certificate of Airworthiness

F

FAA	Federal Aviation Administration

FDR	Flight Data Recorder
FEAC	First European Aviation Company
FI	Flight Instructor
FH	Flight Hours
ft	foot/feet
FWD	Forward

H

h	Hour(s)
hPa	Hectopascal

I

ICAO	International Civil Aviation Organisation
IIC	Investigator-in-Charge

K

kg	kilogram
km	kilometre
kt	knot

L

LMT	Local Mean Time
LH	Left Hand

M

min	Minute(s)
MTh	Motor hours
MTOM	Maximum Take-off Mass

N

N	North / Northern latitude
NTSB	National Transportation Safety Board

P

PKBWL	State Commission on Aircraft Accident Investigation

POH	Pilot Operating Handbook
PPL(H)	Private Pilot License (Helicopters)
psi	pound per square inch
P/N	Part Number

Q

QNH	The pressure set on the subscale of the altimeter so that the instrument indicates its height above sea level. The altimeter will read runway elevation when the aircraft is on the runway

R

RH	Right Hand
RHC	Robinson Helicopter Company
RTR	Robinson Technical Publication
RWY	Runway

S

SCT 3-4/8	Scattered
SI	Service Information
SL	Service Letter
S / N	Serial Number

T

TBO	Time Between Overhaul
TSN	Time Since New
TSO	Time Since Overhaul
TR	Type Rating
TT	Total Time

U

ÚCL	Czech Aviation Authority (Czech: Úřadu pro civilní letectví)
UTC	Coordinated Universal Time
ÚZPLN	Institute for Aircraft Accident Investigation (Czech: Ústav Pro Odborné Zjišťování Příčin Leteckých Nehod)

V

VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

1. FACTUAL INFORMATION

1.1 Flight history

On 6 July 2023, a training course for the PPL(H) licence was held at the Warsaw-Babice aerodrome (EPBC) in a Robinson R44 II helicopter with the registration mark OK-LUK. The training was conducted by DTO GSA Aviaton Sp. z o.o. The plan was to carry out a spot hovering practice in the designated area of EPBC and then transfer to Chrcynno landing field (EPNC), where an emergency response training was to take place.

Based on the CCTV footage, it was established that the helicopter occupied a position on the north side of the aerodrome on the helipad in front of hangar 11A (Figure 1). At around 15:00, the student-pilot, under the supervision of the instructor-pilot, proceeded with the pre-flight inspection. After the inspection, the crew took their seats in the cabin, the instructor-pilot taking the left seat, the student-pilot – the right. After completing the activities from the checklist at around 15:17, the crew started the engine and tested it – no malfunctions were noticed.

After obtaining the parameters for take-off, the student-pilot established communication on the frequency of 122.305 MHz ‘Babice Radio’, reporting his intention to take off and transfer the helicopter to the designated area of the aerodrome intended for spot hovering.

After establishing communication and receiving movement information, the student-pilot started the take-off procedure.

During the take-off attempt, the helicopter initially rotated to the right by approximately 30° with simultaneous lateral displacement, without losing contact with the helipad. It then leaned to the starboard side pulling the left skid off the ground after which it rapidly began to rotate to the left around the vertical axis making more than two 360-degree rotations.

The rotation was accompanied by a dynamic change in the helicopter’s tilt (front to back) and multiple contacts of the skids with the asphalt surface of the helipad. During the second rotation, the helicopter hit the ground with the tail boom three times. After the third hit, the rotation around the vertical axis of the helicopter was stopped.

According to the instructor-pilot’s statement, as soon as the helicopter made its first left turn, the instructor-pilot took over the controls. After more than two rotations relative to the vertical axis, the rotation was stopped, the helicopter remained on the asphalt apron of the helipad.

The instructor-pilot shut off the engine with the shutoff valve control and then switched off the electrical supply.

During the final phase of the main rotor speed reduction, the crew exited the helicopter on their own, without suffering any injuries.

The helicopter was transported by the DTO employees from the place of the accident to the apron in front of hangar 11.

The occurrence happened during the day under VMC conditions.

On 7 July 2023, at approximately 6:30 a.m., a third person informed PKBWL that he had a CCTV recording of an aviation occurrence involving a Robinson R44 helicopter.

On 7 July 2023, a PKBWL representative arrived at the Warsaw-Babice aerodrome, where he received the CCTV footage. After reviewing the CCTV recording and determining the owner of the helicopter, a member of PKBWL and a representative of the operator went to the helicopter's staging area (the apron in front of hangar 11). The damaged helicopter was then parked in hangar 11, where it was inspected. The helicopter was secured for further investigation.

During the inspection, which was attended by a Board Member of the operator's company (instructor-pilot), it was ruled out that the cause of the occurrence could have been "*a malfunction of the tail rotor blade angle control system".*

The results of the inspection are presented in section 1.16.2.

PKBWL classified the occurrence as an accident and decided to investigated it by the user under the supervision of PKBWL.

A few days after the occurrence, another Board Member of the operator's company / another representative of the operator (instructor-pilot) during a telephone conversation with the Investigator-in-Charge stated that he had had a similar incident "*some time ago*" during take-off. He suggested that the cause may have been "*a malfunctioning hydraulic amplifier responsible for the helicopter tilt*". In that situation, there was no rotation of the helicopter, only a single front-to-back tilt. The pilot managed to take off safely; however, he did not record the occurrence in the Technical Logbook or any other document. The pilot assumed that a gust of wind may have been the cause of the said occurrence.

The operator stated that during the investigation of the occurrence (after the helicopter had been re-deployed to AMO's premises) tests were performed on the control system with an external hydraulic pump connected in accordance with the procedure in the AMM. As advised by the operator, a hydraulic system check was carried out by the pilots, who found that the cyclic stick moved with noticeable resistance in the tilt control channel.

On the basis of the aforementioned investigation, the operator prepared an "*Aircraft Occurrence Investigation Report*", which was sent to PKBWL on 28 November 2023.

The report included the following indication: "*the probable cause of the occurrence was a malfunction of the hydraulic cylinder in the longitudinal axis".*

PKBWL did not agree with the theses in the Operator's Report.

Therefore, on 26 January 2024, Chairman of PKBWL decided to take over the investigation.

PKBWL ordered the dismantling and transfer of the three hydraulic amplifiers to PKBWL.

PKBWL decided to have them tested by the Manufacturer under the supervision of NTSB.

The results of the test of hydraulic amplifiers are presented in section 1.16.3.

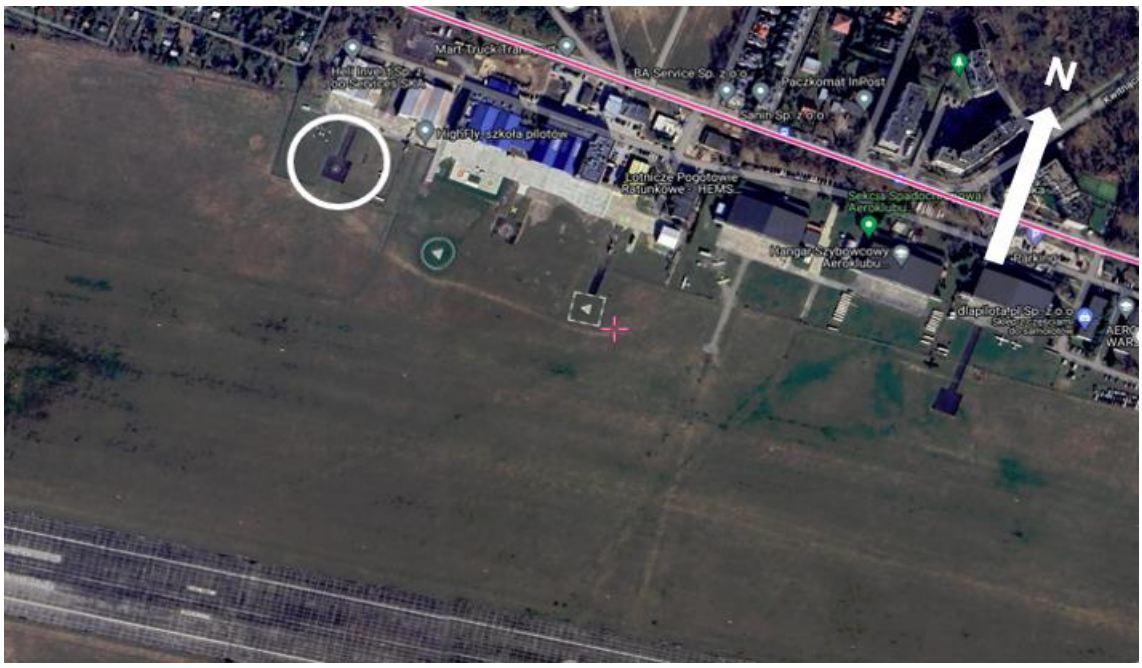

Figure1. Place of the occurrence: Warsaw-Babice aerodrome (EPBC), 52°16'22" N 20°54'22" E (marked with a white circle), elevation 348 ft. [source Google Maps].

Figure 2. The helicopter involved in the occurrence [source: Facebook].

1.2 Injuries to persons

Table 1. General – summary of the number of injuries

Injuries	Crew	Passengers	Total on board the aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	2	-	2	-
TOTAL	2	-	2	-

The crew suffered no injuries.

1.3 Damage to the aircraft

The helicopter was seriously damaged.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Pilot-in-command

Instructor-pilot (FI): male, aged 43.

Licence: CPL(H)

Competences included in the above licence:

- TR R44: valid until 30 June 2024;
- ICAO level 5: valid until 17 October 2027;
- FI (with restrictions): valid until 28 February 2026.

Total flight time: 475 h.

Type flight time:

- R44: 475 h, including 370 h in-command flight time;
- R44 112 h instructor flight time.

Flight time before the occurrence:

- in the last 24 hours: 1 h 20 min, R44;
- in the last seven days: 9 h, R44;
- in the last 90 days: 129 h, R44.

Aero-medical assessment: class I without restrictions, valid until 2 September 2023.

Rest in the last 48 h – the pilot was provided with 8 hours of rest per day at home.

Familiarity with the aerodrome – the pilot has been flying at the Warsaw Babice aerodrome since 2021 and is familiar with the flight procedures in force and the rules of communication.

Place in the cabin and activities performed – the instructor-pilot occupied the front left seat, acted as a practical training instructor.

1.5.2 Student-pilot

Student-pilot: male, aged 23.

Licence: student pilot in training for PPL(H)

Total flight time: 22 h R44.

Type flight time:

- R44 II: 22 h.

Flight time before the occurrence:

- in the last 24 hours: 2 h on R 44;
- in the last seven days: 2 h on R44;
- in the last 90 days: 22 h on R44.

Aero-medical assessment: class 2 without restrictions, valid until 19 June 2028.

Rest in the last 48 h – the pilot was provided with 8 hours of rest per day at home.

Familiarity with the aerodrome and experience of the student-pilot – he was prepared to fly at the EPBC aerodrome and the EPNC landing field.

Place in the cockpit and activities performed during the occurrence: the student-pilot occupied the right front seat, carried out radio correspondence, and acted as a student-pilot.

The student-pilot was at the practical training stage and flew according to the training programme for the PPL(H) helicopter pilot licence approved on 19.01.2020.

The student-pilot was scheduled to practice spot hovers according to Exercises 8A, (keeping the helicopter in hover) 8B (piloting in vertical flow) (performing air-taxi and hovering turns) and circle flights according to Exercise 8C (preparation for the first solo flight).

1.6 Aircraft information

The R44 II helicopter is manufactured by Robinson Helicopter Company based in Torrance (USA).

It is a four-seat, single-rotor helicopter of metal-composite construction in a classic configuration with a two-blade carrier rotor and tail rotor. It is fitted with a fixed landing gear with two skids, powered by a single piston engine in a Lycoming boxer configuration no. IO-540AE1A5, air-cooled.

1.6.1 Airworthiness and maintenance:

a) General information:

- factory designation (model) – R44 II;
- factory (serial) no. – 10259;
- year of manufacture – 2004;
- registration mark – OK-LUK;
- nationality: Czech Republic;
- owner – private;
- operator – GSA Aviation Sp. z o. o;
- CofR – date of entry 29 June 2023, date of document issue 1 July 2023, registration number 6008/3 issued by ÚCL of the Czech Republic;
- CofA – issued on 25 March 2015, by ÚCL of the Czech Republic, with restrictions – helicopter authorised only for VFR flights;
- Airworthiness Review Certificate (ARC) no. 6008/3 issued on 4 November 2020, valid until 13 November 2023.

b) Aircraft history:

- flight time from the beginning of operation – 1274.8 MTh;
- flight time after the 12-year inspection – 330.9 MTh – completed on 25 October 2016;
- flight time since the last 100 FH / annual inspection (airframe) – 28.9 MTh – completed on 10 November 2022;
- modifications – no modifications made;
- technical logbook – kept with numerous omissions, errors and deletions;
- airworthiness directives – all airworthiness directives were completed on time;
- service bulletins – all mandatory bulletins were completed on time.

c) Engine, main rotor blades and tail rotor:

- engine type: IO-540-AE1A5, S/N: L-29109-48A, US manufacturer Lycoming Engines operation time:

- 1274.8 MTh since the start of operation, since the last overhaul – none (engine operated after reaching 12 years without the overhaul), after the last periodic inspection 100 FH 28.9 MTh;

– main rotor blades, operating time:

- 607.8 MTh since the start of operation, 28.9 MTh after the last periodic inspection;

– tail rotor blades, operating time:

- since the start of operation 331.8 FH, after the last periodic inspection 28.9 MTh.

d) Fuel:

– recommended (according to POH) – AVGAS 100, 100LL, 100VLL and B95/130;

– used in flight – AVGAS 100 LL;

– amount on board (according to the pilot-instructor's statement about 50% of the fuel tanks' capacity) - about 63.4 kg.

e) Equipment and units that failed during the flight:

– Not applicable.

f) Aircraft mass and balance

- MTOM – 1134 kg;
- Student-pilot weight: 80 kg, pilot-instructor weight 96 kg;
- MTOM was not exceeded;
- CG to start – within acceptable limits.

1.6.2 Aircraft systems or components

1.6.2.1 Control system

The helicopter is equipped with a conventional single control system, in which the forces exerted on the flight controls are transmitted via push rods and angle levers. The control system ends with dual flight controls (cyclic and collective controls). All bearings in the control system are maintenance-free.

The helicopter control system is conventional. The cyclic stick is positioned in the centre (between the pilots) with a transverse control unit ended with two handles allowing control from the right or left seat.

The collective pitch control is also conventional. Each pitch lever is fitted with an engine throttle opening control handle. The engine throttle opening control is correlated with the movements of the pitch lever by means of a mechanical connection.

Control signals from the collective pitch lever and the cyclic stick are summed through the aft support assembly located between the rear passenger seats.

The control disc is steered by means of three push rods divided into two sections, with hydraulic amplifiers between them. The push rods transmit control signals from the aft support assembly to the control disc.

1.6.2.2 Hydraulic system

Hydraulic boosting of the control system eliminates aerodynamic back forces and vibrations transmitted from the main rotor to the control system (cyclic and collective pitch control).

The hydraulic system consists of a gear pump driven mechanically from the main gearbox, three hydraulic amplifiers, a hydraulic tank and Teflon connection hoses with metal braiding.

The hydraulic system is filled with hydraulic fluid compliant with the MIL-H-5606 standard (Aeroshell Fluid 41 is the most commonly used), with an operating pressure in the system of 450 to 500 psi.

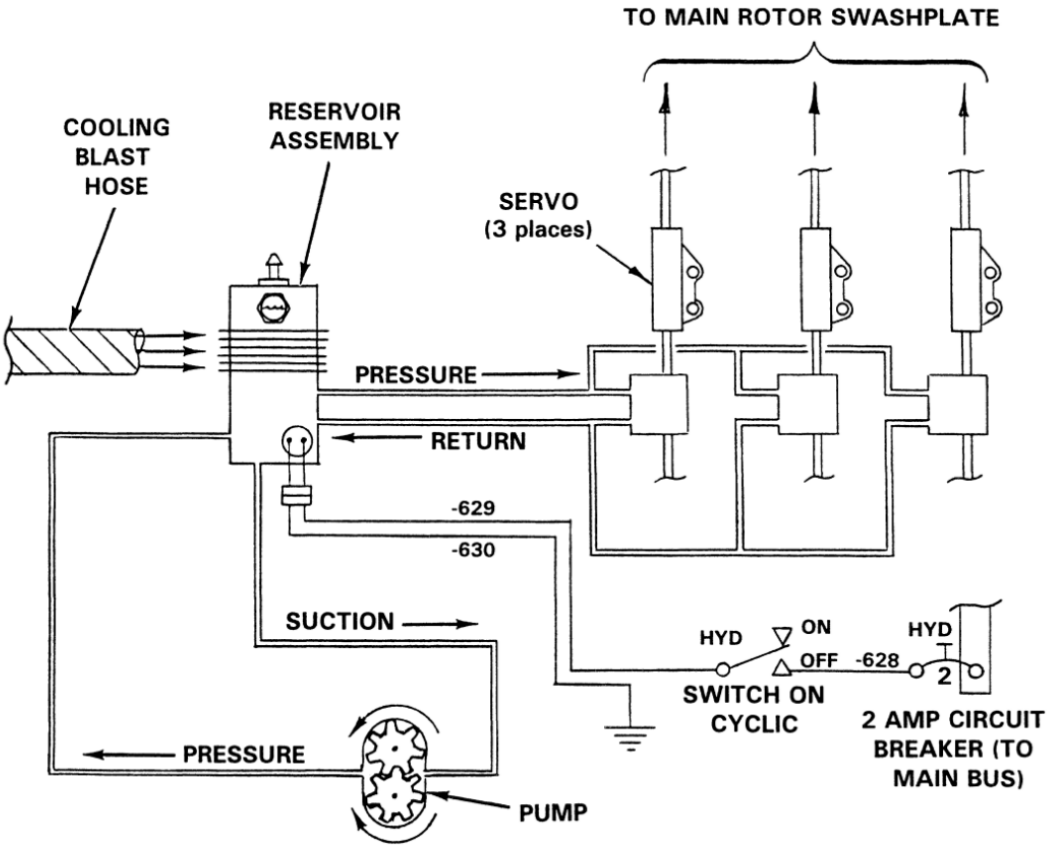

Figure 3. Schematic diagram of the hydraulic system of the Robinson R44 II helicopter [source: RTR 460 vol. I].

1.6.2.3 Hydraulic amplifiers:

The main function of the hydraulic amplifier is to provide an output displacement equal to the input displacement without transferring forces and vibrations from the rotor to the flight controls (in other words, reducing the force required from the pilot to control the helicopter). In-flight forces are transmitted to the hydraulic amplifier via the carrier rotor push rods (2 pieces), the control disc and the push rods between the control disc and the hydraulic amplifiers (3 pieces). The hydraulic amplifier counteracts these forces using hydraulic pressure (hydraulic power). The maximum force that can be generated by the hydraulic amplifier is constant and is a function of the pressure in the hydraulic system.

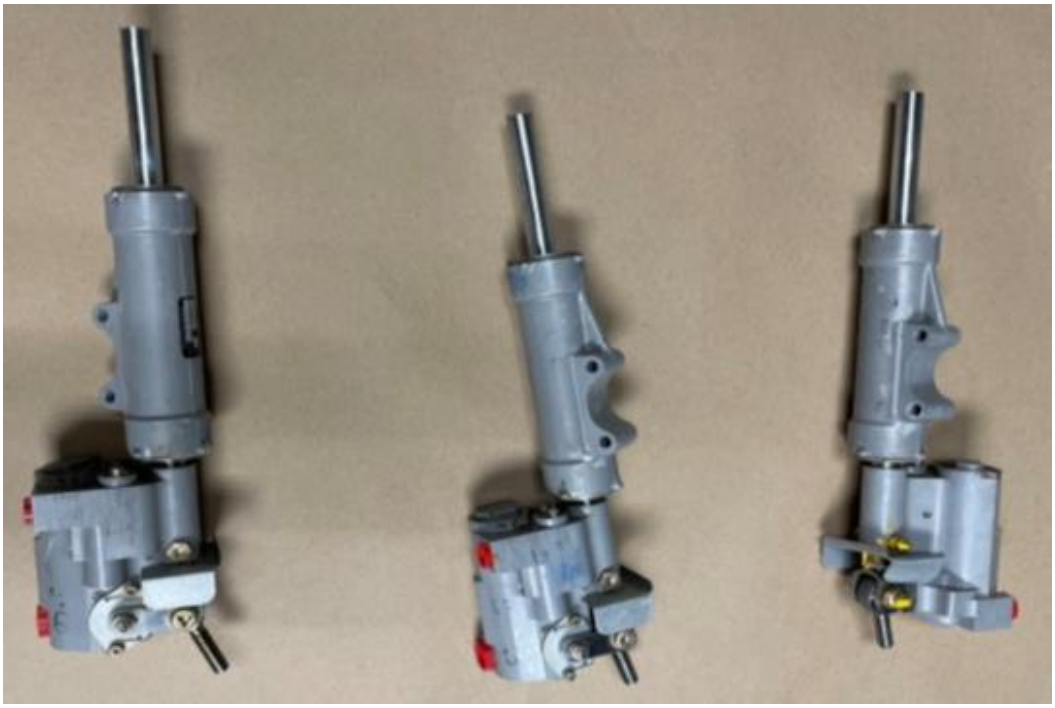

Figure 4. Hydraulic amplifiers removed from the helicopter [source: NTSB].

Continuing airworthiness records for hydraulic amplifiers (operational history)

Table 2 Summary of hydraulic amplifiers installed during the accident

No.	Location	P/N	S/N	Review
1	RH FW	D212-1	2942	F
2	LH FWD	D212-1	2943	F
3	AFT	D212-1	2944	F

As all hydraulic amplifiers have an identical operating history, it is described together below:

a) Hydraulic amplifiers built during the production of the helicopter on 7 January 2004 with 0:00 FH and the status as new. The installation certified by a person with authorisation PC#424WE. The time between overhaul (TBO) was set at 2200 FH without the calendar service life.

b) The last inspection including maintenance tasks on the hydraulic amplifiers was carried out on 10 November 2022 by AMO Dara-Air, certificate no. CZ.145.0078, with a total helicopter flight time of 1245.9 FH – no defects were found.

The serial numbers of the hydraulic amplifiers installed in the helicopter were consistent with the S/N recorded in the factory books and continuing airworthiness statuses.

1.6.2.4 Hydraulic pump:

Hydraulic pump continuing airworthiness records (operating history)

a) The installation certified by a person with authorisation PC#424WE. The time between overhaul (TBO) was set at 2200 FH without the calendar service life.

b) The last inspection including maintenance tasks on the hydraulic pump was carried out on 10 November 2022 by AMO Dara-Air, certificate no. CZ.145.0078, with a total helicopter flight time of 1245.9 FH – no defects were found.

1.6.2.5 Hydraulic tank:

Hydraulic tank continuing airworthiness records (operating history)

a) The last inspection including maintenance tasks on the hydraulic tank was carried out on 10 November 2022 by AMO Dara-Air, certificate no. CZ.145.0078, with a total helicopter flight time of 1245.9 FH – no defects were found;

b) The service life of the hydraulic tank was not exceeded during the occurrence. All required maintenance checks have been carried out.

1.6.2.6 Hydraulic hoses:

a) According to the type certificate holder, the hydraulic system hoses have no limited service life or overhaul intervals. The installed hoses met the requirements of the type certificate holder.

1.7 Meteorological information

Meteorological conditions according to the METAR report for EPWA on 6 July 2023 between 10:00 and 16:00 UTC were as follows.

- wind direction – 300º;
- wind speed – 10 to 15 kt;
- visibility above 10 km;
- cloudiness locally from SCT (3/8 to 4/8), BKN (5/8 to 7/8) AC, AS 9000 ABV 10000FT AMSL;
- ambient temperature, 25ºC;

- dew point, 15ºC;
- QNH pressure: 1021 hPa.

Meteorological conditions did not affect the occurrence.

1.8 Navigation aids

Not applicable.

1.9 Communications

The crew carried out standard radio correspondence with ‘Babice Radio’ in Polish. The correspondence in both directions was clear.

1.10 Airport information

The EPBC aerodrome is listed in the Register of Aerodromes and Airstrips. Aerodrome operator allows for operations to be carried out by the aircraft, in accordance with the procedure described in the Aerodrome Operations Manual (AOM). Permitted air traffic: VFR day and night.

1.11 Flight data recorders

The helicopter was not equipped with a flight data recorder (FDR), nor did it have a cabin voice recorder (CVR).

1.12 Information on the wreckage and the occurrence

1.12.1 Place of the occurrence

The occurrence took place on the helipad near hangar 11A at the EPBC aerodrome – Figure 1.

The occurrence was captured by a CCTV camera installed at hangar 11.

A time-lapse record of the event is shown in Figures 5–11.

Figure 5. Helicopter during start up – starting position [source: CCTV footage].

Figure 6. The initial attempt to take off, linear movement of approximately 1 m to the right with a simultaneous rotation of approximately 30º to the left with a forward tilt [source: CCTV footage].

Figure 7. Leftward rotation of approximately 180º with simultaneous forward tilt [source: CCTV recording].

Figure 8. Leftward rotation of approximately 315º with simultaneous backward tilt [source: CCTV footage].

Figure 9. After another rotation of approximately 90º with the tail skid hitting the helipad for the first time (marked with a red circle) [source: CCTV footage].

Figure 10. After another rotation of approximately 270º with the tail skid hitting the helipad for the second time (marked with a red circle) [source: CCTV footage].

Figure 11. Just before the leftward rotation stops, hitting the helipad for the third time, destroying the tail rotor (marked with a red circle) [source: CCTV footage].

During the take-off attempt, the helicopter made a rapid 360º left turn at a speed of approximately 75°/s, in approximately 4.5 s.

1.12.2 Damage to the aircraft

During the occurrence, the helicopter was in constant contact with the surface of the helipad, where it remained after the engine was shut down. All wreckage of the helicopter was found on occurence site (on the day of the inspection of the wreck by the member of PKBWL). They covered the area of approximately 50 m². No part of the helicopter was found to have separated from it prior to the occurrence. The first tail rotor blade broke off near the hub as a result of hitting the asphalt surface of the helipad, while the second blade bent and delaminated at approximately 25% of its length and was completely deformed.

During the occurrence, the helicopter hit alternately with the front and rear parts of the skids, which resulted in permanent deformation (destruction) of the entire helicopter landing gear and landing gear attachment points.

As a result of the occurrence, the following damage to the helicopter was found:

- destruction of the tail rotor;
- damage to the angle gearbox;
- destruction of the tail skid;
- destruction of the lower vertical stabiliser and its attachment;
- damage to the horizontal stabiliser;

- damage to the attachment of the tail boom to the fuselage top truss;
- damage to skid landing gear attachment nodes;
- destruction of the skid landing gear;
- damage to the tail boom (broken angle gearbox attachment and stabiliser mounts);
- damage to the seat mountings in the cockpit.

Figure 12. Destroyed tail rotor, damaged angle gearbox attachment to the tail boom.

Figure 13. Broken tail skid, damaged lower vertical stabiliser and broken tail rotor bracket.

Figure 14. Broken angle gearbox including attachment to the tail boom assembly, damaged skid landing gear (red circle, left skid).

1.13 Medical and pathological information

No evidence was found that any illness, incapacity or physiological factors affected crew activities.

The crew submitted to a breathalyser test at the nearest Police Station on the day of the occurrence. The result of the test was 0.0 [mg/l] of alcohol in the exhaled air.

1.14 Fire

None.

1.15 Survival factors

The crew occupied two front seats in the helicopter cabin. Each helicopter seat has been factory-fitted with three-point seat belts.

The crew were wearing seatbelts. During the aviation occurrence, with accelerations and inertial forces acting, seatbelts ensured that the crew left without any injuries.

The brackets securing the cabin seats to the floor were partially deformed.

1.16 Tests and studies

1.16.1. Inspection of the helicopter

The inspection revealed the damage indicated in section 1.12.2.

1.16.2. Checking the continuity of the control system kinematics

During the inspection of the helicopter (the day after the occurrence) carried out by the member of PKBWL in the presence of the operator's representative, the kinematics of the helicopter control system were checked, with particular reference to the controls of the angle of the tail rotor blades. The kinematics of the main rotor blade angle control system were also checked. The results of the inspection are presented in section 2.4.5.

1.16.3 Hydraulic amplifier check

Given the suspected malfunction of the hydraulic amplifiers, PKBWL requested the assistance of NTSB to determine the correctness of their operation. Once the date was agreed with NTSB, the PKBWL Commission sent the three amplifiers to NTSB for examination.

The test was carried out in the presence of an NTSB representative and an RHC representative responsible for investigating aviation occurrences involving Robinson helicopters.

The test included a visual inspection of the amplifiers and bench testing.

Each amplifier was subjected to bench tests in accordance with the SP/component manufacturer's procedure, which included:

- checking the correct speed of the piston movement;
- pressure test and measurement of hydraulic fluid leaks;
- checking the friction of the amplifier cylinder;
- checking the correct operation of the input valve;
- pilot input force test.

Testing of the three hydraulic amplifiers showed full compliance with the manufacturer's parameters. No malfunctions were identified.

1.17 Information on organisations and management

The flights were organised by GSA Aviation Sp. z o.o., which held DTO certificate No. PL.DTO–31. The certificate was valid at the time of the occurrence.

1.18 Supplementary information

1.18.1. Publication of the final report

Prior to the publication of the final report, PKBWL consulted its draft version, asking the parties involved, as well as EASA, for comments:

The crew of the aircraft involved in the accident – made comments, which were not accepted. (concerning the circumstances and causes of the accident).

Aircraft operator – made comments, some of which were accepted. (concerning the circumstances and causes of the accident).

Comprehensive Airworthiness Organisation (CAO) – which manages the continuing airworthiness and operates the aircraft – made no comments.

Logistics Service Centre (Aerodrome operator) – made a comment, which was accepted.

NTSB (representing the state of the aircraft manufacturer and designer) – did not make or made comments.

ÚZPLN (State of registration – Czech Republic) – did not make or made comments.

1.19 Useful or effective investigation methods

Standard investigation methods were used.

2. ANALYSIS

2.1 Helicopter flight analysis

After analysing the CCTV footage, the Commission presented a probable course of events.

During the take-off attempt, the student-pilot increased the collective pitch while pressing the left foot control pedal. This relieved the helicopter of weight on the

skids (a condition where the thrust of the main rotor virtually balances the weight of the helicopter). The helicopter initially rotated to the right by approximately 30° with simultaneous lateral displacement to the right, without losing contact with the helipad. It then leaned to the starboard side pulling the left skid off the ground after which it rapidly began to rotate to the left around the vertical axis.

Turning abruptly to the left, the helicopter tilted alternately forward and backward, with a simultaneous cessation of lateral movement. It is likely that the student-pilot reacted by swinging the cyclic stick too much to the left and forward and pushing the left pedal which caused the above reaction. Belated attempts to respond to fluctuations in the transverse axis resulted in their aggravation. It can be assumed that the student-pilot, being in a new and stressful situation, held the left foot control pedal pushed firmly. Rotations of the helicopter stopped when the tail rotor hit the surface of the helipad.

According to the instructor-pilot's statement, he took over the controls after the helicopter's first left turn. The analysis of the video does not make it possible to determine which crew member was performing which activities.

2.2 Aircraft

2.2.1 Aircraft maintenance

The aircraft was operated in accordance with applicable regulations and approved procedures.

2.2.2 Aircraft operation

No malfunction or failure of the aircraft was identified that could have contributed to the accident.

2.2.3 Mass and balance

The aircraft's mass and centre of gravity were within the regulatory limits.

2.2.4 Aircraft systems

The Commission examined the hydraulic system for possible damage:

a) Hydraulic hose rupture

b) Hydraulic pump seizure/blockage

c) Hydraulic tank filter clogging

d) Filter clogging of one of the hydraulic amplifiers

In the case of the malfunctions listed in subsections a) – d), the hydraulic system will become inoperative and **steering the helicopter will be difficult (high forces on the controls) but fully possible.**

e) Blockage of the relief valve in the hydraulic tank

The valve blockage will result in increased pressure in the hydraulic system. This fault will not affect the operation of the system or damage the hydraulic hoses (the maximum value of the pressure hoses is 2 times their nominal flow).

f) Malfunction of the return shut-off valve

A malfunction of the return shut-off valve in the closed position will result in a lack of circulation in the hydraulic system, i.e. excess pressure will be sent back to the hydraulic tank via the relief valve before entering the hydraulic amplifier system. **This will cause the hydraulic system to malfunction, but steering the aircraft will be possible (with increased forces).**

g) Blocking of the solenoid shut-off valve in the closed position.

If the solenoid valve is blocked in the closed position, there will be no flow through the hydraulic system from the tank to the amplifiers. The system will not work, **but steering the helicopter is possible.** When training pilots for licensing, it is a normal procedure to shut down the hydraulic system and thus train pilots in the event of a malfunction.

h) Blocking of the solenoid shut-off valve in the open position.

If the solenoid valve is blocked in the open position, it will not result in any malfunction of the hydraulic system perceptible to the pilot or affecting the flight. The only consequence of such failure will be the inability to train and practice in an emergency situation, i.e. hydraulic failure.

i) Airlock in the hydraulic system

An airlock in the hydraulic system can result in increasing the force required to steer the helicopter. However, due to the design of the installation, the system will vent itself automatically as a result of movements of the flight controls.

j) Incorrect amount of hydraulic fluid

Excessive amounts of hydraulic fluid will result in increased pressure in the system. Such a malfunction can result in a leakage of hydraulic fluid through the vent plug and damage to seals, pump, tank, etc.

k) Loss of voltage in the electrical system associated with the hydraulic system.

Blocking of the hydraulic amplifier will result in a complete blockage of the helicopter control system. Both the pitch lever and the cyclic stick will be locked for movement in every possible direction.

l) Excessive fluid leakage from the hydraulic amplifier

One possible result would be the erosion of rubber components or other helicopter components flooded with the fluid (hydraulic fluid is highly corrosive).

m) Hydraulic amplifier seizure/blockage

Blocking of the hydraulic amplifier will result in a complete blockage of the helicopter control system. Both the pitch lever and the cyclic stick will be locked for movement in every possible direction.

In the case of the malfunctions listed in subsections e) – l), **steering the helicopter will be difficult (high forces on the control units) but fully possible.** However, the expertise commissioned by PKBWL did not reveal any of the above faults.
Steering the helicopter would be impossible in the event of a seizure or blockage of the hydraulic amplifier (subsection m). Tests of the amplifiers carried out by NTSB showed that no such failure had occurred.

2.3 Continuing airworthiness management

At the time of the occurrence, the helicopter complied with the Part-ML regulations concerning continuing airworthiness management for the type of operations being performed.

2.4 Analysis of hydraulic system continuing airworthiness records

2.4.1. Hydraulic amplifiers

During the investigation of the occurrence, the operating and maintenance records of the hydraulic system components on the helicopter were analysed. **During the aviation occurrence, the hydraulic system was in working order.**

2.4.2 Hydraulic tank

The service life of the hydraulic tank was not exceeded during the occurrence. All required maintenance checks have been carried out.

2.4.3. Hydraulic pump

The service life of the hydraulic pump was not exceeded during the occurrence. All required checks according to maintenance data have been carried out.

2.4.4. Hydraulic hoses

The installed hoses met the requirements of the type certificate holder.

2.4.5. Control system components

During the inspection of the helicopter (the day after the occurrence) carried out by the member of PKBWL in the presence of the operator's representative, the kinematics of the helicopter control system were checked, with particular reference to the controls of the angle of the tail rotor blades. The kinematics of the main rotor blade angle control system were also checked. The check was carried out without introducing external pressure into the hydraulic system.

The tail rotor drive connection was also checked – the connection was retained (despite the damage from the tail rotor hitting the ground).

The check showed that kinematic continuities were maintained.

2.4.6. Testing of the condition of hydraulic amplifiers

Based on the Expert Report issued by NTSB, testing of the three hydraulic amplifiers showed full compliance with the manufacturer's parameters. **No malfunctions were identified.**

The hydraulic system installed met the requirements of the type certificate holder.

2.4.7. Hydraulic system performance analysis

The investigation and analysis clearly showed that the hydraulic system was in working order at the time of the occurrence.

3 CONCLUSIONS

3.1 Findings

3.1.1 The instructor-pilot had valid documents and a licence to act as a practical training instructor.

3.1.2 The student-pilot met the necessary conditions to participate in the practical training for the PPL(H).

3.1.3 The crew carried out radio communications on the 'Babice Radio' frequency, the communication was clear in both directions.

3.1.4 The aircraft was certified, equipped and operated in accordance with applicable regulations and approved procedures.

3.1.5 The aircraft had a valid airworthiness certificate and was operated in accordance with regulations.

3.1.6 When the decision to fly was taken, the aircraft was airworthy.

3.1.7 No malfunction or failure of the aircraft was identified that could have contributed to the aviation occurrence.

3.1.8 The aircraft was structurally intact prior to the occurrence.

3.1.9 All structural surfaces of the helicopter were recovered, and all of the damage to the aircraft can be attributed to the impact forces.

3.1.10 Continuing airworthiness records were kept carelessly and contained numerous errors.

3.1.11 The aircraft mass and centre of gravity were within the regulatory limits, in accordance with the Operations Manual.

3.1.12 The fuel that remained in the aircraft tanks was of the recommended class and was not contaminated.

3.1.13 Meteorological conditions did not affect the aviation occurrence.

3.1.14 The flight crew's behaviour was not found to be affected by inability to perform duties or other physiological factors.

3.1.15 The breath alcohol tests of the crew were negative.

3.1.16 The operator failed to notify the Aviation Services Centre-aerodrome operator of Warsaw Babice Aerodrome (EPBC) of the aviation occurrence.

3.2 Probable causes of the occurrence

1. Inadequate co-ordination of the student-pilot actions during the take-off, involving inappropriate correlation of the speed of movement of the collective pitch lever relative to foot controls.
2. Late reaction of the instructor-pilot to the mistake made by the student-pilot.

4 SAFETY RECOMMENDATIONS

PKBWL did not present any safety recommendations.

END