PKBWL

State Commission on Aircraft Accidents Investigation

FINAL REPORT

2024-0057

OCCURRENCE NUMBER

ACCIDENT

CFIT: Controlled flight into terrain

Salt Aviation Sp. z o. o.

Robinson Helicopter Company R44 Cadet SP-NHM

Toruń Włościański 1 sierpnia 2024 r.

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.

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

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INTRODUCTION

LEGAL BASES

The State Commission for the Investigation of Aviation Accidents is the body responsible for investigating aviation incidents referred to in Article 4(1) of Regulation (EU) No 996/2010 of the European Parliament and of the Council of October 20, 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (OJ EU L No. 295, p. 35).

The Commission conducts investigations on the basis of the provisions of the Act of July 3, 2002, Aviation Law (Journal of Laws of 2023, item 2110, as amended) and European Union law on accidents and incidents in civil aviation, 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 December 7, 1944 (Journal of Laws of 1959, item 212, as amended).

BASIC INFORMATION ABOUT THE OCCURRENCE

Operator (user), flight number or type – Salt Aviation Sp. z o. o., Private flight.

Manufacturer, type, model and registration mark of the aircraft – Robinson Helicopter Company R44 Cadet SP-NHM.

Place and date of occurrence – Toruń Włościański 1 sierpnia 2024 r.

OCCURRENCE REPORT

The PKBWL was notified of the occurrence by the pilot under the mandatory occurrence reporting system on 1 August 2024.

The occurrence was assigned the registration number – 2024-0057.

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

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

NOTIFICATION OF THE OCCURRENCE

PKBWL notified the following bodies of the occurrence:

- state of registration - Poland (ULC);
- state of the operator – Poland;
- state of design – the United States of America (NTSB);
- state of manufacture – United States of America (RHC, Lycoming);
- EASA

ORGANISATION OF THE INVESTIGATION

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

Member of the Commission - Krzysztof Błasiak.

Member of the Commission - Dominik Głowacki

Member of the Commission – Paweł Ruchała

Member of the Commission – Paweł Jajkowski.

Specialist groups – no specialist groups have been appointed.

Authorized Representatives (and their advisors) (ACCREP) – Joshi Deepak (NTSB).

RECOMMENDATIONS

No recommendations were formulated.

TIME

The times in the report are given in LMT, on the day of the event LMT=UTC+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 August 1, 2024, the pilot planned a non-commercial flight from Warsaw-Modlin (EPMO) to Niedźwiedzi Róg with a Robinson R44 Cadet helicopter, registration number SP-NHM. After arriving at the airport at around 2:00 p.m., the pilot checked the weather forecast and current meteorological conditions, as well as the occupancy of the zones.

He performed a PFI and then the helicopter was moved out of the hangar. The pilot took his seat in the cockpit and obtained clearance for take-off. He started the engine and tested it. He took off from FATO 26 at 3:43 p.m. After take-off, he climbed to an altitude of 1,500 ft AMSL and maintained course to the YANKEE point.

During the climb, the pilot noticed that the helicopter was climbing at a lower vertical speed than normal, and found that the charge pressure gauge pointer fluctuated within +/- 1 inHg (all other parameters were normal). Once above 1,000 ft AMSL, he continued his ascent and noticed an increase in the fluctuation of the charge pressure readings to an amplitude of +/- 2.5 inHg with a simultaneous noticeable decrease in power. The pilot corrected the power shortfall of the power unit with the collective pitch lever. With it set near its maximum position he continued to lose altitude while maintaining its forward speed.

At an altitude of approximately 900 ft AMSL, the pilot decided to make an emergency landing and selected a landing site. Shortly before touchdown, the pilot performed the *'FLARE'* manoeuvre and a run-in touchdown. The helicopter crashed into the ground. The pilot exited the helicopter by his own efforts. The pilot suffered minor injuries as a result of the accident. The helicopter was destroyed.

Causes of the occurrence:

1) Unjustified decision to perform an emergency landing (autorotation) instead of a precautionary landing (with the engine running).

2) Improperly executed emergency landing without engine power reduction.

SYMBOLS AND ABBREVIATIONS

SYMBOLS

' Minute

” Second

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

ABBREVIATIONS

A

ACCREP Accredited representative

AD Airworthiness Directive

AGL Above Ground Level

Alt Altitude

AMSL Above Mean Sea Level

ARCC Aeronautical Rescue Coordination Centre

AUP Airspace Use Plan

B

BHP Break Horse Power

C

°C Degrees Celsius

CAO Combined Airworthiness Organisation

CPL(H) Commercial Pilot Licence (Helicopters)

CTR Control Zone

E

E East / Eastern longitude

F

FAA Federal Aviation Administration

FATO Final Approach and take-off Area

FH Flight Hours

ft foot/feet

ft/min feet per minute

FTIR Fourier Transform Infrared Spectroscopy

G

GAMET General Aviation Meteorological Information

GS Ground speed

H

h Hour(s)

hPa Hectopascal

I

ICAO International Civil Aviation Organisation

in inch

inHg Inch of mercury

K

KIAS Knots-Indicated Air Speed

kg kilogram

Km kilometer

kt knots

L

l litres

L Left

lbs pounds

LMT Local Mean Time

LH Left Hand

M

MAP Manifold Pressure

METAR Meteorological Aerodrome Report

MTh Motor hours

MTOM Maximum take-off Mass

MGB Main Rotor Gearbox

mg/l milligram per litre

N

N North / Northern latitude

NTSB National Transportation Safety Board

O

OAT Outside Air Temperature

P

PKBWL State Commission on Aircraft Accident Investigation

POH Pilot Operating Handbook

PPL(H) Private Pilot License (Helicopters)

psi pound per square inch

PFI Preflight inspection

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

R Right

RH Right Hand

RHC Robinson Helicopter Company

RPM Revolutions per minute

RTR Robinson Technical Publication

S

SB Service Bulletins

S / N Serial Number

T

TAF Terminal Aerodrome Forecast

TCCA Transport Canada Civil Aviation

TBO Time Between Overhaul

TSN Time Since New

TR Type Rating

TT Total Time

TGB Tail Rotor Gearbox

TWR Tower

U

UTC Coordinated Universal Time

ULC Polish Civil Aviation Authority

US qt United States Quart

V

VFR Visual Flight Rules

V/S Vertical Speed

1. FACTUAL INFORMATION

1.1 Flight history

On 1 August 2024, the pilot planned a non-commercial flight (in accordance with PART-NCO) on the route Warsaw-Modlin (EPMO) - Niedźwiedzi Róg in a Robinson R44 Cadet helicopter, registration number SP-NHM. On the day of the incident, the pilot booked the helicopter with Salt Aviation Sp. z o.o., where he had previously received training for his PPL(H) licence.

Fig. 1. Robinson R44 Cadet helicopter involved in the accident [source: Lukasz Stawisz].

On his way to the airport, the pilot filed two required flight plans in accordance with the planned route. He had flown this route several times in this very helicopter. Upon arrival at EPMO airport at around 2:00 p.m., the pilot checked the GAMET weather forecast for the flight area, TAF and METAR for the departure airport and the nearby airport where the landing was to take place, i.e. Olsztyn-Mazury (EPSY), at the company's office. In addition, to ascertain the meteorological conditions, he checked the data on the Windy weather app. Flight preparation also included a zone occupancy check in accordance with the AUP (none of the zones through which the route passed were occupied). The pilot then proceeded to the hangar to prepare the helicopter for flight and perform PFI accordance with the POH. This was to be the first flight of the helicopter on that day. During the PFI he checked, among other things, the condition of the fuel (full tanks - 176 l) helicopter's external condition, the cockpit (he took three fuel samples from the helicopter), the oil level in the engine (about 8 US qt) and the oil level in the MGB and TGB - level was in line with the requirements. After completing the PFI, the pilot concluded that the condition of the helicopter was satisfactory (no irregularities were found). After completing the PFI, the helicopter was moved out of the hangar to parking space No. 51. The pilot took the right seat in the cockpit and then established communication with Modlin Delivery, obtaining take-off clearance (permission for a VFR flight in controlled airspace CTR EPMO, no higher than 1500 ft AMSL, and departure from FATO 26 via the INDIA and then YANKEE points). The pilot performed a 'pre-engine start' checklist and liaised with Modlin TWR for permission to start the engine. Once this was obtained and the engine was started, he tested it in accordance with the POH. During the engine test, he performed, among other things, a check of the spark generators - engine speed drop (turning off spark generators R, L in turn and then back to BOTH positions)[1], the clutch, the carburetor heater, and the low rotor speed warning system (audible and visual). The pilot found no abnormalities[2]. After obtaining the parameters for take-off and receiving clearance from Modlin TWR, he made an approach to FATO 26 via taxiways ALFA and WHISKY, and then requested clearance for departure, which he received (departure directly to point YANKEE). The take-off took place at 3:43 p.m. After take-off during the climb to 1,500 ft AMSL, he maintained course to the YANKEE point with a forward speed of 70 - 80 kts and a charge pressure of 21 inHg. During the climb, the pilot noticed that the helicopter was climbing at a lower vertical speed than normal (it had less power than normal) but concluded that this was due to the high air temperature.[3]. Furthermore, during the climb, the pointer of the charge pressure indicator fluctuated +/- 1 inHg[4] (other parameters were normal). At an altitude of approximately 1,000 ft AMSL, he turned on the carburetor heater (pulling the heater cable out about halfway). After exceeding 1,000 ft AMSL, he continued climbing to 1,200 ft AMSL. At this altitude, at a speed of approximately 70–80 kts, he noticed an increase in boost pressure fluctuations (the reading began to oscillate +/- 2.5 inHg) with a simultaneous noticeable drop in power. This was not accompanied by increased or other perceptible vibrations, unusual noises or the signalling of malfunctions in the cockpit. According to the statement, the pilot corrected the power shortfall of the power unit with the collective pitch lever by increasing the angle of the rotor blades and the throttle opening. With the collective pitch lever set near its maximum position (the pilot does not remember if the *'FULL THROTTLE*[5]' light came on) he continued to lose altitude while maintaining forward speed. At an altitude of approximately 900 ft AMSL (670 ft AGL), the pilot decided to make an emergency landing, selecting a landing site. The pilot intended to perform an autorotation descent. To do this, he

[1] The ignition switch was in the BOTH position after the accident.

[2] The only anomaly was a short high-frequency sound in the headphones when checking the plumbing system (opening the shut-off valve).

[3] The air temperature at the ground was 27°C according to METAR for EPMO at 3:30 p.m.

[4] According to the pilot's statement, such readings of the charge pressure indicator were typical for this helicopter.

[5] The "FULL THROTTLE" light indicates that maximum throttle opening is imminent.

lowered the collective pitch lever (without turning the throttle to the 'closed' position) while simultaneously moving the cyclic control toward himself. In this way, he transitioned to reduced power flight. Just before touchdown, the pilot performed the *'FLARE'* manoeuvre ,swung the cyclic control away from himself and then moved the collective pitch lever to the upper position. On touchdown, he landed the aircraft way with a run-up of about 10 metres. With the collective pitch lever in the upper position at all times and the throttle open, the helicopter collided with the left side of the fuselage with the ground and then rolled over onto its starboard side. The helicopter was destroyed.

The pilot got out of the helicopter on his own and notified the services, and upon their arrival was transported by Polish Medical Air Rescue helicopter to a hospital in Płońsk.

The pilot suffered minor injuries as a result of the accident.

Fig. 2. Flight path based on data from SkyDemon software plotted on Google Earth map, 52°31'31" N 020°43'26" E, elevation 314 ft.

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	1	-	1	-
None	-	-	-	-
TOTAL	1	-	1	-

1.3 Damage to the Aircraft

The helicopter was destroyed.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Pilot-in-command

Male, aged 32.

Licence: CPL(H)

Authorizations included in the above license:

- TR R44: valid until 31 July 2025;
- TR Cabri G2: valid until 31 July 2025;
- TR EC135/635: valid until 31 July 2025 (Incorrectly entered by the ULC in the license. The pilot should have a TR AS350/EC130 entered, for which he took the exam on 06.07.2024 with an expiry date of 31.07.2025);
- ICAO/level 4: valid until 25 August 2026;

Flight time on helicopters: 379 h.

Flight time on type:

- R44: 184 h, including 94 h in-command flight time;

Flight time before the occurrence:

- in the last 24 hours: 0 h;
- in the last 7 days: 5:23 h;
- in the last 90 days: 56 h incl: 17 h on R44, 2.5 h on R66, 8 h on Cabri G2, 29 h on AS 350.

Class I aeromedical certificate without restrictions, valid until 3 April 2025.

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 EPMO aerodrome since 2021, and is familiar with the flight procedures in force and the rules of communication.

Seat in the cockpit and duties performed – he sat in the front right seat and performed the duties of commander.

1.6 Aircraft information

The Robinson R44 Cadet is a four-seat, lightweight, single-engine helicopter of metal-composite construction in a classic layout. It is manufactured by Robinson Helicopter Company based in Torrance, USA.

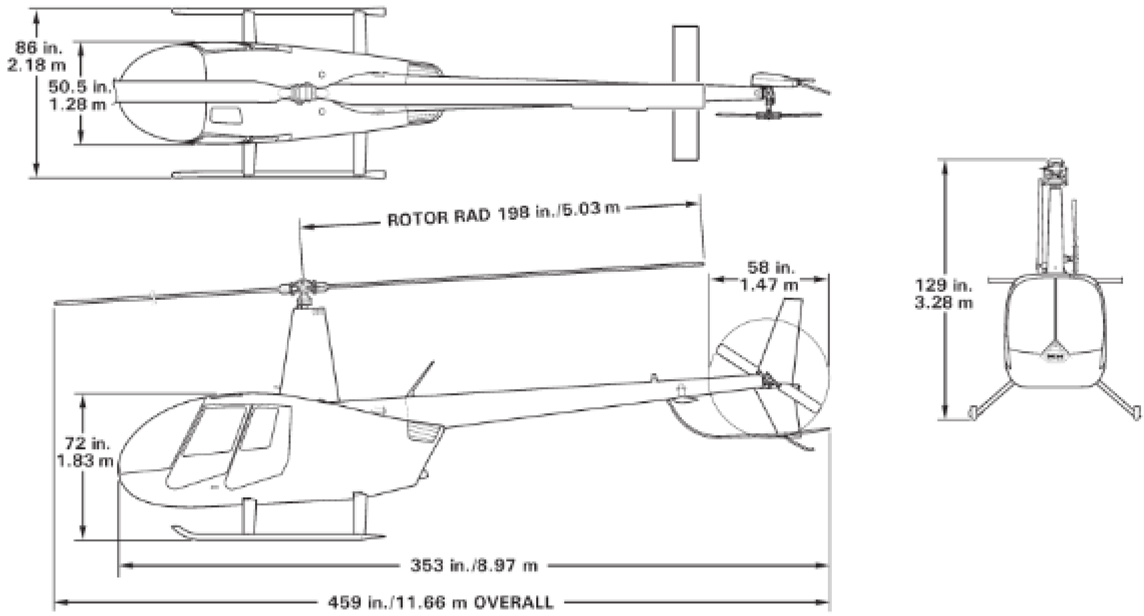

Fig. 3. Main dimensions of the R44 helicopter [source: RTR 463].

1.6.1 Airworthiness and maintenance

a) General information:

Table 2. Aircraft data

Factory designation (model)	Serial No	Year of construction	Identification marks	Registration No.	Date of registration
R44 Cadet	30040	2018	SP-NHM	807	2021-06-17

- owner - SQ Equipment Leasing Sp. z o. o.;
- operator – Salt Aviation Sp. z o. o.;
- Certificate of Airworthiness (CofA) - issued 10.05.2019 . - unlimited.
- Airworthiness Review Certificate (ARC) no. 6008/3 issued on 26 October 2023; Extended on October 26, 2023, valid until October 29, 2024.

b) Aircraft history:

- flight time from the beginning of operation – 1580.55 MTh;
- flight time since last major repair - not applicable;
- flight time since last inspection 100 FH (airframe) – 33.36 MTh – completed on 08.07.2024;
- modifications - made in accordance with the regulations;
- on-board technical log - kept neatly and up to date;
- airworthiness directives – all airworthiness directives were completed on time;
- mandatory service bulletins – all mandatory bulletins were completed on time.

c) History of the aircraft engine:

Table 3. Aircraft engine data

Manufacturer	Type	Serial No	Year of construction
Lycoming	O-540-F1B5	L-27802-40E	2018

- flight time since the start of operation: 1580.33 MTh;
- flight time since last major repair - not applicable;

- flight time since last inspection 50/100 FH (engine) – 33.36 MTh – completed on 8 July 2024;
- modifications – no modifications made;
- airworthiness directives – all airworthiness directives were completed on time;
- mandatory service bulletins – all mandatory bulletins were completed on time.

d) Main rotor blades and tail rotor blades:

- main rotor blades, operating time: since commissioning 1580.33 MTh, since last periodic inspection 33.36 MTh – inspection completed on July 8, 2024;[6];
- tail rotor blades, operating time: since commissioning 298.07 MTh[7], since the last periodic inspection 33.36 MTh – inspection completed on July 8, 2024.

e) Fuel:

- recommended (according to POH) - AVGAS 100LL, UL 91[8];
- used during flight – AVGAS 100LL;
- quantity on board: approximately 176 l (full tanks).

f) Equipment and aggregates:

- spark generator LH, TCM, P/N: 10-600616-3, S/N: E18AA020, operating time: since commissioning: 1580.33 MTh, after a recent review of 100 FH: - 33.36 MTh - completed on 08.07.2024, following the last 500 FH review: 133.1 MTh - completed on 18.04.2024;
- spark generator RH, P/N: 10-600646-201, S/N: E18AA050, operating time: since commissioning: 1580.33 MTh, after a recent review of 100 FH: - 33.36 MTh - completed on 08.07.2024, following the last 500 FH review: 133.1 MTh - completed on 18.04.2024;
- carburettor, Avstar, P/N: AV10-6035-11, S/N: AV26549145, operating time: since commissioning: 1580.33 MTh, after a

[6] Maintenance tasks for the main rotor blades and tail rotor are included in the 100FH / annual inspection in accordance with RTR 460 vol. 1 section 2.400.

[7] The tail rotor blades were replaced in accordance with FAA AD 2023-11-07 and SB-112C requirements.

[8] Only fuel types found in Poland are listed.

recent review of 100 FH: - 33.36 MTh - completed on 08.07.2024;

– charge pressure indicator (*"MANIFOLD PRESSURE GAUGE")*, United Instruments, P/N: A600-7, S/N: 201031, operating time: since commissioning: 1580.33 MTh, built in during the production of the helicopter. No maintenance required;

– dual tachometer ("DUAL TACHOMETER"), Phaostron, P/N: C792-4, S/N: 7709, operating time: since commissioning: 1580.33 MTh, built in during the production of the helicopter. No maintenance required.

g) Aircraft mass and balance

– MTOM - 998 kg (2200 lb);

– Empty helicopter weight - 664 kg (1464 lb);

– Fuel weight - 127 kg (279 lb);

– Pilot weight - 83 kg (183 lb);

– Luggage weight - 9 kg (20 lb);

– Take-off weight – 883 kg (1,944 lb).

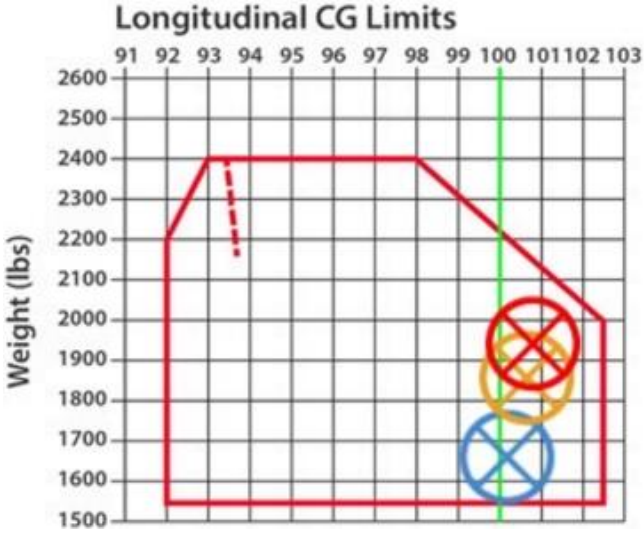

Fig. 4. Location of the center of gravity on the longitudinal axis (red marker – take-off weight, blue marker – helicopter weight without fuel, yellow marker – landing weight for the planned flight).

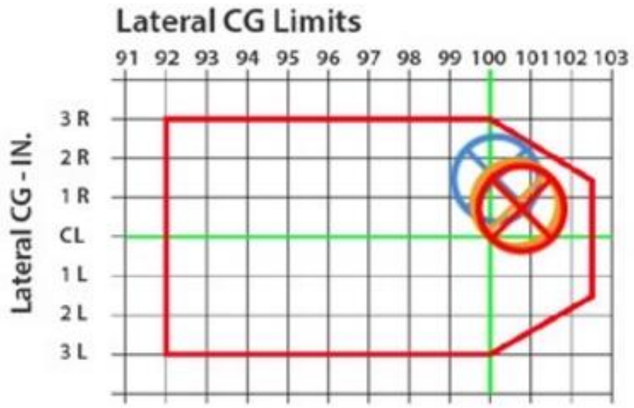

Figure 5. Position of the centre of gravity in the transverse axis.

The centre of gravity was in the correct position throughout the flight. The maximum take-off weight was not exceeded (Figures 4 and 5).

1.6.2 Aircraft systems or components

a) Motor

The O-540-F1B5 engine is manufactured by Lycoming Engines based in Williamsport, USA. A six-cylinder engine, in boxer configuration, undercharged, without transmission, designed for horizontal operation and air-cooled.

The fuel-air mixture is created in the carburetor. At the inlet to the intake system, there is an air filter in a composite housing equipped with an alternative air intake ("BYPASS") and a hot air intake (used to prevent carburetor icing).

Table 4. Basic parameters of the Lycoming O-540-F1B5 engine.

Parameter	Value
Nominal motor power[9]	235 BHP
Nominal rotational speed[10]	2800 RPM
Cylinder displacement	541.5 [in^3]
Oil sump capacity	12 US qt
Maximum oil consumption	0.78 US qt / h

A spark-ignition engine that consists of two individual spark generators, ignition wires, spark plugs and a starting module (vibrator). Each cylinder is equipped with two spark plugs fed individually from two different spark generators.

[9] By limiting the rotational speed, the maximum engine power is limited to 185 BHP for continuous power and 210 BHP for starting power (5 minutes).

[10] The engine rotational speed is limited by the helicopter manufacturer to 2718 RPM.

Fig. 6. Engine removed from the helicopter involved in the incident.

Wet oil sump system. Oil is filtered using two filters - an external (full-flow) and an internal (mesh *"SUCTION SCREEN* " - built into the oil sump). Pressure is generated using a single-stage gear pump. The oil is cooled using a radiator; maintaining the oil temperature is done by a thermostat.

Engine control is limited to controlling mixture composition, throttle opening and carburettor heating. The manufacturer prohibits the control of the mixture composition in flight, it is only used for starting and shutting down the engine.

Throttle opening control is provided by a rotary handle located on both collective pitch levers. Above 81% of rpm, throttle opening is controlled automatically via the governor (rotation controller).

The carburettor heater is controlled by remote control from the cockpit via a linkage near the cyclic control.

Engine operation is monitored by indications of oil temperature, oil pressure, cylinder head temperature No. 5, fuel-air mixture temperature, its speed and charging pressure.

b) Normal procedures

Autorotation training

The procedures for autorotation training with the power unit running, power recovery, and touchdown are described in detail in **Appendix 1.**

The following is a note on autorotation training with touchdown (found in the POH for the R44 Cadet):

"Before executing the "FLARE" manoeuvre with the cyclic control, turn the throttle below the minimum ("OVERTRAVEL SPRING") up to the stop until the autorotation is complete. (This will prevent the correlator from adding power when the lever is raised)."

<u>Determination of maximum charging pressure</u>

One of the points in the engine start-up and test procedure is to check the MAP restriction. This involves reading the maximum MAP value from a table located in the POH and cockpit (Fig. 7) for the current take-off conditions (temperature and altitude).

For the prevailing conditions (take-off aerodrome elevation of 344 ft and ambient temperature of +27ºC), the maximum MAP value was 22.56 inHg for the cruise and 24.56 inHg for the 5-minute take-off power. Due to the accuracy of the charging pressure indicator, the pilot should assume values of 22.5 inHg for flight and 24.5 inHg for take-off power.

LIMIT MANIFOLD PRESSURE - IN. HG

MAXIMUM CONTINUOUS POWER								
PRESS ALT-FT	OAT-°C							
	-30	-20	-10	0	10	20	30	40
SL	21.2	21.4	21.7	22.0	22.2	22.5	22.7	22.9
2000	20.7	21.0	21.3	21.5	21.8	22.0	22.2	22.5
4000	20.2	20.5	20.8	21.1	21.3	21.6	21.8	22.0
6000	19.8	20.1	20.4	20.7	20.9	21.1	21.4	21.6
8000	19.5	19.7	20.0	20.3	FULL THROTTLE			
FOR MAX TAKEOFF POWER (5 MIN), ADD 2.0 IN.								

Fig. 7. Limitation of maximum MAP [source: RHC]

c) Emergency procedures

The emergency procedure for loss of power to the power unit is detailed in Appendix 1.

1.7 Meteorological information

On August 1, 2024, in the afternoon, most of the area was under the influence of high pressure system.

According to the METAR report for EPMO airport on August 1, 2024, at 3:30 p.m., the meteorological conditions were as follows:

- wind direction: from 290°, variable from 250° to 350°;
- wind speed: 11 kt;
- visibility above 10 km;

- clouds: none;
- no hazardous weather events;
- ambient temperature: 27ºC:
- dew point: 13ºC:
- QNH pressure: 1010 hPa.

1.8. Navigation aids

Not applicable

1.9. Connectivity

The pilot conducted standard radio communication with Modlin TWR in Polish. The communication in both directions was clear.

1.10. Aerodrome information

Not applicable.

1.11. Flight data recorders

The helicopter was not equipped with an FDR and CVR - these were not required by any regulations.

The pilot used a mobile phone with 'SkyDemon' software for navigation, which allows route planning and in-flight navigation.

PKBWL downloaded the flight record of the incident from the pilot's phone. After converting and recalculating the data, the following flight parameters were obtained (Fig. 8):

- Progressive velocity as a function of time;
- AMSL and AGL altitude as a function of time;
- Vertical speed as a function of time;
- Flight route including take-off time and event.

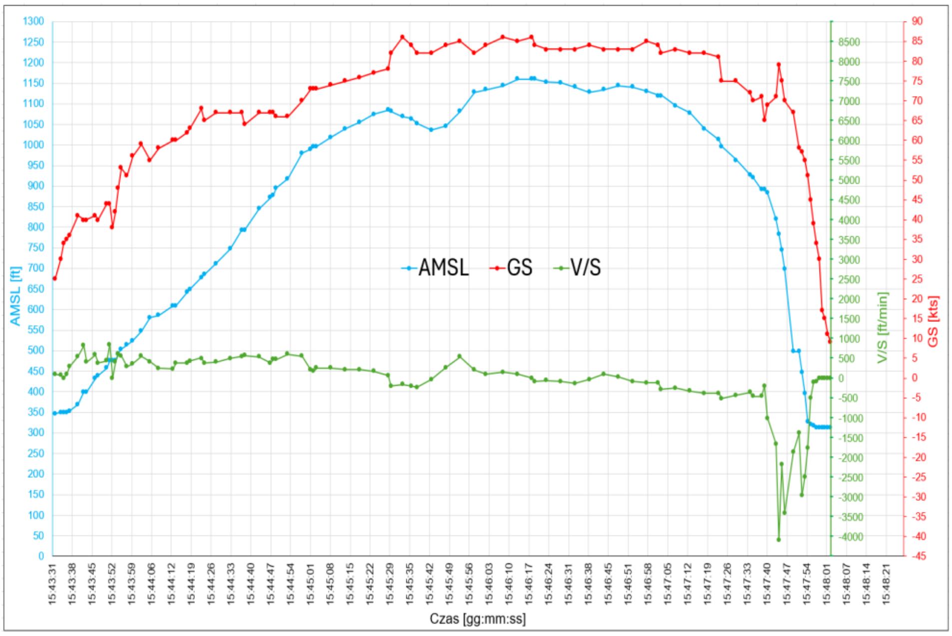

Fig. 8. Record of flight altitude (AMSL), speed (GS) and vertical speed (V/S) read from SkyDemon software.

1.12. Information on the wreckage and the crash

1.12.1 Crash site

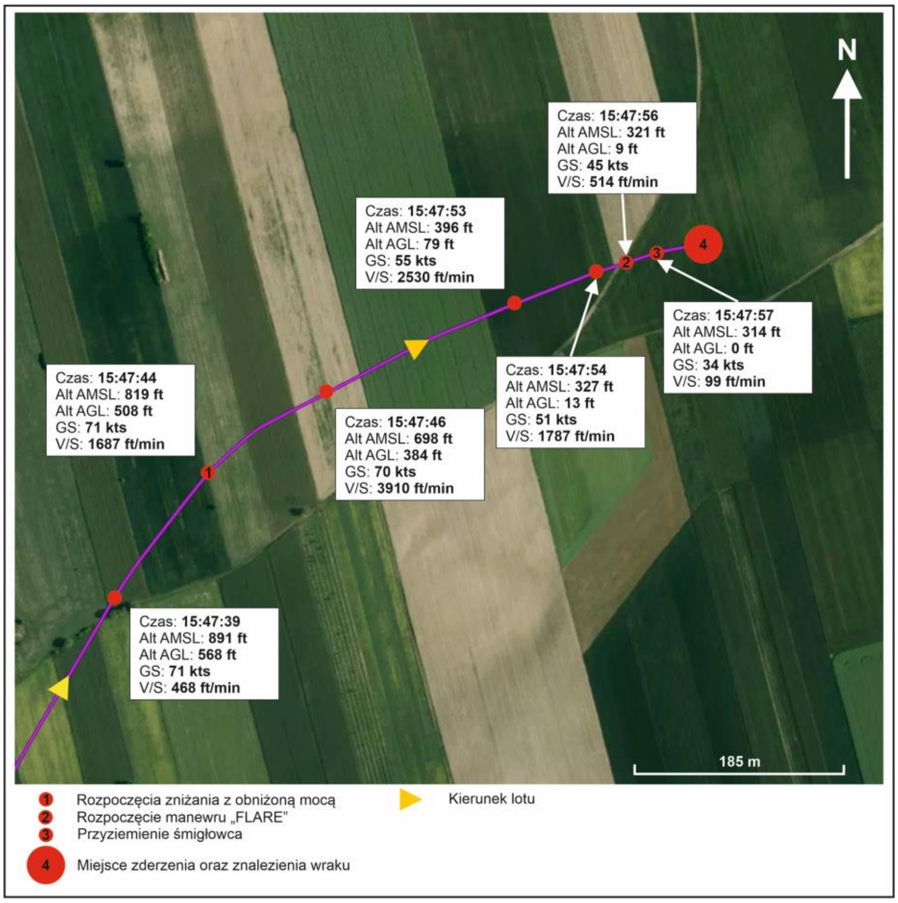

Fig. 9. The site of the air incident in question with the trajectory plotted.

Touchdown occurred at a speed of approximately 35 kt.

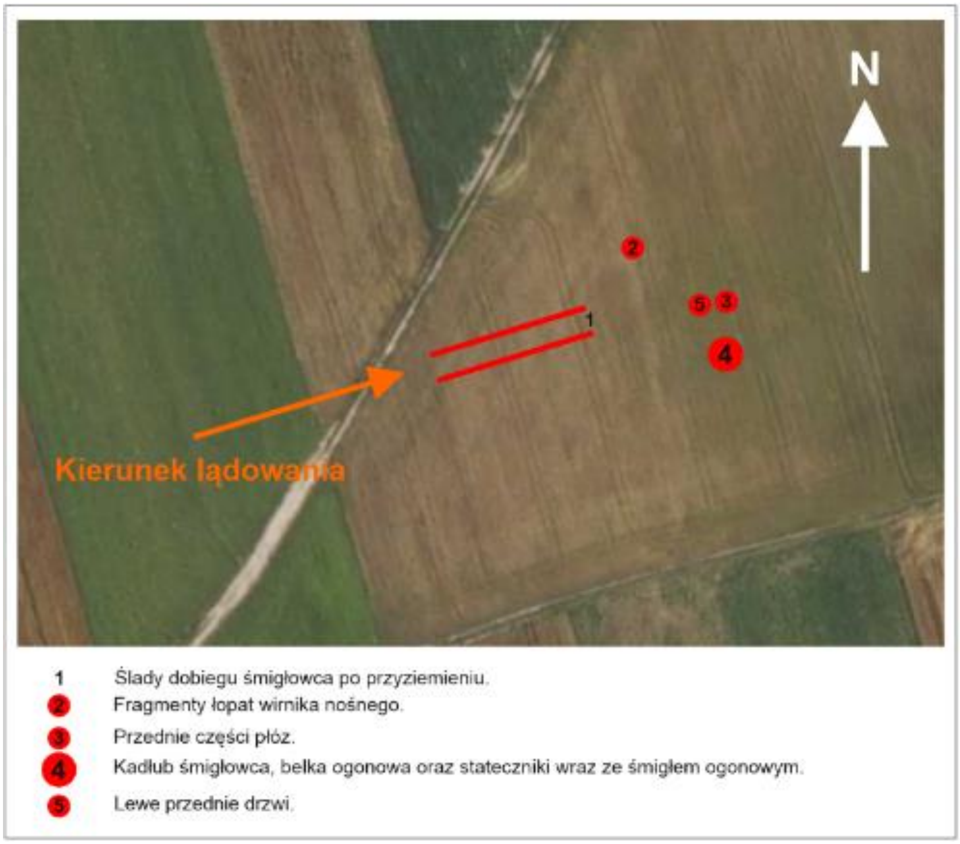

Fig. 10. Sketch of the crash site.

Fig. 11. The crash site as seen from the direction of landing. 1 - traces of touchdown and run-up; 2 - fragments of the lifting rotor blades, 3 – front parts of the skids, 4 – helicopter wreckage with the tail boom and broken tail rotor gearbox and stabilisers.

1.12.2 Damage to the aircraft

The wreckage of the helicopter (Fig.12) was located approximately 20 metres from the first touchdown mark. The fuselage lay on its right side along with the broken tail boom and separated stabilisers along with the tail gear and tail rotor (there were no signs of ground contact on the tail skid). Approximately 10 metres beyond the run-in marks were detached front skid pieces along with fragments of the left front door.

Fig.12. Wreckage of the helicopter.

The two lifting rotor blades separated as a result of the impact on the ground (Fig.13). The first blade separated at the very root the second about 1 meter from the root.

The tail rotor was slightly bent (Fig. 14), which indicates that it was not operating at the moment of contact with the ground. The helicopter struck the ground with the horizontal stabiliser, which caused the tail rotor gearbox and its attachment along with the stabilisers to detach from the tail boom.

Fig. 13. Deformed helicopter cockpit.

Fig. 14. Separate tail rotor gearbox including tail rotor and stabilisers.

Fig.15. Visible damage to the lower part of the fuselage.

There were traces of their contact with the ground where the front skid fragments of the helicopter were found (Figures 16, 17). At this point, the helicopter made contact with the ground again.

Fig. 16. Separated right skid section.

Fig. 17. Separated left side of skid and left front door.

1.13. Medical and pathological information

On the day of the incident, the pilot was tested for alcohol in his breath. The test result was 0.0 [mg/l].

The pilot suffered minor injuries to his face.

1.14. Fire

None.

1.15. Survival factors

The pilot occupied the right seat in the helicopter cockpit. Each seat is factory-fitted with three-point seat belts.

The pilot had his seatbelt fastened. There were significant accelerations and inertial forces during the impact with the ground - seatbelts ensured the pilot's survival.

Five minutes after losing radar contact and radio communication, the Modlin TWR controller notified the ARCC supervisor and contacted the helicopter owner in order to attempt to contact the helicopter pilot.

After the incident, the pilot contacted his family and Warsaw Briefing, to which he had submitted his flight plan. Briefing also contacted the ARCC. All these activities allowed the rescue operation to be quickly performed, and the helicopter to be located.

1.16. Tests and studies

The PKBWL conducted a series of tests to verify the technical efficiency of the helicopter's systems that were involved in the accident.

- The helicopter control system was examined - no malfunctions were found.
- The engine control system was examined – no malfunctions were found.
- The transmission system was examined - no malfunctions were found.
- The fuel system was examined - no malfunctions were found.
- The engine intake system was examined - no malfunctions were found.
- The lubrication system was examined - no malfunctions were found.
- Spectrographic and FTIR analysis of oil samples was performed – results were normal.
- Tests of the ignition system were carried out - no malfunctions were found.
- An inspection of the cylinders was carried out - no malfunctions were found.
- A inspection of the charge pressure measurement system was carried out - no malfunctions were found.
- The charge pressure indicator was checked - no malfunction was found.
- The engine/rotor carrier speed indication system was examined - no malfunctions were found.
- A functional test of the engine was performed on a dynamometer - no malfunctions were found.
- Continuing airworthiness documents were checked - no discrepancies were found.

The above mentioned tests are detailed in **Appendix 2** of this report.

1.17 Information on organizations and management

Not applicable.

1.18 Supplementary information

1.18.1 Publication of the final report

Prior to publishing the final report, the PKBWL conducted consultations on its draft, requesting comments from interested parties and the European Aviation Safety Agency (EASA):

Aircraft crew involved in an accident - did not or did not make comments (on the circumstances and causes of the accident).

The aircraft operator - did or did not make comments (on the circumstances and causes of the accident).

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

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

The helicopter manufacturer- did or did not make comments.

1.19 Useful or effective investigation methods

Standard investigation methods were used.

2. ANALYSIS

2.1 Fluctuation in charging pressure readings

In connection with the pilot's statement about the observed excessive fluctuation of the charging pressure readings, the PKBWL analysed the possible causes of this phenomenon together with the possibility of their occurrence in the flight in question. The following possible causes were identified:

a) **A clogged air filter** disrupts the continuity and quantity of air flowing into the intake system. The Commission, after examining the air filter as described in section 1.16, found no malfunctions. In addition, the filter was replaced in accordance with the service data. The condition of the air filter was therefore not the cause of the fluctuating charging pressure readings.

b) **A leak in the engine intake system** draws in additional air from outside the engine, which can cause a change in intake system vacuum. The intake system was checked for leaks. The inspection was carried out in accordance with section 1.16 - no malfunctions were found. The condition of the intake system was not the cause of the fluctuations in the charging pressure reading.

c) **Failure of the charge pressure indicator** results in display errors, a delay in its operation ("LAG") and oscillation of the indicated values. The indicator was checked in accordance with section 1.16 - no malfunctions were found. The charging pressure indicator was not the cause of the fluctuating charging pressure readings.

d) **A leak in the charging pressure measuring** system can cause the entry of external air from outside the intake system. The effect will be that the charging pressure readings will be disturbed or fluctuate. A leakage test was carried out in accordance with chapter 1.16 - no malfunctions were found. The installation of the charging pressure indicator was not the cause of the fluctuating charging pressure reading.

e) **Icing on the carburettor** despite the high ambient temperature is a risk for loss of power. The "GOVERNOR" engine speed controller can mask carburettor icing by continuously increasing the throttle opening. Also, accumulating ice can cause fluctuations in the charging pressure reading. PKBWL analysed the possibility of carburettor icing for the flight in question.

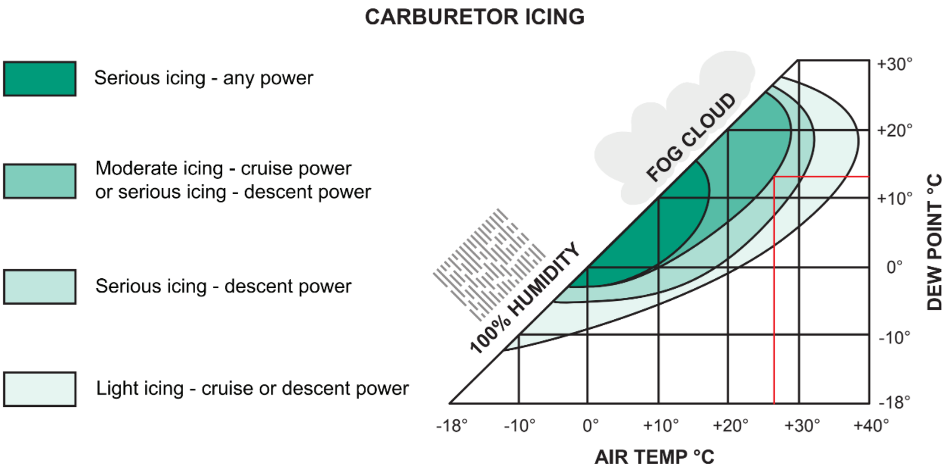

Fig. 18. Diagram of the possibility of carburettor icing - red lines indicate prevailing weather conditions at the time of the incident [source: TCCA].

According to the diagram at the time of the incident, high carburettor icing may have occurred for cruising power, and severe icing may have occurred during descent. In contrast, the possibility of carburettor icing at full power during climbing is negligible. In addition, the pilot stated that he had turned the carburettor preheat up to half while passing through an altitude of 1,000 ft AMSL. This cannot be confirmed because the stroke lever is correlated with the carburetor heater – when it is lifted up (increasing power), it closes the heater.

Based on the above analysis, it was concluded that carburettor icing was not the cause of the fluctuations.

f) **Turbulence** (including variable wind speed) can affect the performance of the charging pressure system in two ways. The first is the increased operation of the 'GOVERNOR' speed controller, which attempts to compensate for differences in power demand caused by turbulent air. When the governor changes the throttle opening setting, the boost pressure gauge follows this movement, which results from the actual change in boost pressure in the system.

A second possible influence of turbulence on the operation of the charging pressure system is the disruption of the air intake to the engine through changes in direction or wind gusts and vertical air 'currents'.

PKBWL did not exclude the influence of turbulence on the operation of the charging pressure reading system, particularly on sunny days in high-pressure areas during the summer season.

g) **Malfunction of the "GOVERNOR" speed controller** similar to the case given in (point f). Its malfunction affects fluctuations in the engine speed and therefore fluctuations in the charging pressure readings. According to the pilot's statement, fluctuations in engine speed did not occur. In addition, the engine speed indication and automatic control system was checked. No malfunctions were identified. The speed regulator was not the cause of the fluctuations in the charging pressure readings.

h) **Knocking combustion** can also affect fluctuations in landing pressure readings. The fuel used during the flight was of the correct type and, in addition, inspection of the cylinders (boroscopy) in accordance with section 1.16 showed no signs of knocking combustion. Knocking combustion was not the cause of the fluctuating charge pressure readings.

The PKBWL did not find a cause for the fluctuation of the charging pressure readings.

2.2 Technical condition of the helicopter

PKBWL analysed the technical condition of the helicopter in accordance with section 1.16. No malfunction was found to have occurred prior to the impact with the ground. The technical documentation of the helicopter was also analysed. All maintenance was performed correctly and the helicopter's records including its continuing airworthiness management were kept correctly. The technical condition of the helicopter was not the cause of the incident.

2.3 Evaluation of the correct operation of the engine

The decrease in engine power can be caused by various technical, pilot- and atmospheric-related factors. PKBWL has analysed those that may relate to the subject event:

a) **Engine failure**. A number of tests, listed in section 1.16 and detailed in Appendix 2, were carried out to assess the condition of the engine and other key helicopter components. None of the tests revealed malfunctions in the components tested. Following the component tests, the engine was tested on the dynamometer. The engine test on the dynamometer, performed 4.5 months after the incident, yielded positive results. The engine started without any problems. None of the tests performed showed any anomalies. Oil analyses performed immediately after the incident, as well as after the dynamometer test, showed no signs of mechanical damage or excessive wear on components.

   The cause of the oily bottom plug of cylinder 6 was the position of the wreckage after the accident. The helicopter was tilted to the right side after the incident.

   Oil from the oil sump drained into the cylinder combustion chamber through the rings, flooding the plugs. Engine oil was also found in the exhaust manifold of cylinder 6 and in the muffler. Through the boroscope, it was found that the exhaust valve had opened, through which oil entered the manifold from the cylinder.

Traces found on the clutch shaft and fan housing show that the power unit was working up to the moment of impact with the ground.

The PKBWL did not find any anomaly explaining the drop in power observed by the pilot.

b) **Reduction in power through inadequate engine control.** It is possible by incorrectly adjusting the mixture composition, blocking the operation of the "GOVERNOR" (holding down the throttle rotation handle), overdriving the "GOVERNOR" by reducing the throttle opening or switching it off. The mixture lever was in the “RICH” position and, when the helicopter was inspected after the incident (despite extensive damage), it was found to be functioning properly. "GOVERNOR" was on and functioning until the moment of impact. If it were to be overdriven (throttle opening reduced), this would be combined with a drop in engine speed and a "LOW RPM" reading (audible and visual). According to the pilot's statement, this did not occur during the flight. The engine control was not the cause of the engine power loss.

c) **Carburettor icing.** This is described in section 2.1(e). It was not the cause for the engine's power loss.

d) **The impact of weather conditions.** Atmospheric (ambient) conditions always have an impact on engine and aircraft performance. The high temperature at the time of flight (+27ºC) results in a reduction in density altitude and thus in the performance of the engine and aircraft. Nevertheless, these are not harsh or extreme conditions and flights at this temperature are standard. The pressure (QNH) was also lower than according to the reference atmosphere, resulting in a decrease in performance. Both of the above had the effect of reducing the aircraft's performance. The pilot's feelings in such atmospheric conditions are consistent with the statement that "the helicopter had less power than usual after take-off".

Also, ambient thermal conditions as well as gusts of wind can cause the impression of a drop in engine power. Descending air currents in particular can affect the impression of a loss of power. On the day of the incident (a cloudless, sunny day), cloudless thermals occur, especially in the vicinity of fields and forests. On the day, the wind was moderate from variable directions (for the flight in question, there was a tailwind and a tail-side wind). This wind angle can also cause an illusory drop in engine power.

The atmospheric conditions may have had an impact on the impression of a drop in engine power.

2.4 Flight analysis

Based on data from SkyDemon, it is possible to reconstruct the parameters of the final phase of the flight from the moment the pilot noticed that it was impossible to continue climbing and maintain level flight.

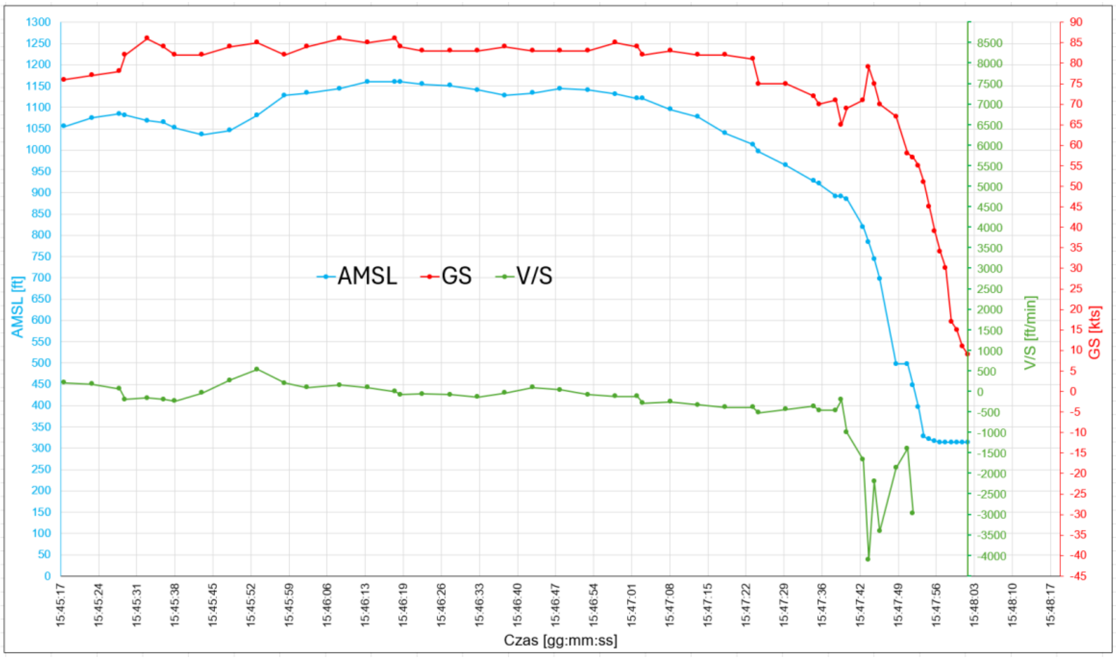

Fig. 19. Parameters of the final phase of the flight.

Approximately 90 seconds before impact, the helicopter began to lose altitude with an average descent of 300 ft/min (highest value minus 526 ft/min). By the time the decision was made by the pilot, it had lost 259 feet of altitude. This is a slight drop in altitude, but may prompt a decision to make a precautionary landing.

SkyDemon does not record the performance of the power unit, which would allow an objective assessment of performance. However, the values of the descent speed during this phase indicate that the engine was working - otherwise the helicopter would be in autorotation, during which the descent speed is around 2500 ft/min.

At 3:47:40 p.m., the pilot made the decision to go into 'autorotation flight' and reduced the forward speed to about 69 kts. At this point, the rate of descent increased to more than 1,000 ft/min. The pilot successively reduced his progressive speed during the landing approach, suggesting an attempt to aim for a selected landing spot. This also resulted in increased descent. Reducing forward speed during autorotation is not an appropriate emergency landing profile - it reduces the glide range and the helicopter's kinetic energy reserve for landing. The pilot initiated the *'FLARE'* manoeuvre at an altitude of approximately 13 ft above the ground at a forward speed of approximately 55 kts. Touchdown occurred at a forward speed of around 35 kts which is too high a speed.

2.5 Emergency landing

The POH for the R44 Cadet helicopter provides in section 3 (Emergency Procedures) for an emergency landing in the event of a "Loss of power above 500 ft" (see section 1.6.2(c)). In addition, the POH provides general information on the loss of power i.e.: “Power loss can be caused by both the engine and the drive system and is usually indicated by “LOW RPM.” Engine failure may be indicated by changes in engine noise, the nose veering to the left, the “OIL PRESSURE” light coming on, and a drop in engine speed. Transmission failure can be signalled by a different sound or vibration, a deviation of the nose to the left or right, and a decrease in the rotor speed with an increasing engine speed reading.

Nonetheless, the Emergency Procedure for 'Lost Power' is applied when power is fully lost. If none of the symptoms described above are present and the helicopter is still capable of flight even at reduced power (preventing climb or level flight), continue the flight or decide to make a precautionary landing. Use the remaining engine power for a safe landing.

You cannot, by design, enter autorotation (emergency landing).

In the incident in question, the decision to autorotate was taken too early and in the absence of sufficient symptoms, as the engine was running and delivering power to the drive train. The “LOW RPM” light did not come on, the engine and rotor speeds did not drop, and there were no indications of oil system malfunction (drop in oil pressure readings or “OIL PRESSURE” light). The pilot also did not confirm any excessive vibration or unusual noises.

Also, the POH does not provide for entry into autorotation when the power unit and engine are running. However, when analysing autorotation entry, in this case, normal procedures should be considered, i.e., autorotation training, which is used for training with a fully functional propulsion system. This procedure dictates that the throttle handle be twisted on the collective pitch lever first (which is obvious in training as we need to reduce power). During this event, the throttle should also have been turned to perform a full autorotation procedure in accordance with the POH, as the power unit was still providing power (the rate of descent according to section 2.4 at the time of the decision was up to 500 ft/min).

Failure to twist the throttle implied further consequences during touchdown. The procedure for training autorotation with touchdown, as described in the POH (see section 1.6.2(b) contains the following provision: "Before executing the *"FLARE"* manoeuvre with the cyclic control, turn the throttle below the minimum (*"OVERTRAVEL SPRING")* up to the stop until the autorotation is complete. (This will prevent the correlator from adding power when the lever is raised)." In this case, the power lever was raised during the touchdown and run-in, increasing the power of the continuously running engine, caused a loss of control over the helicopter on the ground, resulting in its destruction. In addition, the high progressive speed during the touchdown phase contributed to the loss of control on the ground.

The helicopter, after touchdown, having a high kinetic energy of the rotor, bounced off the ground, then hooking the front of the skids it leaned forward hitting the left front part of the fuselage against the ground (which absorbed the main energy of the impact) resulting in the destruction of the tail rotor blades and fuselage (Fig. 13).

3 CONCLUSIONS

3.1 Findings

3.1.1 The pilot had valid documents and authorizations to perform his duties.

3.1.2 No evidence was found that the pilot's behavior was affected by incapacitation or other physiological factors.

3.1.3 The pilot was not under the influence of alcohol.

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

3.1.5 The weight and center of gravity of the aircraft were within the regulatory limits, in accordance with the Flight Manual.

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

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

3.1.8 PKBWL did not establish the cause of the helicopter's degraded performance (inability to continue horizontal flight or climb) as well as the fluctuation of the charging pressure readings.

3.1.9 The aircraft was destroyed by impact forces.

3.1.10 The pilot made the decision to make an emergency landing based on a misinterpretation of the helicopter's condition.

3.1.11 The throttle remained in the open position during the initiation of the emergency landing manoeuvre.

3.2 Causes of the occurrence

1) Unjustified decision to perform an emergency landing (autorotation) instead of a precautionary landing (with engine running).

2) Improperly executed emergency landing without engine power reduction.

4 SAFETY RECOMMENDATIONS

PKBWL did not present any safety recommendations.

END