State Commission on Aircraft Accidents Investigation

FINAL REPORT

2023-0008

OCCURRENCE NUMBER

ACCIDENT

USOS: Undershoot/Overshoot
CTOL: Collision with obstacle(s) during take-off and landing

The sole purpose of both the investigation and the Final Report is to prevent aviation accidents and incidents.

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

Any use of this Report for any purpose other than prevention of air accidents and incidents may lead to wrong conclusions and interpretations.

Blue Sky Balloons, flight with passengers
Cameron Balloons, Z-160, SP-BOK
Bór, EPNT

This Final Report was issued by the State Commission on Aircraft Accidents Investigation (PKBWL) on the basis of information available on the date of its publication.

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

This Report was drawn up in Polish.

Warsaw, 20 March 2024

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INTRODUCTION

LEGAL GROUNDS

The State Commission on Aircraft Accidents Investigation (PKBWL) is a safety investigation authority referred to in Article 4(1) of Regulation (EU) No 996/2010 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, 12.11.2010, p. 35, as amended).

The Commission conducts safety investigations pursuant to the provisions of the Aviation Law of 3 July 2002 (Journal of Laws No 130 of 2002, item 1112, as amended) and the European Union law on accidents and incidents in civil aviation, taking into account the standards and recommended practices laid down in Annex 13 to the Convention on International Civil Aviation made in Chicago on 7 December 1944 (Journal of Laws of 1959, item 212, as amended).

KEY INFORMATION ON THE OCCURRENCE

Operator (user), flight no. or type – Blue Sky Balloons, flight with passengers.

Manufacturer, type, model and registration marks of the aircraft– Cameron Balloons, Z-160, SP-BOK.
Place and date of the occurrence– Bór, EPNT.

NOTIFICATION OF THE OCCURRENCE

PKBWL was notified of the occurrence under the mandatory reporting system on 19 March 2023.

The occurrence was assigned the reference number – 2023-0008.

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

The classification was not changed in the course of the investigation.

PKBWL notified the occurrence to:

- the State of design (United Kingdom via AAIB);
- the State of manufacture (United Kingdom via AAIB);
- EASA;
- European Commission;
- ULC.

ORGANISATION OF THE INVESTIGATION

The investigation was conducted by – PKBWL.

Investigator-in-Charge (IIC) – Michał Ombach.

Specialist groups – no specialist groups were appointed.

Accredited Representatives (and their advisers)

- the State of design – United Kingdom (AAIB);
- the State of manufacture – United Kingdom (AAIB).

RECOMMENDATIONS

Unless otherwise specified, the recommendations contained in this Report are addressed to the regulatory authorities of the State concerned. The decision on how to proceed is the responsibility of those authorities. Details are provided in Chapter 4 of this Report.

TIME

Time in the Report is provided as LMT. LMT on the occurrence day = UTC+1.

DATE

Where a date is provided in this Report in a digital format, the respective digits represent DD/MM/YYYY, where DD means day, MM means month, and YYYY means year.

FIGURES AND TABLES

Unless otherwise specified in this Report, the PKBWL is the source.

SYNOPSIS

On 19 March 2023 at 12:51 hrs, a Cameron Z-160 balloon took off from the vicinity of the village of Szaflary for a commercial flight with seven passengers on board. The flight proceeded normally, and after around one hour, the pilot landed on a meadow some several hundred metres to south from the EPNT aerodrome. The landing took place in the immediate vicinity of a field road and a fenced plot of land. Since the aforementioned obstacles could have damaged the balloon's envelope while it was being laid on the ground following its partial cooling, the pilot instructed four passengers to alight from the basket to – when outside – move and hold the balloon above the ground in a safer place. However, a gust of wind made it impossible for the persons outside the basket to hold the balloon. The balloon moved towards the tree group, came into contact with them and ascended above the tree tops. The pilot reacted by activating the rapid envelope deflation system, as a result of which the balloon hit hard on the ground. Two female passengers sustained serious injuries. The third female passenger and the pilot survived the accident without any injuries. The balloon was not damaged.

SYMBOLS, ACRONYMS AND ABBREVIATIONS

SYMBOLS

°	degree e.g. °C (temperature) and 1° (angle)
'	minute
„	second

ACRONYMS AND ABBREVIATIONS

AAIB	Air Accidents Investigation Branch
ACCREP	Accredited Representative
AGL	Above Ground Level
AMSL	Above Mean Sea Level
BPL	Balloon Pilot Licence
C	degree Celsius
CAVOK	visibility, cloud and weather conditions at the moment of observation are better than the recommended values or conditions (Cloud And Visibility OK)
CAMO	Continuing Airworthiness Management Organisation
CCTV	Closed-Circuit Television
DOW	Dry Operating Weight
E	East / eastern geographical longitude
EASA	European Union Aviation Safety Agency
ft	foot/feet
h	hour(s)
hPa	hectopascal
IGC	International Gliding Commission
IIC	Investigator-in-Charge
kg	kilogram(s)
km	kilometre(s)

km/h	kilometres per hour
kt	knot(s)
LAPL	Light Aircraft Pilot Licence
LMT	Local Mean Time
LPG	Liquefied Petroleum Gas
m	metre(s)
METAR	Meteorological Aerodrome Report
min	minute(s)
MTOM	Maximum Take-Off Mass
N	North / northern latitude / Newton
QNH	Barometric pressure adjusted to mean sea level)
RDS	Rapid Deployment System
s	second(s)
S	South / southern latitude
TCDS	Type Certificate Date Sheet
ULC	Polish Civil Aviation Authority (Polish: *Urząd Lotnictwa Cywilnego*)
UTC	Coordinated Universal Time
VHF	Very High Frequency (30 to 300 MHz)
VMC	Visual Meteorological Conditions
W	West / western longitude

1. FACTUAL INFORMATION

1.1. History of the flight

On 19 March 2023, the operator (a provider of commercial passenger balloon operations) scheduled commercial hot-air balloon flights. The first flight of the day, with passengers, was performed from area of Szaflary to Gronków and lasted for 1 h. After landing, the balloon was deflated, disassembled and transported to the second take-off site. There, the balloon was again prepared for flight, and the pilot carried out a pre-flight inspection.

For the second flight, the basket of the balloon accommodated seven passengers: three females and four males. The pilot conducted a passenger safety briefing and presented the procedures concerning behaviour in flight, and prepared a list of passengers and load. The balloon took off at 12:51 hrs from a meadow located to the east of the village of Szaflary. The plan provided for a flight lasting around 1 h and a landing either at the EPNT aerodrome or in its vicinity.

The flight proceeded normally. The balloon ascended to around 850 m AGL and for about 30 minutes travelled with the average speed of 10 km/h and maintained average heading of 35°. Subsequently, the pilot initiated a descent to around 150 m AGL, where the wind changed direction. The course of the flight from take-off to landing is depicted in the barogram below (Fig. 1).

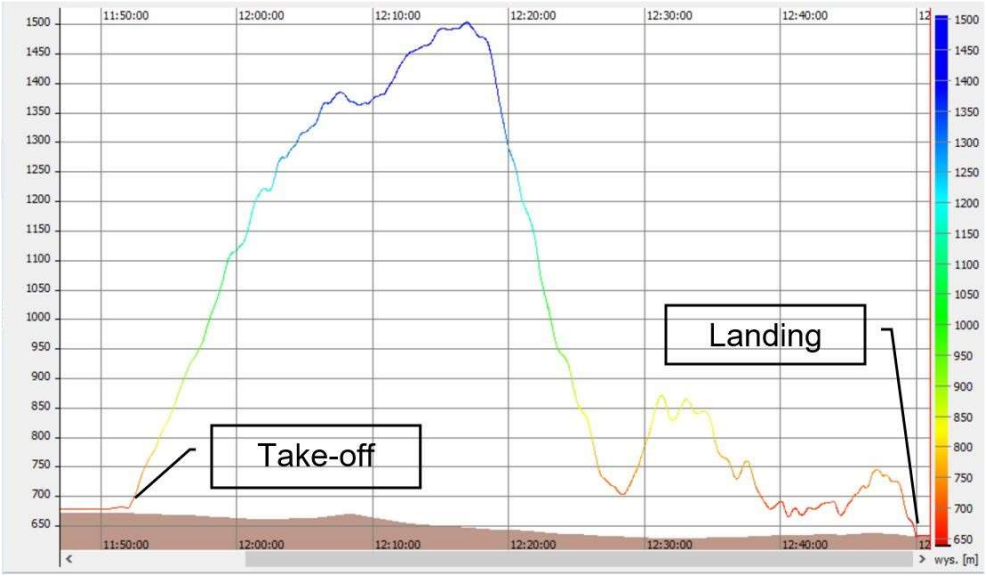

Fig. 1. Barogram of the flight, AMSL [source: SeeYou]

The flight path, from take-off to landing, is shown in Fig. 2.

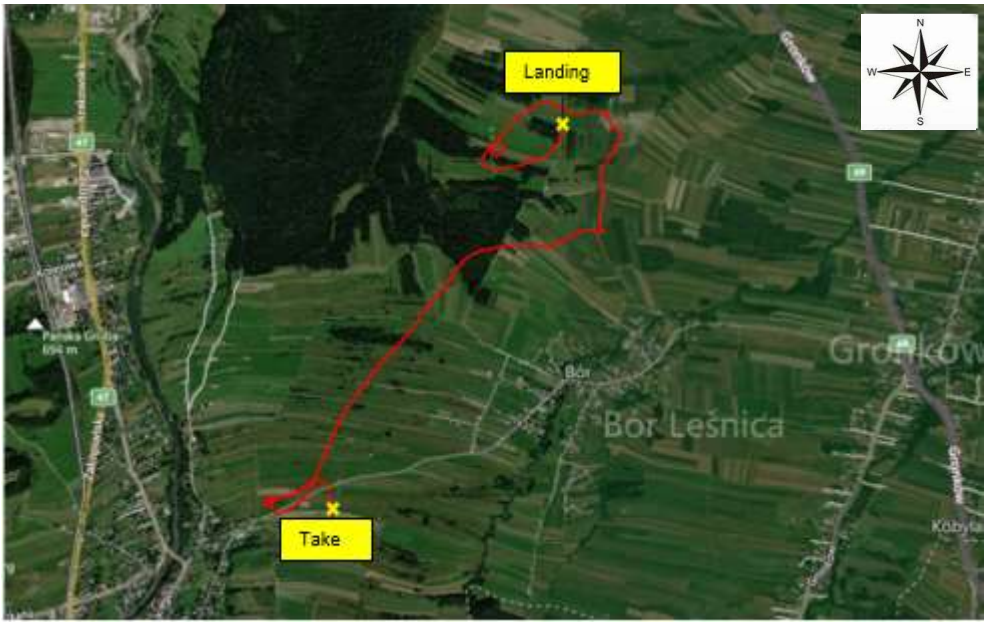

Fig. 2. Flight path of the SP-BOK balloon from take-off to landing [source: pilot – as recorded by the flight recorder]

After flying for 47 min (around 12 min before the planned landing), the balloon started moving in the south-west direction (S-W). Since there was a vast peatbog in the west, and the gas reserve did not guarantee flying over it, the pilot decided to initiate a landing.

In the 56th minute of the flight, while at an altitude of approximately 30÷40 m above ground level, the balloon accelerated to 11 km/h. The pilot briefed the passengers on the landing procedure, instructing them on the positions they were supposed to assume in the basket and the way they were supposed to hold on to handles securely.

At 13:50 hrs, at the airspeed of approximately 10 km/h, the pilot of the balloon performed landing in random terrain. A recording from an EPNT aerodrome camera was provided for analysing the character of the approach to that landing and the performance of the balloon in successive minutes.

The balloon landed on a meadow close to a hardened field road, at a fenced plot of land, where it became stationary (Fig. 3).

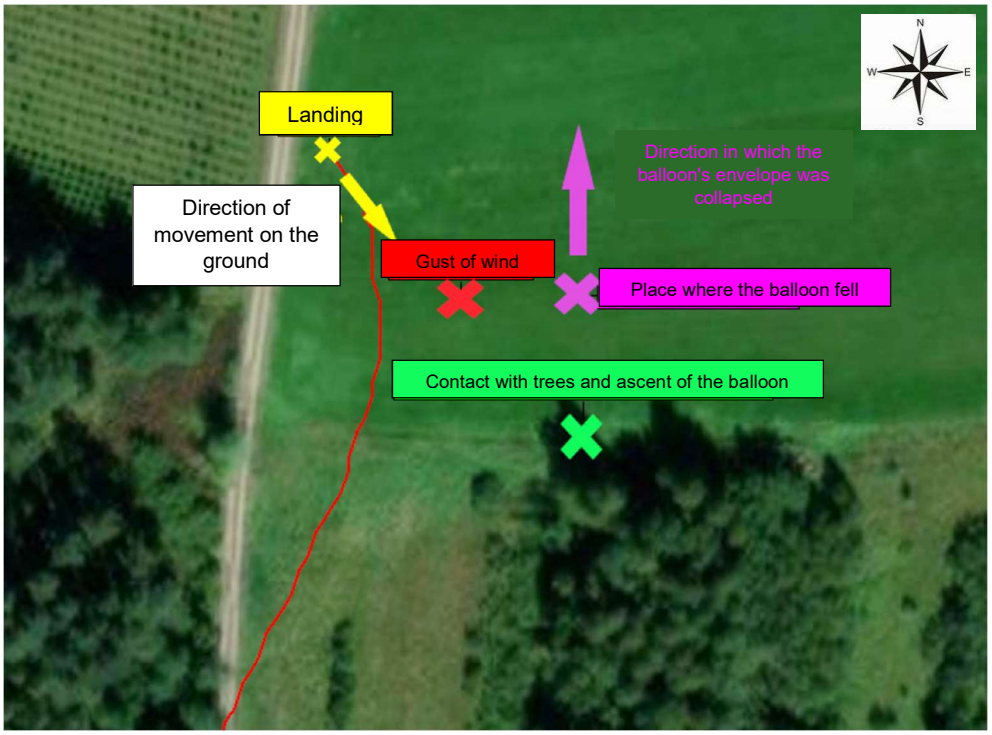

Fig. 3. Place of landing (yellow cross) and fall of the balloon (violet cross), and the position of the balloon after the occurrence [source: a sketch by the pilot/recording of the approach to landing (red line) comes from the flight recorder and represents the balloon's approach to the first landing]

The pilot judged that the terrain obstacles pose a risk of damage to the balloon envelope as it would be laid on the ground. Therefore, after the balloon partially cooled, he instructed the passengers (four males) to disembark from the basket. He also instructed them how to hold and where to move the basket to ensure safe positioning of the envelope on the grass without risking damage.

While the passengers were leaving the basket, the pilot continued to cool the balloon by lifting the rapid envelope deflation system with the burners on. The male passengers started shifting the balloon in the indicated direction, moving it away from the road and fence.

A sudden gust of wind made it impossible for the persons outside the basket to maintain control of the balloon. The pilot considered the situation as dangerous and ordered the men to release (let go) the basket. The lightened balloon, with four persons in the basket, moved suddenly towards a group of trees, came into contact with them and ascended above the tree tops. The pilot reacted by activating the rapid deflation system (RDS), while at the same time instructing the female passengers to "brace for landing and hold on tight". At 13:57 hrs, the balloon collided with the ground at a high rate of descent. The basket and envelope fell in the northerly (N) direction (Fig. 4).

Two female passengers reported serious injuries. The pilot notified rescue services and his assistant coordinated the arrival of the ambulance and police.

Fig. 4. The balloon after hard landing on the meadow – the overturned basket and a fragment of the envelope can be seen [source: Police]

1.2. Injuries to persons

Table 1. General summary of the number of injuries

Injuries	Crew	Passengers	Total on board the aircraft	Other
Fatal	0	0	0	0
Serious	0	2	2	0
Minor	0	0	0	0
None	1	1	2	4
TOTAL	1	3	4	4

1.3. Damage to the aircraft

Since the PKBWL investigation team was not present on the scene of the occurrence, no inspection of the aircraft was carried out.

The pilot stated that despite the balloon coming into contact with trees, followed by a subsequent hard landing which caused the basket to overturn, he did not identify any damage to the envelope, basket or equipment.

1.4. Other damage

No fire occurred.

1.5. Personnel information

1.5.1. Pilot-in-Command

Pilot: male, aged 29.

Licence: BPL – Balloon Pilot Licence.

Ratings endorsed in the licence:

- hot-air balloon, Group B;
- performing flights in commercial operations;
- tethered flights.

Overall flight time: 473 h, including as PIC: 468 h, number of landings: 440.

Type flight time: Z-160: 100:30 h.

Flight time before the occurrence:

- within last 24 h: 2:55 h on Z-160;
- within last 7 days: 2:55 h;
- within last 90 days: ~4 h on G30/24 and Z-160.

Check in flight – passed "initial check and check in flight", carried out on 3 May 2022.

Aero-medical certificate – Class II and LAPL with VDL[1], valid until 24 September 2023

Rest during last 48 h – the pilot had been provided with 12 h rest time in hotel accommodation.

Familiarity with the terrain in terms of landing and the pilot's experience on the flight path – the pilot had performed landings in random terrain in the area concerned.

Location in the basket and actions undertaken – during the occurrence, the pilot was operating the balloon and was the only crew member.

[1] VDL - a limitation concerning far vision, resulting in the obligation to wear corrective glasses and carry one reserve pair of glasses.

1.6. Aircraft information

The Cameron Z-160 (Fig. 5) is a hot-air balloon with the capacity of 4.531 m^3. Z-160 balloons are used for recreation flights with passengers. The structure of the envelope is sewn from nylon gores. The envelope is fitted with the so-called rapid deflation system (RDS), which provides for rapid discharge of hot air from it.

The balloon's T2 basket, manufactured by Lindstrand Balloons Ltd., USA, model BA434, is made of wicker. It has two passenger compartments and a pilot compartment. The basket has 24 safety handles for passengers. The gas cylinder fitting system provides for carrying 4 gas cylinders on board.

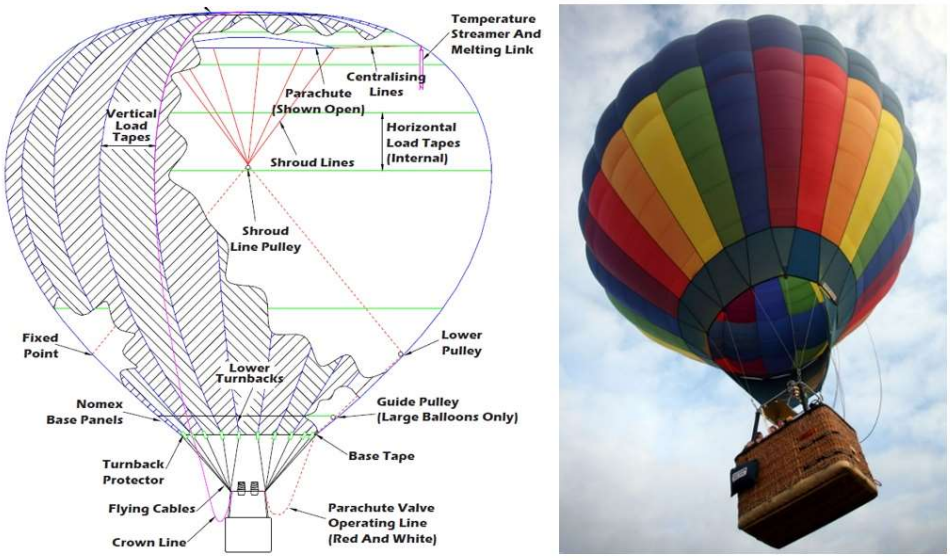

Fig. 5. The Cameron Z-160 balloon [source: Flight Manual / Internet]

1.6.1. Airworthiness and maintenance

a) General information:

- the manufacturer of the balloon – Cameron Balloons Ltd., United Kingdom;
- manufacturer designation (model) – Cameron Z-160;
- TCDS: EASA.IM.BA.013;
- serial number – 12393;
- year of manufacture – 2020;
- owner/operator – Aviation Services – Usługi Lotnicze "BLUE SKY BALLOONS";

- Certificate of Registration – date of entry 1 October 2020, no. of registry 364 – valid as of the day of the occurrence;
- Certificate of Airworthiness (CofA) – issued on 12 October 2020, no limitations – valid as of the day of the occurrence;
- Airworthiness Review Certificate – valid until 29 September 2023

b) History of the aircraft:

- time since new – 133:20 h;
- time since overhaul – no overhaul carried out;
- time since last check (annual/100h maintenance) – 14:30 h;
- modifications – none;
- balloon log book – kept clearly and up to date, without any errors or deletions;
- operating documentation – an EASA-approved Flight Manual (FM), revision no. 18, assigned to the specific aircraft;
- maintenance documentation – consisting of maintenance records in the balloon log book and separate confirmation of release to service. Continuing airworthiness supervision was provided by CAMO LT.MG.034.

c) Burners: One BU-0080A001 double burner, manufactured by Lindstrand Hot Air Balloons Ltd.

d) Fuel:

- recommended – liquefied propane-butane (LPG) under pressure;
- used during the flight – liquefied propane-butane under pressure;
- quantity on board – reserve for 90 min of flight;
- distribution on board – gas contained in three cylinders fitted in the balloon's basket in the gas cylinder compartment.

e) Devices and generators which malfunctioned during the flight – none.

f) Defects – none identified.

g) Aircraft load:

- MTOM: 1,451 kg (as per TCDS);

- DOW: 418 kg (as per weighing report);
- mass of passengers and baggage – as per the loading list: 685 kg;
- fuel mass: 128 kg (including the gas cylinders);
- actual take-off mass: 1,231 kg;
- minimum landing mass: 726 kg;
- actual landing mass (actual take-off mass - mass of burnt gas - mass of four passengers): 807 kg.

1.6.2. Aircraft systems or components which influenced the accident – none

1.7. Meteorological information

Before take-off, the pilot measured the wind with a helium-filled balloon. For the height range between 50 and 100 m AGL, he obtained the following results:

- wind speed: 1 m/s;
- wind gusts: none;
- navigation direction of the wind: 70÷90°.

Weather conditions as per the METAR for EPKK, around 72 km from the balloon's lift-off site, as of 19 March 2023 at 14:00 hrs (13:00 hrs UTC) were as follows:

METAR EPKK 191300Z VRB02KT CAVOK 15/M02 Q1016=

Which means:

- date: 19 March 2023
- time: 13:00 hrs UTC;
- wind direction: variable, wind speed: 2 kt;
- visibility at least 10 km, no clouds below 5,000 ft, no Cb (Cumulonimbus) or TCU (towering cumulus) clouds, no precipitation, storms, etc.;
- ambient temperature: 15ºC;
- dew point temperature: minus 2ºC;
- pressure: QNH = 1016 hPa.

1.8. Aids to navigation

None were used.

1.9. Communications

The pilot had a portable radio operating on the aviation range VHF 118 – 137 MHz, for which an applicable radio licence was issued. The pilot stated that he had remained in radio and telephone contact with a ground crew throughout the flight.

1.10. Information on take-off and landing site

The balloon took off and landed in a random terrain, the vicinity of the town of Szaflary and Bór near Nowy Targ respectively. The local terrain (Orava-Nowy Targ Basin) is characterised by diversified topography with the average elevation of around 630 m AMSL.

The landing took place at the edge of a grassy meadow, around 600 m to S from the start of RWY 30 at the EPNT aerodrome, close to a dirt road and an adjacent field fenced off from the road by a mesh fence (Fig. 6, see also Fig. 3).

Coordinates: 49°26'52.7"N; 20°03'24.5"E

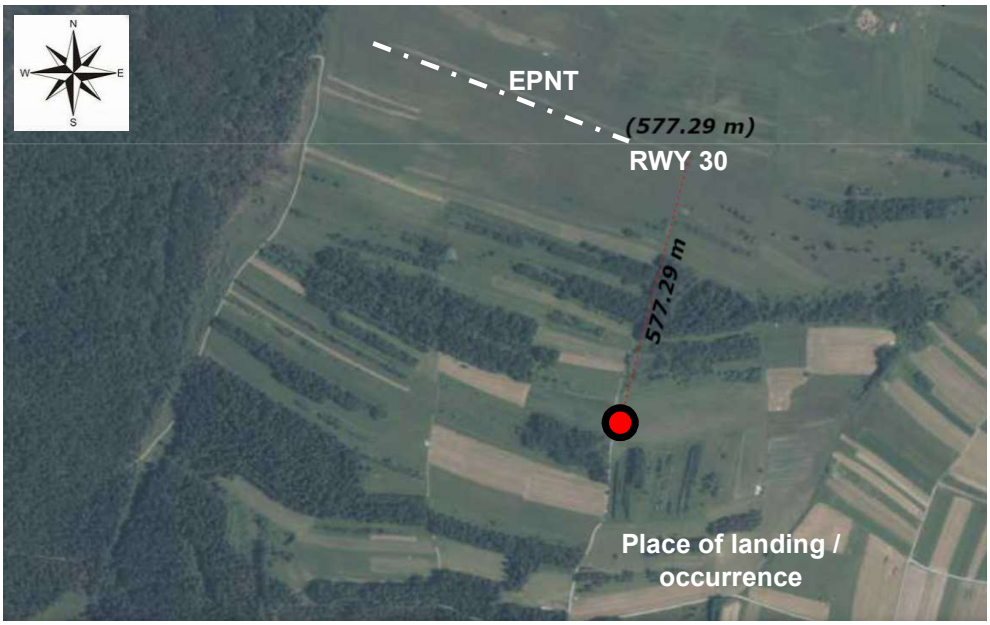

Fig. 6. The place of landing/occurrence relative to the position of RWY 30 at the EPNT aerodrome [source: Geoportal]

1.11. Flight data recorders

The pilot possessed a device named Flytec Balloon Live Sensor, which recorded flight parameters. The pilot provided the Commission with an IGC file for analysis. The file contained a complete record of the flight from Szaflary to the town of Bór, covering the first, correct, landing. However, it did not contain any records from the moment the balloon was lifted off and collided with the ground.

1.12. Wreckage and impact information

The pilot stated that after the occurrence, when disassembling the balloon for transport, he had not identified any damage to any of the balloon's elements. As a result of the collision with the ground (hard landing), at a low forward speed, the basket of the balloon and the partially deflated envelope overturned.

1.13. Medical and pathological information

As a result of the accident, two female passengers in the basket sustained serious injuries. They were transported to the hospital, where they received medical treatment and were hospitalised. The third female passenger and the pilot did not sustain any injuries.

The passengers who had disembarked from the basket did not sustain any injuries.

The pilot stated that for landing, he had worn a safety belt, which is a part of the basket's equipment. This is a requirement of the landing procedure specified in the FM.

The pilot was not under the influence of alcohol.

1.14. Fire

No fire occurred.

1.15. Survival aspects

During the preparation for the flight, before take-off, the pilot conducted a passenger briefing. The pilot stated that he had briefed all the passengers the position they had to assume for landing. After lift-off, but before the hard touch-down, the pilot gave instructions on positions to be assumed for landing. The female passengers were in separate passenger compartments, and one of them in the same compartment with the pilot.

The position for landing required bending the legs slightly and holding the handles on the basket. The pilot explained that he could not control the positions of the female passengers prior to impact. He was preoccupied by operating the rapid deflation system and did not monitor how the female passengers behaved. A fragment of the basket (lying on the ground) with the equipment configuration is shown in Fig. 7.

Fig. 7. Configuration of the balloon's basket – partially visible are the passenger compartments and components: burners and 3 gas cylinders [source: materials obtained from the pilot].

The basket turned over on impact against the ground due to the forward movement of the balloon caused by the effect of the wind. During the hard landing, the female passengers and the pilot were subjected to strong G-force and inertial force directed downwards and in the direction of the balloon's movement.

It was not established whether any of the female passengers fell out of the basket as it collided with the ground and overturned.

The impact took place with the burners on and gas valves on the gas cylinders open. In one of the compartments, there were three metal cylinders. The reserve of gas was around 60 l. These circumstances posed a real hazard of burns to the persons in the basket, and of a fire of the balloon.

1.16. Tests and research

None carried out.

1.17. Organisational and management information

The company organising commercial flights in the Z-160 balloon was entered in the "Registry of entities performing air carriage or providing air services with the use of balloons" kept by ULC (entry no. PL.BOP.008).

The scope of the entity's activities included "paid passengers operations carried out with a balloon". The entity was authorised to provide passenger carriage services.

Passenger balloon flights were performed in accordance with the guidelines outlined in the operations manual (applicable to the organisation concerned).

1.18. Additional information

Before publication of the final report, PKBWL consulted its draft, requesting the interested persons, entities and authorities to submit their comments:

a) the Pilot-in-Command of the accident aircraft submitted his comments concerning the circumstances of the accident;

b) the operator of the balloon submitted comments concerning the draft final report;

c) the Polish Civil Aviation Authority submitted its comments;

d) a translated draft of the final report was submitted to AAIB (representing the State of manufacture) and EASA. The aforementioned institutions raised/did not raise any comments to the draft final report.

1.19. Useful or effective investigation techniques

Standard investigation techniques were applied.

2. ANALYSIS

2.1. General provisions

The Investigation Team was not present at the scene of the occurrence. PKBWL was notified about the accident by the pilot of the balloon. The pilot submitted a statement and provided explanations, in addition to a record of the flight from a flight recorder device. The record was analysed with the use of the SeeYou software developed by Naviter.

2.2. Flight operations

2.2.1. Pilot qualifications

The pilot's qualifications are described in Point 1.5. The pilot held the required licence, relevant ratings and an aero-medical certificate.

He met the requirements specified in the operations manual applicable to the organisation concerning carriage of people by balloon.

He performed his first flights of the 2023 season a day before (after a break of 3 months). The flights included two 1-hour commercial flights with passengers in the same balloon.

In December 2022, the pilot performed two training flights on another balloon type, and in November 2022 six flights on Z-160, also with passengers.

The investigation team established that in 2019 the pilot was involved in an occurrence – an aviation accident (occurrence no. 1656/19). The said accident, which involved a Schroeder "G" balloon, took place during a recreational flight with two persons on board. The PKBWL investigation team investigating the occurrence established that it had been cause by "(…) a pilot error consisting in selecting a landing site that was too close to an overhead power line located in the direction of the landing".

2.2.2. Operating procedures

The operating procedures referred to in the operations manual, applicable to the organisation and the pilot, were met. In particular, the pilot-in-command conducted the required passenger safety briefing concerning landing.

The operations manual contains a clear provision that states that a passenger is not a member of the crew (air crew), which is understandable and obvious. Therefore, it means that unqualified passengers should not be involved in tasks relating to securing the balloon, in particular tasks that may pose a potential threat to them.

Such dangerous tasks may include moving the balloon by passengers on the landing site, especially when the aerostate has not settled on the ground – as was the case in the occurrence concerned. The obvious, albeit not only threats include person outside the basket being crushed under it and/or lifted into the air.

Although the operations manual contains a provision that in special cases related to the safety of the balloon and persons carried on board, the pilot-in-command is authorised to give "any orders", one cannot consider the need to move the balloon on the landing site as such a special case – whether necessary or urgently necessary. The circumstances did not require the pilot to involve the passengers in any actions related to securing the balloon.

It must be noted that a short time after the landing (and after the accident), a ground handling car with a qualified assistant arrived at the scene. The pilot estimated that time to be 10 minutes, but it was likely to be shorter.

The passengers together with the pilot should stay in the basket and wait for the assistant. The pilot could maintain the balloon in the vertical position (with the envelope over the basket) in order to avoid its possible collapse onto ground obstacles. It was fully possible, as there was a sufficient reserve of gas and, as the pilot stated, "After landing, the balloon was in the vertical position and the wind conditions did not indicate there could be any wind gusts". Therefore, the pilot did not need to hurry to deflate the envelope and risk its emergency collapse onto obstacles.

The balloon should be cooled to the condition in which it could be lifted, and then – after the arrival of the assistant – try to take further actions related to letting the passengers out of the basket, collapsing the envelope and disassembling the set.

In the absence of emergency, passengers should not be given any instructions other than those related to flight safety.

The people on board should not leave the basket until the arrival of the ground crew and until the balloon was anchored or, alternatively, the envelope was deflated (collapsed) - even if that was to take place on the terrain obstacles (the dirt road and/or fence – see also the situation sketch in Fig. 3).

The possible complications after landing should be foreseen based on observations before landing. The said observations should have told the pilot the wind at the ground level had a greater speed than at height, and that its direction was changing significantly.

According to the mass data (passenger mass) recorded in the passenger/loading list, the aggregate mass of the men who left the basked was 344 kg. Such a great reduction of the weight of the aerostate, with its envelope maintained upright, could lead to relifting it into the air, or at least cause a tendency to move the basket on the ground – in the event of a wind gust. The pilot, keeping the burners

on, indeed maintained the balloon in the state of aerostatic balance. This is shown by the fact that he instructed the men not only to move the basket, but also to burden it with the weight of the bodies.

When the balloon was lifted, the pilot, fearing that the men outside the basket, who were holding the balloon, could be crushed under the basket, instructed them to let go of the aerostate. However, one of the men was lifted by the basket and fell to the ground, but he sustained no injuries. The balloon ascended to the tree top height. The situation was recorded by a CCTV camera at the EPNT aerodrome (Fig. 8).

Based on that recording, it was established that the time that passed between the first landing (touchdown) and lifting of the balloon was only around 2 minutes 50 seconds. Over that time, the men got out of the basket and moved it on the meadow for several metres.

Fig. 8. Recording from a CCTV camera at the EPNT aerodrome – a view to S: (a) the balloon after being lifted into the air, just before the accident (the highest point), (b) an enlarged fragment of (a) [source: Aeroklub Nowy Targ]

The Flytec recorder did not record any parameters of that ascent (occurrence). Because the device lacks a function enabling it to automatically detect landing and switch off, it means that the pilot probably switched it off after the first landing.

The height of the balloon, from the base of the basket to the highest point on the envelope, is around 25 m. Based on the photograph (Fig. 8), it can be estimated that the aerostate ascended to the height close to its size, i.e. around 20÷25 m AGL. At the moment the balloon was lifted, the pilot activated the rapid deflation system to prevent the balloon from being lifted to a greater height.

The pilot stated that he could not heat up the air in the envelope to mitigate the touchdown, for "the bottom mouth of the envelope had already closed". This means that the burners were active. The pilot reported that (in accordance with the guidelines in the flight manual) he had turned off the burners and such the gas valves for the first landing. He also stated that he had reopened them after landing in order to keep the balloon in the vertical position and make in possible to move it on the meadow.

After landing, the changing wind direction might not necessarily guarantee that the pilot alone could safely collapse the envelope, i.e. so that it was not damaged by e.g. catching the obstacles. However, it was possible to keep the partially inflated envelope upright. All people on board should have stayed in the basket and waited for the ground crew, with the help of whom it was possible to either professionally collapse the envelope on the grass (meadow) or move the entire set without involving the passengers in the process.

2.2.3. Weather

The pilot attributed the cause of the accident to the thermal conditions (convection) which were not forecast in the weather bulletins, and stated that its appearance had caught him by surprise and he could not effectively counteract it. Prior to the flight, the pilot analysed weather maps and carried out his own wind direction measurement by releasing and observing a helium-filled balloon.

Weather bulletins provide information about the current weather in a given area, whereas weather forecasts may bear a risk of weather phenomena which they do not include.

The pilot should have taken information about the current atmospheric conditions primarily from his own observations during the flight. On the day of the occurrence, the pilot performed two flights, both under VMC, and each lasting around 1 h, over the same take-off and landing area.

In the ground layer, there were wind gusts and changes in the wind direction. These conditions likely affected the thermal conditions. The surrounding terrain can generate updrafts due to the local thermal contrasts (the peatbog, stretches of forest, farming fields). The occurrence took place just before 14.00 hrs. At that

time of the year (late winter, early spring) and day, sun rays fall on the ground at a very large angle, and air masses are normally characterised by strong volatility. In such conditions, development of convection is expected. Absence of cumulus clouds does not mean absence of thermic – the lifting air does not reach the condensation level and clouds do not form, but the vertical air movements are still generated.

The vast surface of the balloon envelope is naturally susceptible to wind gusts, making it practically impossible to keep an unanchored balloon on the ground in the buoyancy conditions.

Therefore, the weather had an impact on the occurrence.

The wind gust which took place caused the balloon to move on the ground. The weather conditions prior to landing indicated that the air in the ground layer is not ideally calm – the wind direction and speed had been changing as illustrated by Fig. 9, which shows the flight path in the final 15 minutes before landing, from the height of around 200 m AGL and below. The coloured line corresponds with the colour scale on the right side of the figure (the so-called ground speed). However, it must be assumed that the speed was equal to the wind speed, as the aerostate gives in completely to the effect of the air, moving with it. Recordings show the balloon touchdown took place at the speed of around 10 km/h.

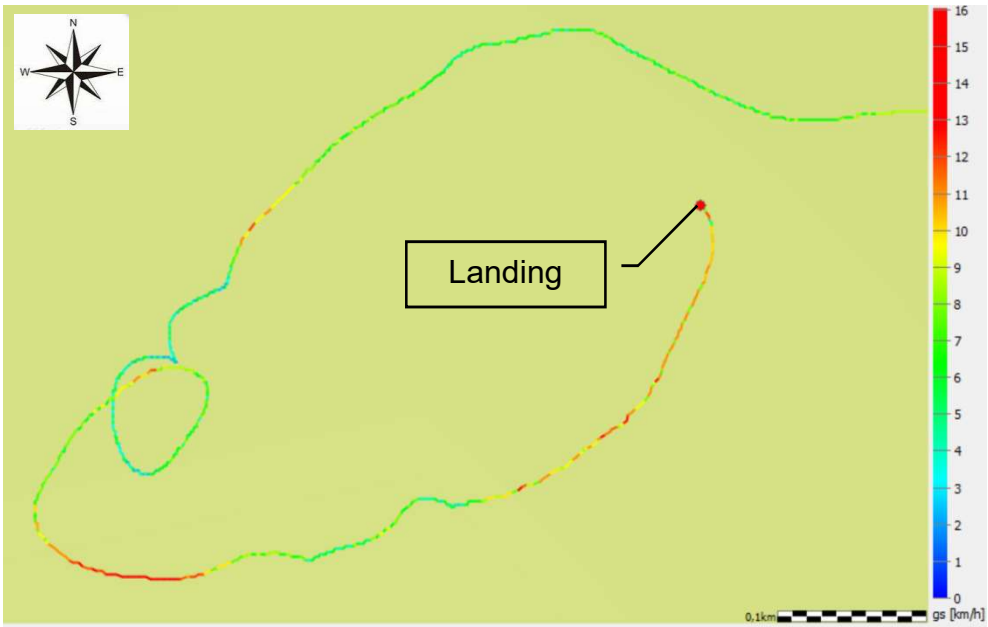

Fig. 9. The path and ground speed of the balloon in the final 15 minutes. The distribution of wind speeds and directions prior to landing [source: SeeYou]

2.2.4. Place of landing

The area of the possible landing was initially identified by the pilot as part of the preparation for the flight. In addition to the weather forecast, the pilot experience

from the previous flight was also important. By analysing the weather bulletins, and comparing the meteorological data with the balloon's performance, the pilot correctly foreseen the landing area to be in the vicinity of the EPNT aerodrome. The flight went on as planned, and within the assumed time the aerostate found itself between the aerodrome and the village of Bór situated to the south. Due to the decreasing reserve of gas and drift of the balloon towards the peatbog (to the south of the EPNT aerodrome), the pilot decided to land. He selected a meadow (wasteland) separated on the west by a dirt road and a fence, and on the south by a small grove.

Due to the fact the wind was stronger and had a variable direction in the ground layer, the landing could not be planned with precision.

The pilot stated that the limited reserve of gas in the cylinders and the vast peatbog in the direction of drifting had made landing a necessity. He estimated that before landing he had had around 40% of gas left after one hour of flight.

2.3. Aircraft

2.3.1. Aircraft maintenance

The balloon was maintained in accordance with the maintenance schedule and within the required scope.

2.3.2. Aircraft performance

It was not demonstrated that the serviceability of the aircraft, including equipment installed on board, had any impact on the occurrence and place of the accident.

The aircraft was operational. The rapid deflation system performed correctly.

2.3.3. Mass and balance

The balloon take-off and landing mass was not exceeded.

2.3.4. Aircraft equipment

The balloon's systems, such as burners, gas cylinders and equipment, were compliant with the provisions of the FM.

2.3.5. Aircraft systems

Not applicable.

2.3.6. Human factors

Due to the limited manoeuvrability, characteristic of balloons, depending on the wind direction at the flight level, it is not possible to plan landing on a pre-selected landing site(s). Depending on the weather and terrain conditions, as well as the gas reserve and other factors, the pilot selects a location that is most suitable for

landing. Most frequently it is a grassy meadow at an appropriate distance from local terrain obstacles (buildings, trees, power lines, roads, other).

It seems that the decision made by the pilot just after landing to involve the passengers in operating the balloon was too hasty and reckless. The pilot did not consider the weather factor or changed performance characteristics of the balloon after four passengers left the basket. Psychological and physiological factors which affected the personnel involved in the accident

The forward movement towards the trees, contact with the trees and the balloon lift-off occurred suddenly and unexpectedly. The pilot and passengers alike in no way expected that such a situation could take place. The pilot acted under time pressure, initiating emergency deflation of the balloon's envelope. It is likely that he was unable to appropriately prepare the three female passengers to assume the emergency landing position, which involves bending their legs slightly in the basket and holding onto the handles with both hands. The pilot focused mainly on controlling the balloon, activating the rapid deflation system. Although he gave another instruction to assume the landing position, he was unable to control or correct the female passengers' positions. The injuries sustained by one of the female passengers could have been caused by her assuming an inappropriate position before impact against the ground.

2.4. Survival aspects

2.4.1. Response by rescue services

After the accident, the pilot was actively involved in assessing the condition of the injured, checking their consciousness, contact and injuries sustained. He administered pre-medical assistance. After the arrival of the ground crew, he notified the occurrence to the rescue services by telephone. The arrival of the rescue services was coordinated by a person from the balloon crew.

The female passenger with a spine injury was given medical treatment by the ambulance crew and was taken to hospital, where she underwent surgery.

The pilot, who did not sustain any injuries, was instructed by the paramedics and administered medical assistance to the female passenger with a leg injury.

2.4.2. Analysis of the injuries

Based on the information collected, it was established that two female passengers present in the basket had sustained serious injuries – to the spine and leg - which resulted in hospitalisation and long recovery.

2.4.3. Survival aspects

Balloon passengers are not secured with safety belts, and have only handles inside the basket to hold on to. Every hard landing/collision with the ground and/or an obstacle, as well as the related overturning of the basket may lead to serious health consequences.

The balloon's basket was equipped only with a safety belt for the pilot, and the obligation to use it (fasten it) arose directly from the procedures laid down in the FM. The pilot probably unfastened the safety belt after the first landing. However, he did not foresee that the balloon would be lifted into the air again.

The three metal gas cylinders were fitted in the special compartment and remained in their place.

One of the injured female passengers probably sat on the bottom of the basket, which was a wrong position for landing and could contribute to her injuries.

There was a risk that the people in the basket could sustain burns and a fire would break out, as the burners remained active (the pilot did not manage to turn them off after the balloon had been lifted), and the gas cylinders remained open. The gas feed system was filled with flammable gas.

The balloon's heavy basket, moving just above the ground, could pose a threat to the persons who were trying to hold it. According to a witness account, the distance of the uncontrolled movement on the meadow was around 50 m. The pilot's reaction, who ordered the persons outside the basket to let go of it, clearly prevented lifting some of them into the air and saved them from sustaining possible serious injuries. However, one of the men was lifted by the basket and fell to the ground, but he sustained no injuries.

3. CONCLUSIONS

3.1. Findings

3.1.1. The aircraft was certified, equipped and maintained in accordance with applicable regulations and approved procedures.

3.1.2. The aircraft has a valid Certificate of Airworthiness.

3.1.3. As of the moment of starting the flight, the balloon was airworthy.

3.1.4. The balloon's take-off mass was within the limits prescribed in the Flight Manual.

3.1.5. The minimum landing mass was not exceeded.

3.1.6. There was no defect or malfunction of the aircraft that could contribute to the accident.

3.1.7. No damage to the balloon or malfunction of its systems before or after the accident was found.

3.1.8. The pilot held a licence and qualification to perform the flight in accordance with applicable regulations.

3.1.9. The pilot held an appropriate medical certificate and was sufficiently rested to perform the flight.

3.1.10. The pilot observed the regulation concerning the time of the flight and flight duties.

3.1.11. The pilot instructed the passengers to become involved in ground handling of the aerostate.

3.1.12. The pilot's actions and statements showed that he had sufficient knowledge and understanding of the aircraft's systems.

3.1.13. The operations manual did not contain clear procedures on involving the passengers in ground handling of the balloon, e.g. after landing.

3.2. Causes and contributing factors

3.2.1. The pilot's haste in taking actions after landing.

3.2.2. The pilot's order to four of the seven passengers to leave the balloon's basket to move the balloon on the meadow.

3.2.3. Keeping the balloon in the flying condition after landing (the state of aerostatic balance).

3.2.4. Inaccurate diagnosis of the weather factor, based on weather forecasts and not on the assessment of actual weather conditions.

3.2.5. Failure to secure the balloon against movement or lift-off before some of the passengers left the basket.

3.2.6. Landing close to terrain obstacles.

4. SAFETY RECOMMENDATIONS

None.

5. ADDENDA

None.