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MINISTRY OF INFRASTRUCTURE

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unofficial translation

FINAL REPORT

ON THE ACCIDENT INVESTIGATION

Of a hot air balloon Lindstrand LBL 150A,

reg. mark OO-BDI,

near Ig – Ljubljansko barje ,

January 22, 2022

Republic of Slovenia

» 2022 «

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INTRUDUCTION

The final Aircraft Accident Investigation Report contains the facts, analysis, causes, and safety recommendations of the Aircraft Accident Investigation Board based on the circumstances under which the accident occurred.

In accordance with point 3.1, Chapter 3, Annex 13 to the Convention on International Civil Aviation (12th edition, July 2020), Article 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 (OJ L No 295, 12 November 2010, p. 35), the fourth paragraph of Article 137 of the Aviation Act (Official Gazette of the Republic of Slovenia, No. 81/10 – official consolidated text, 46/16, 47/19 and 18/23) and Article 2 of the Regulation on the Investigation of Aviation Accidents, Serious Incidents and Incidents (Official Gazette of the Republic of Slovenia, No. 72/03, 110/05 and 53/19), **the purpose of the final report on the investigation of the aircraft accident is not to establish guilt or responsibility.**

The final investigation report must undoubtedly serve the purpose of aviation safety.

It is important that the final investigation report be used to prevent aviation accidents or incidents. Using the final aircraft accident investigation report for other purposes may lead to misinterpretation.

SUMMARY

Date and time of accident: January 22, 2022 at 10.00 local time[1]

Place of the accident: in the immediate vicinity of Ig near Ljubljana: N 45°58'17.52" / E 14°32'45.09"

Type of flight: private, VFR flight

Aircraft: hot air balloon

- **Aircraft manufacturer:** Lindstrand Balloons Ltd, England
- **Aircraft registration:** OO-BDI (in the register of the Belgian aviation authorities)

Owner/operator: private

User: private, Belgium

Crew and passenger information:

- **Crew:** pilot (1)
- **Number of passengers:** 5
- **Total number:** 6

Consequences:

Injuries	*Crew*	*Passengers*	*Others*
Fatal	/	/	/
Major	/	**3**	/
Minor/None	1	**2**	

Aircraft and equipment: Apart from minor surface damage to the basket of the balloon, there was no further damage.

[1] In this final report, local time is used. The time of the accident was 9 a.m. UTC (LT-1).

1 FACTS

1.1 Flight information

The pilot and his family travelled to Slovenia with the aim of flying in a formation of two hot air balloons in the Bled area. The weather conditions in this area were not suitable, so he later decided to fly with his family members to the Ljubljana Marshes area, where the weather conditions were announced to be more favourable. He had previously arranged the planned flight with a local hot air balloon pilot, whom they met early in the morning of the day of the accident. In preparation for the panoramic flight, they planned to fly in a formation of two balloons, namely a smaller balloon piloted by a younger member of the family and carrying three passengers, and a larger OO-BDI piloted by an experienced pilot and carrying five passengers, including an experienced local hot-air balloon pilot.

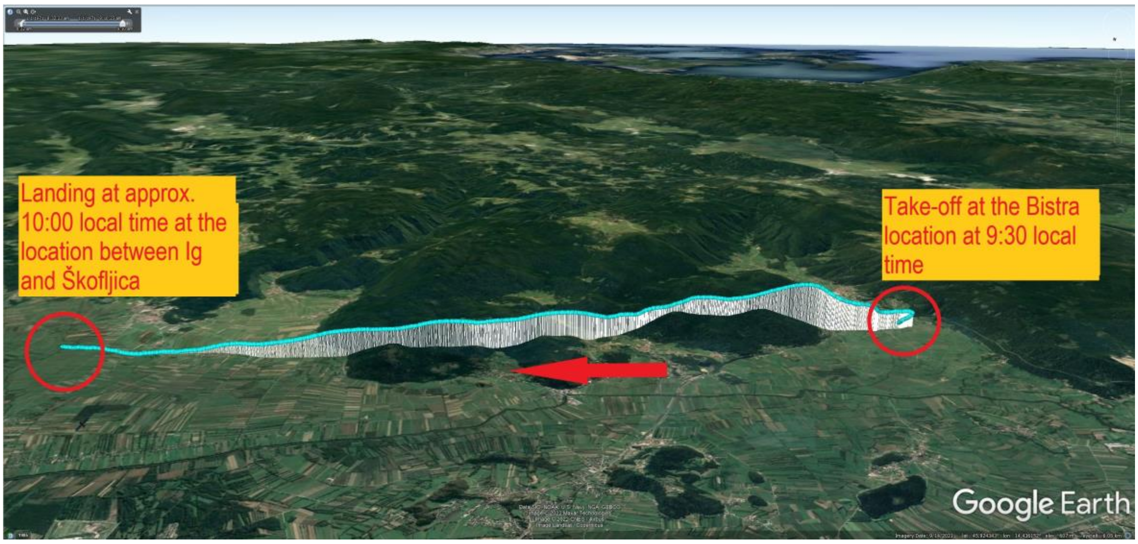


Figure 1: Radar recording of the flight trajectory - KZPS

In preparation, the pilot announced the flight plan with the responsible air traffic control centre (KZPS) and then checked the weather data. At the original location of the planned takeoff, he carried out a wind influence test by lowering a helium balloon. Due to the nature of the terrain and possible obstacles during the take-off, he decided to change the planned take-off place so that both balloons took off at 9.30am after a new wind test and a check of the weather data. The take-off point was located in the town of Bistra in the municipality of Vrhnika, which lies on the south-western edge of the Ljubljana Marshes, between Vrhnika and Borovnica. After taking off in an easterly direction, the two balloons ascended to an altitude of around 1,200 metres above sea level. The flight initially went according to plan and without any particular incidents. Visibility was sufficient, so the pilots of both balloons followed the flight path to the planned landing site, which was located in an open field immediately after crossing the high-voltage power lines near Iška Loka, north of Ig, about 16 kilometres from the take-off location. During the descent, the pilots of both balloons noticed that the wind speed had increased. They coordinated the landing by radio, preparing the passengers for what was likely to be a hard landing and giving them instructions. The pilot of the larger balloon switched off the burners and closed the valves of the gas system before the basket of the balloon hit the ground. Four people fell from the inclined basket of the larger balloon due to a strong collision with the ground. As the weight of the basket decreased, the balloon rose again and collided with the basket on the treetop. After about 50 metres, the balloon descended to the ground again, dragging the inclined basket over the grassy terrain until it came to a halt about 250 metres from the point of initial impact. The basket of the smaller balloon flipped onto its front on the landing line and came to rest on the icy meadow. When the larger balloon landed, three people suffered serious injuries. Nobody was injured when the small balloon landed.

Figure 2: basket of the OO-BDI balloon at the stopping point

After being informed of the accident involving a large balloon, rescue teams from the emergency services, firefighters, and representatives of the police arrived at the scene. A service helicopter flew to the scene of the accident to transport the injured quickly. The injured were taken by ambulance to the University Medical Center Ljubljana. Before the investigators arrived, the police secured the scene of the accident sufficiently. The possibility of a fire or explosion was ruled out.

1.2 Crew information

1.2.1 Pilot

The pilot, 56 years old and an Belgian citizen, is the holder of:

- BPL Hot Air Balloon Pilot Licence with date of issue: August 1, 1997 – BE;
- Authorisations: FI(B), FE(B) valid until October 31, 2025;

- Medical certificate for category 2 (medical certificate class 2), valid until 12/06/2022 and LAPL until 12/06/2023, issued by an authorised organisation - BE.MED.AME.2028 dated 7/06/2021.

The information provided by the pilot involved in the accident shows that he flew continuously in the hot-air balloon category. He is an experienced pilot, instructor, and examiner with a combined flight in the hot air balloon category:

- Up to the date of the balloon accident – 1372 hours, 50 minutes[2],
- In the last 30 days – 3 hours, 10 minutes.

1.3 Hot air balloon information

- Balloon manufacturer: Lindstrand Balloons Ltd, England
- Type: Lindstrand Balloons, LBL.150A (maximum number of passengers 5)
- Balloon registration: OO-BDI (in the register of the Belgian aviation authorities)
- Balloon serial number: 616
- Year of balloon production: 1999
- Balloon owner : Private
- Validity of airworthiness: July 17, 2022[3]
- Balloon registration certificate: issued on June 14, 2013
- Insurance policy: valid until July 19, 2022

1.4 Meteorological data

(Meteorological data obtained by ARSO[4])

There is an area of high pressure over western and central Europe and an area of low air pressure over eastern Europe. The northerly winds brought cold and moist air to us.

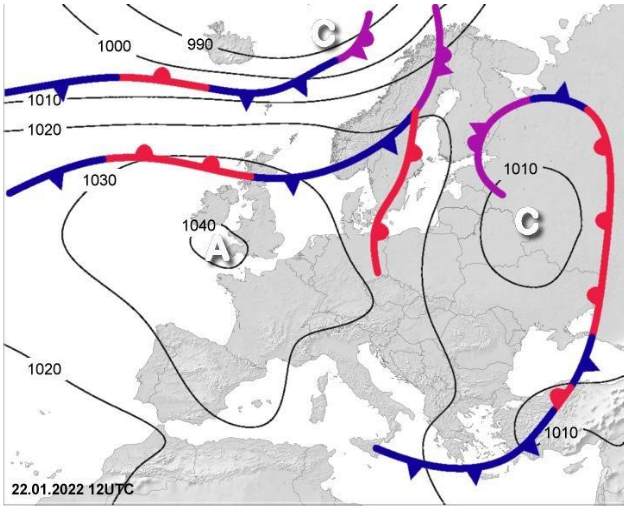


Figure 3: General weather picture over the EU

[2] Based on information from the pilot's logbook
[3] Issued by the approved continuing airworthiness management organisation No BE.CAO.0124 (Annex Vb (Part ML))
[4] ARSO - https://www.meteo.si/met/sl/aviation/

1.4.1 GAFOR - General Aviation Forcast

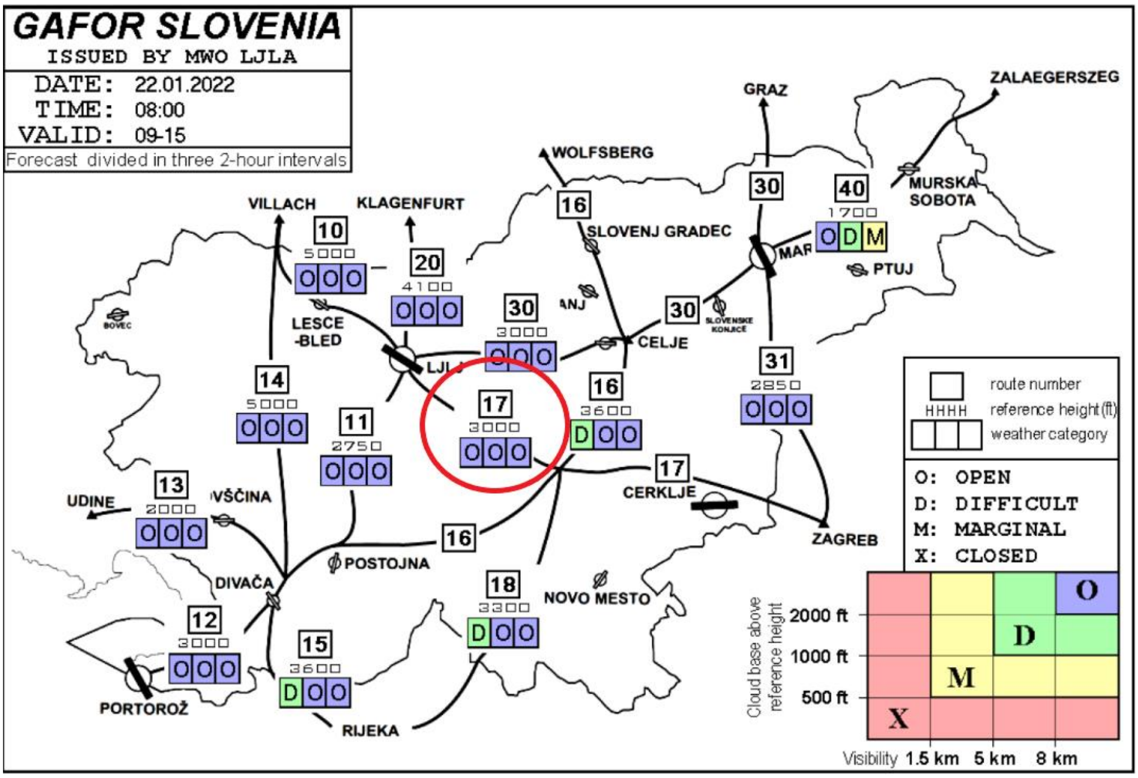
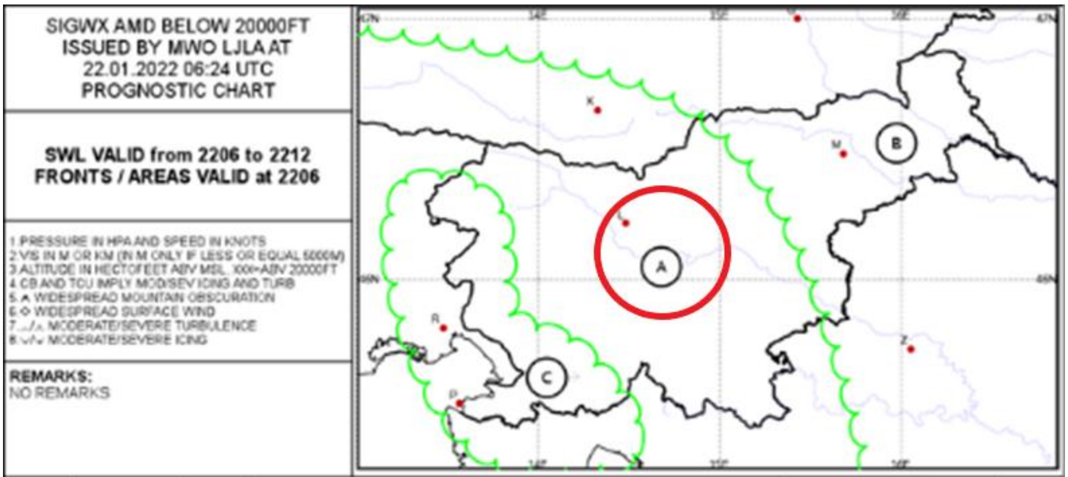


Figure 4: GAFOR forecast predicting suitable conditions for flying under VFR rules

1.4.2 SWL chart of significant weather

The Ljubljana Marshes fall within the area labelled A, for which some stratocumulus clouds with a base at 6000 FT AMSL and locally moderate turbulence above 3000 FT AMSL due to increased winds have been forecast.



AREA	TIME	VIS	WEATHER	CLOUDS	TURB	ICING	0° C
A	06/12 LCA 06/12	15KM	/	NIL/FEW SC 060/090	/ 030/100	/	SFC 030
B	06/12 LCA 10/12	15KM 5000M	/ -SN/-SNRA	BKN SC,AC LYR 060/150 BKN SC 040/100	/	/	SFC 030
C	06/12 LCA 06/10	15KM	/	FEW/SCT SC 060/090 BKN SC 035/080	/	/	030 SFC

Figure 5: SWL chart of significant weather for the time of validity 06UTC and 12UTC

1.4.3 Wind forecasts

On the subpage http://www.meteo.si/met/sl/aviation/ there are various representations of the wind forecasts available, from 2D surface representations by height, time slices by height to plots in the form of sounding measurements (pseudtemp). Some of the relevant products that have been publicly announced can be found below.

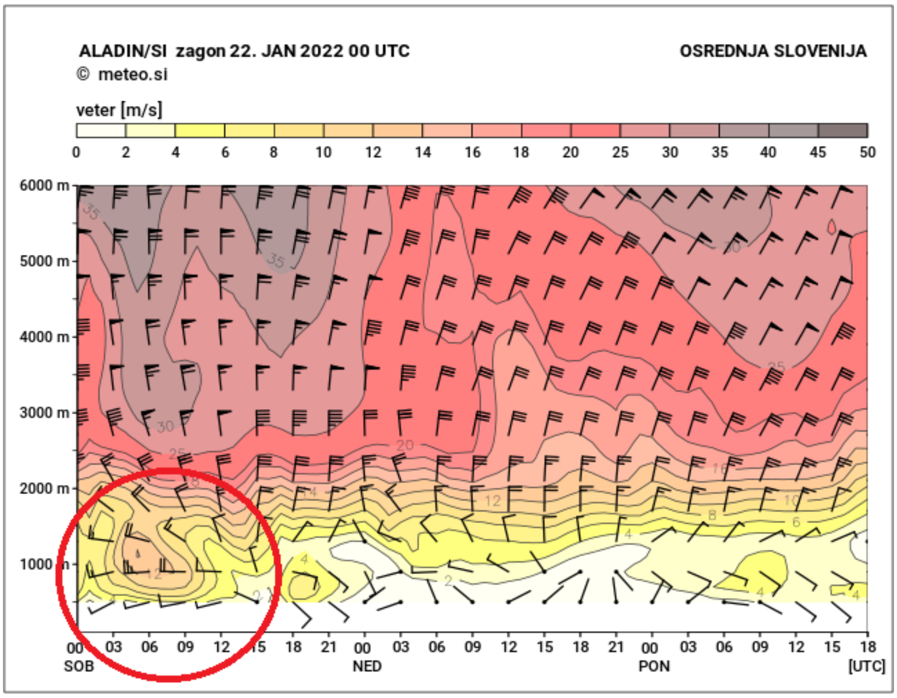


Figure 6: Model wind forecast according to the height of the ALADIN model for the area of central Slovenia: the figure shows a forecast of stronger wind, even in the lower layers

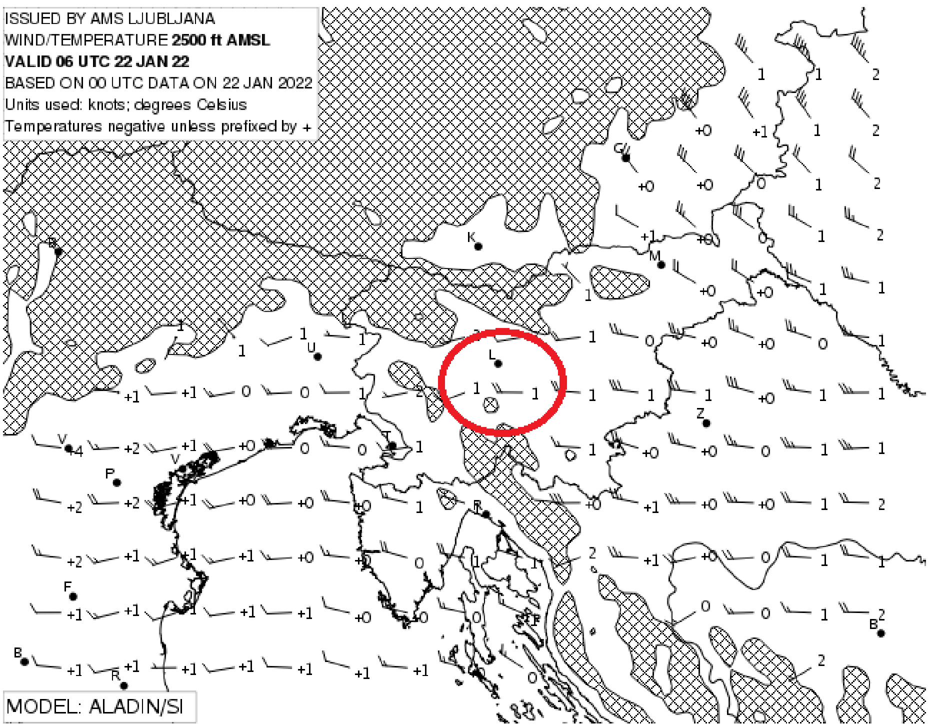


Figure 7: ICAO standard wind and temperature chart of the ALADIN model at 2500 FT AMSL for 06UTC

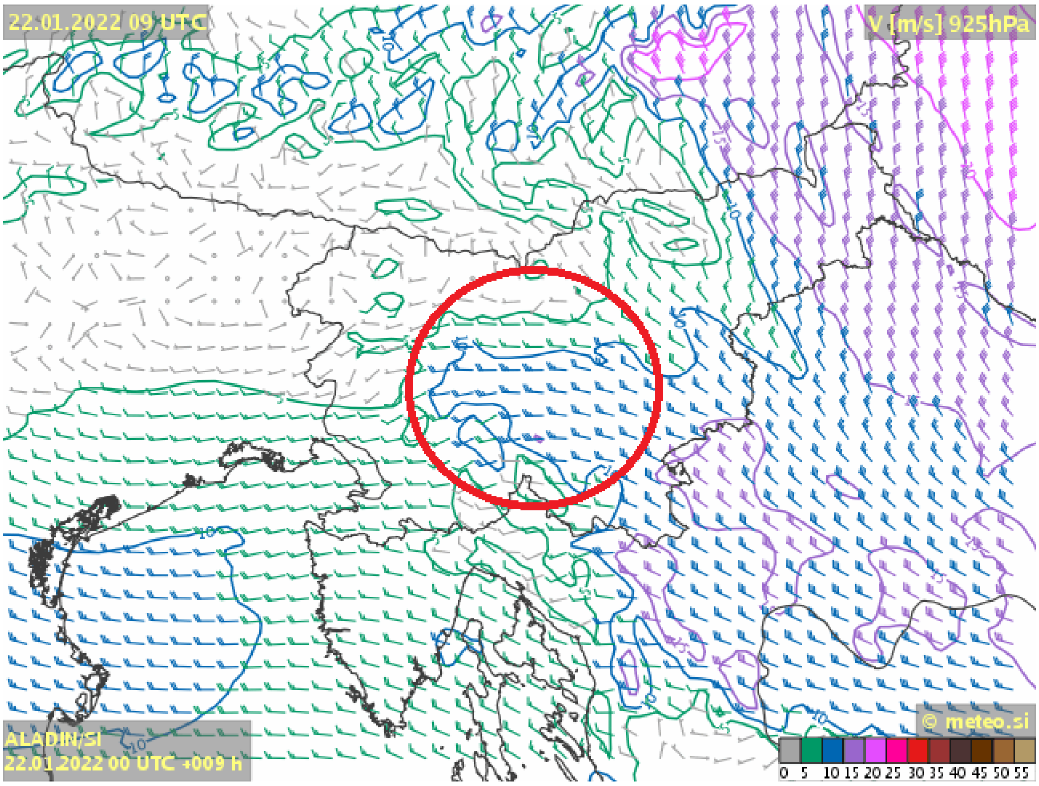


Figure 8: A more detailed map of the ALADIN model winds at about 2500 FT AMSL for January 22, 2022, 09 UTC. The wind legend is given in m/s (blue between 10 and 15 m/s)

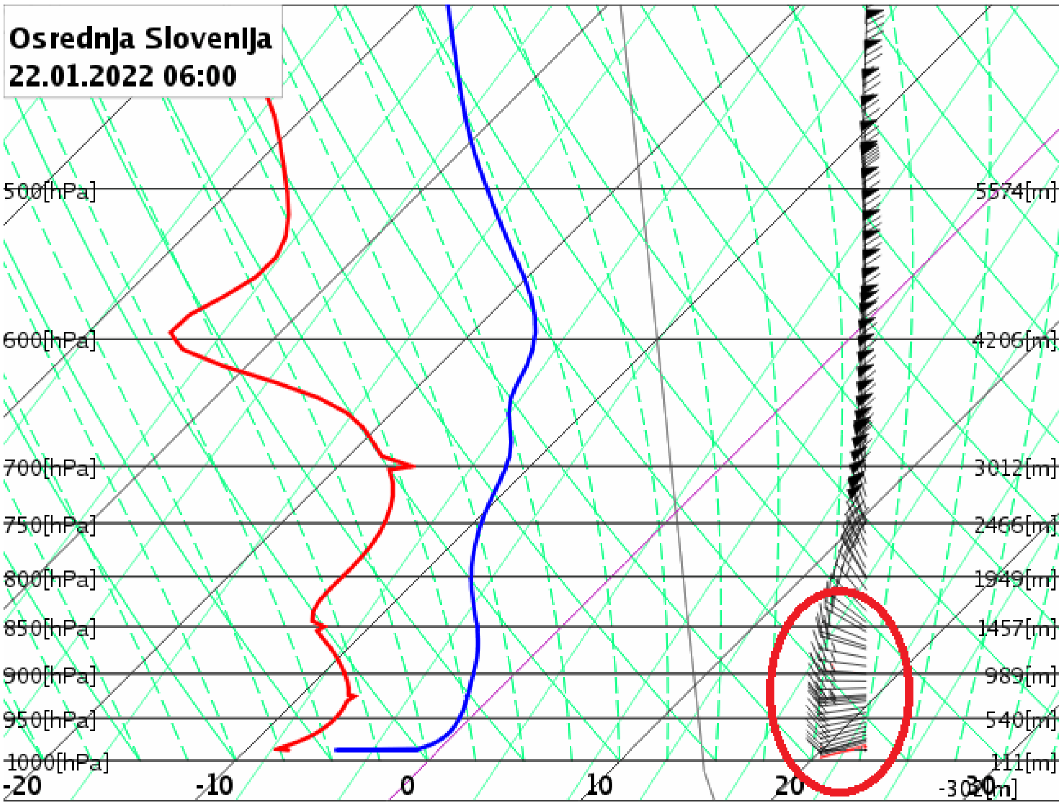


Figure 9: ALADIN model simulation showing how the radiosonde measurement is plotted for 1/22/2022 06UTC[5]

[5] If the wind is indicated with a wind flag, the line shows a speed of about 2.5 m/s (5 kt), the line about 5 m/s (10 kt) and the triangle 25 m/s (50 kt). The values are added together. The wind blows along the flag from the direction in which the speed markings are located.

1.4.4 Measurements and observations

The closest meteorological measurements of the ARSO national network of meteorological stations are carried out in Vrhnika (meteorological station), at the Deponija Barje site (coinciding with the vertical wind profile) and the radiosonde measurement of the atmosphere at the Bežigrad site.

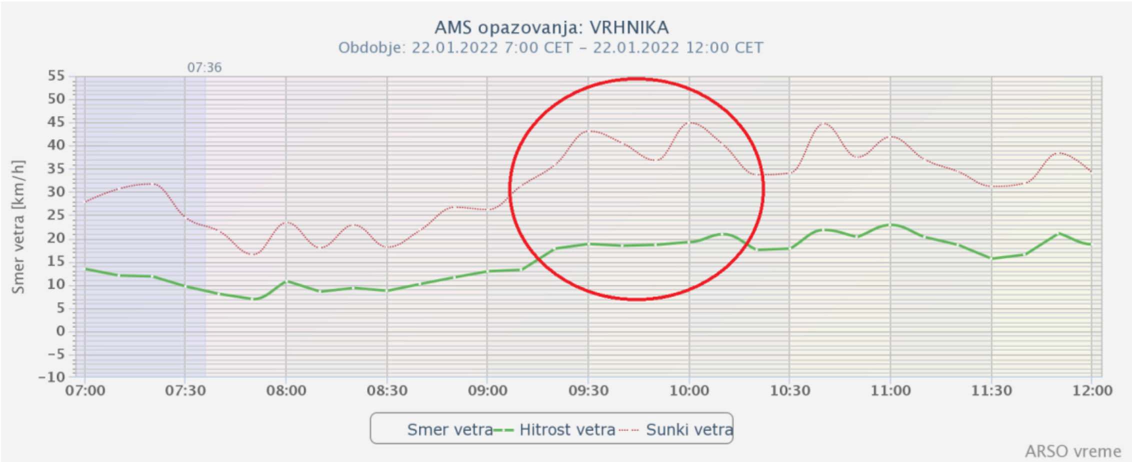


Figure 10: Measurements from the Vrhnika meteorological station, which is located at an altitude of 310 metres. The graph shows the average wind speed (green) and the maximum measured wind gusts (red). The time in the graph is local time (UTC+1)

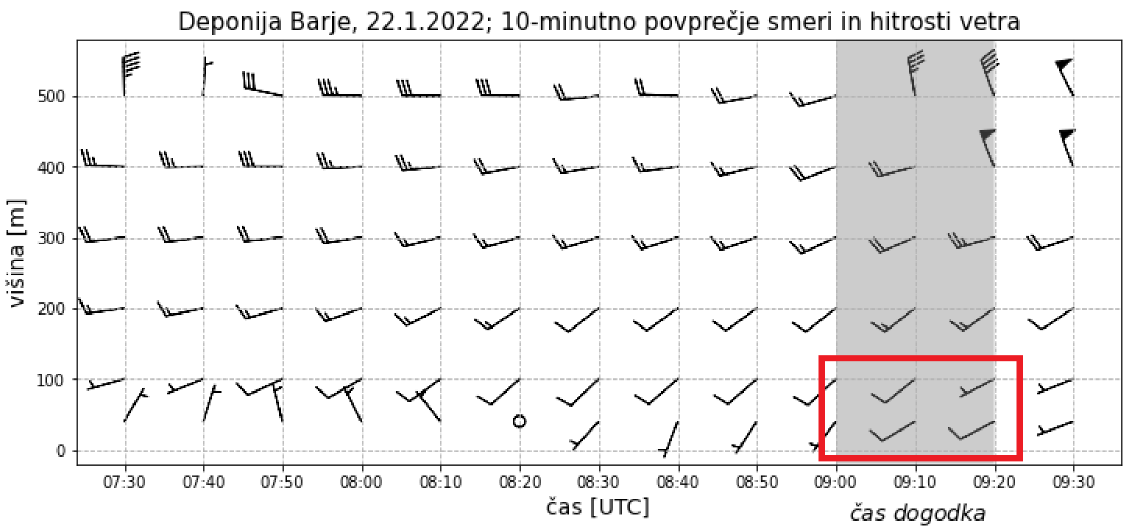


Figure 11: Measurements of the sodar at the site of the Barje landfill. The result of the measurements is a 10-minute average and does not include data on wind gusts. Typically, gusts on the ground reach a factor of about 1.5 to 2.5 in relation to the average ground speed

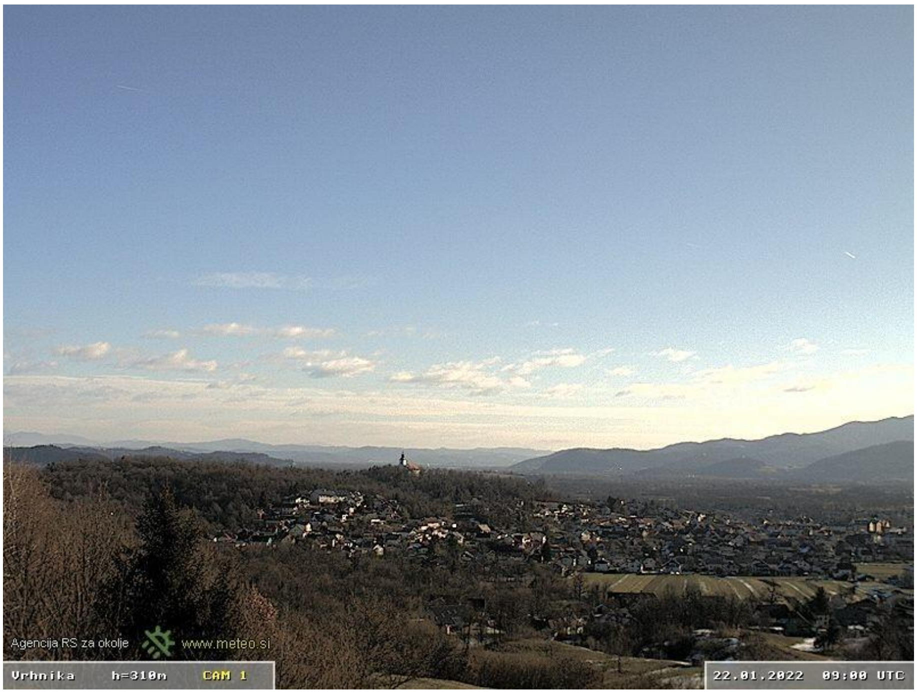


***Figure 12:** Panoramic camera figure from the location of the Vrhnika meteorological station in the direction of the marsh on January 22, 2022, at 9 UTC. The figure shows clouds of the fractus (torn) subtype, which are a fairly typical indicator of increasing wind at altitudes, as well as the presence of turbulence*

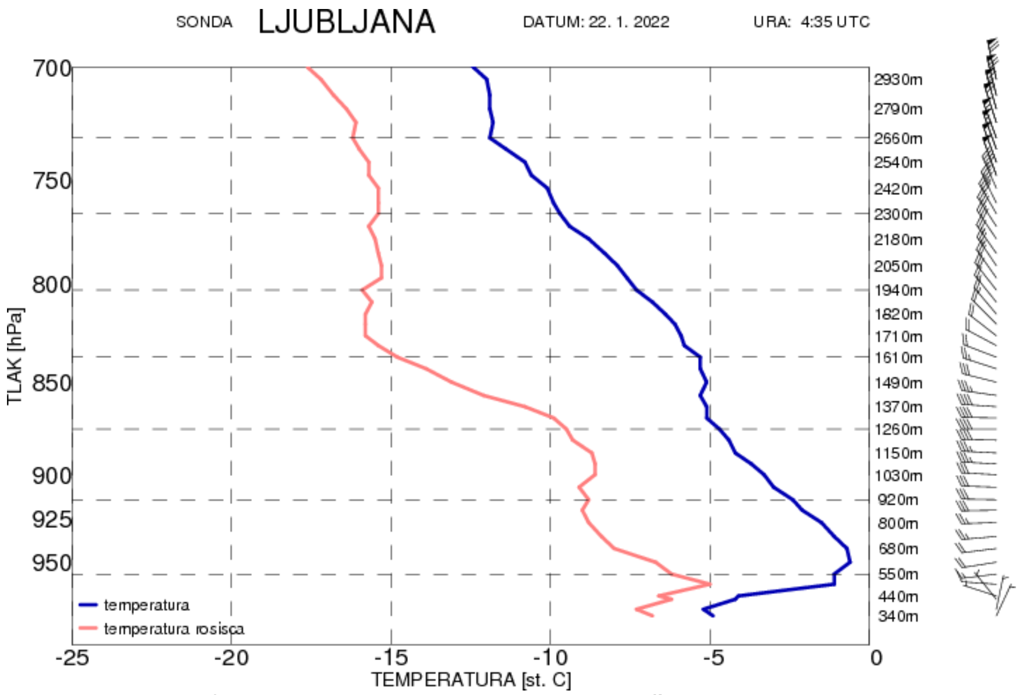


***Figure 13:** The result of a radiosonde measurement at the Bežigrad site. The measurement started at 4:35 UTC, so the morning temperature inversion, which is typical for the colder season, is clearly visible. Above the inversion, the probe measured an increased westerly wind*

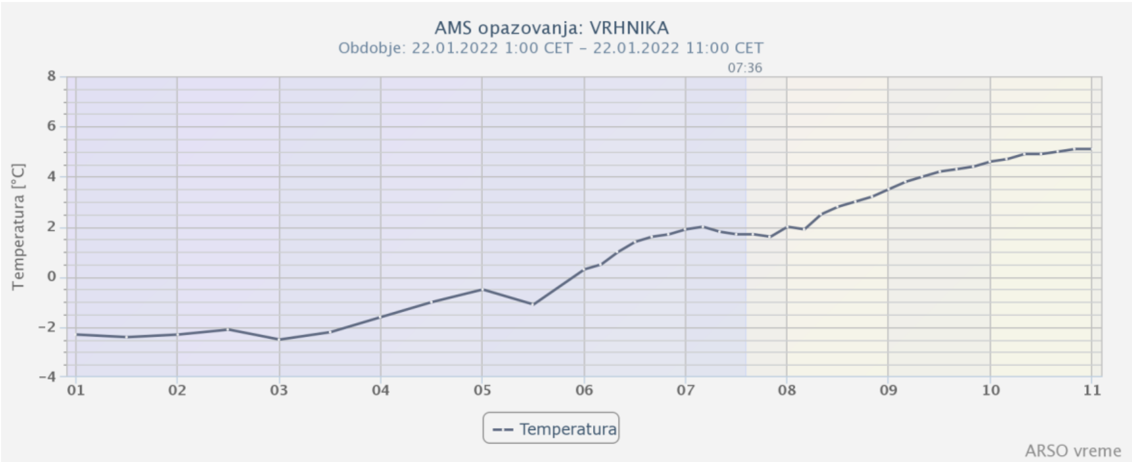


Figure 14: The temperature at Vrhnika station on January 22, 2022. The time is local time (UTC+1). The air temperature began to rise in the second half of the night

1.5 Radio connection information

At the time of the accident, a radio link was established on the frequency of 118.480 MHz. Before take-off, both hot-air balloon pilots checked the operation of the radio stations on the specified frequency and established communication with the KZPS controller. The passenger in the OO-BDI balloon, who is an experienced Slovenian hot-air balloon pilot, was involved in the communication with the controller.

1.6 The course of the investigation

The Aviation Investigation Unit was informed immediately after the event by the Republican Information Centre (ReCO) and OKC Ljubljana. When the investigators arrived, the scene was adequately secured. The inspection of the scene of the accident was carried out in parallel with the investigation by the Ljubljana Police. After documenting the scene of the accident, the investigation continued with interviews and the collection of information. All information necessary for the reconstruction of the event was provided in a timely manner by the pilot, the persons involved in the accident, and other persons and organisations that assisted the investigation commission.

2 ANALYSIS

2.1 Analysis of the preparation and execution of the balloon OO- BDI flight

Originally, the pilot and his family members had planned for the balloon flight to take place in the Lake Bled area, but due to unfavourable weather conditions, the flight was postponed to the next day. The next day, the weather conditions in the Bled area were also unsuitable for a balloon flight, so the location was changed to the Ljubljana Marshes area. When planning the flight, the pilot made contacts and organised a meeting with a local pilot.
On the day of the event, in the early hours of the morning, the family, together with a local pilot, went to Podsmreka near Brezovica, which had been designated as the planned take-off

location. It was determined that the take-off at this location was unsuitable due to various factors, such as unsuitable weather conditions, nearby obstacles, icy terrain, etc. The take-off was cancelled in consultation with the local pilot. The take-off was moved to Dol pri Borovnici in consultation with the local pilot.

For the weather preparation of the flight, the pilot used the TAF data for LJLJ and data from the weather application, which is not known to be on the EASA list of national providers (Figure 15), which predicted a wind speed of 6 kt/s for the landing site. According to one of the passengers, the internet connection to the ARSO weather data was more difficult to access in the take-off area. Preparations for the flight included releasing helium balloons to test the effects of the wind before take-off.

Figure 15: Used weather app in preparation for flight

After completing the pre-flight preparation, the pilot has made the decision to conduct the flight taking into account the weather criteria (BOP.BAS.145 Meteo Conditions—Balloon Air Operations (Part-BOP)), which specify that the pilot will commence or continue the flight under VFR rules if the latest available meteorological information indicates that the weather conditions on the route and at the planned destination are at the estimated time:

- at or above the applicable VFR operating minima; and
- within the meteorological limits specified in the AFM

After the decision was made to carry out the planned flight, the OO-BDI balloon took off in formation with the smaller OO-BLM balloon at 9.30 a.m. local time near the village of Bistra, south of Ljubljana. After takeoff, the balloons ascended normally and without any unusual behaviour. At an altitude of 780 metres, the larger balloon reached its maximum speed, which at one point was 60.9 km/h, in an increasing westerly wind. The final altitude of the flight was 1200 m QNH. From the analysis of the flight path obtained from the KZPS radar image, it was evident that the wind speed during the balloon's descent and landing was significantly higher than expected.

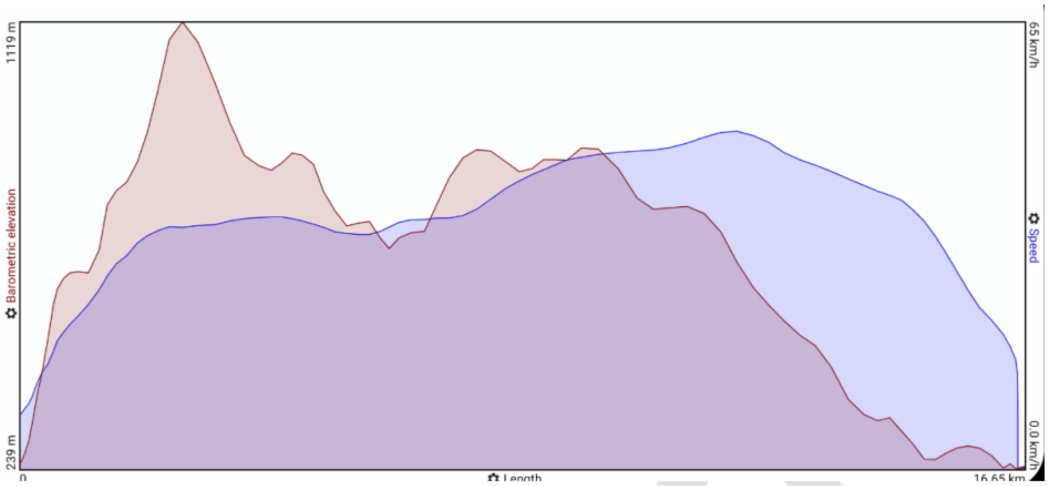


Figure 16: OO-BDI flight profile (red color-altitude, blue color-speed)

The pilot was aware of the increasing wind on the ground, so in the phase before landing, he had the balloon fly in a straight line a few metres above and parallel to the ground surface (as can be seen on the KZPS radar images - figure no. 1) and at the same time warned the passengers that the landing would be hard and had them prepare for it. The pilot stated during the investigation:

Just before the first impact with the ground, I turned off the throttle, opened the exhaust system to the limit, and alerted my passengers to the first impact of the basket with the ground. We all coped well with the first impact, but the balloon was no longer in its normal sailing position but made a rocking motion, followed by a second impact that tilted the basket relative to the ground. I informed the passengers again that there would be a second collision. In the second collision, 4 passengers fell out of the basket due to a strong impact with the ground. The basket then rose a few metres back into the air after the weight shift and got caught between the branches of a nearby tree. The balloon then dragged the basket along the ground for about 50 metres until it came to a standstill. When the balloon was completely deflated, I took care of the injured passengers.

According to the analysis, the smaller balloon had a landing speed of 18,5 kt (9.3 m/sec) at the time of the first collision. Both balloons had a continuous, gentle descent in a line from the beginning of the descent after crossing the power line with a westerly wind that was stronger than the estimated wind at the take-off site.

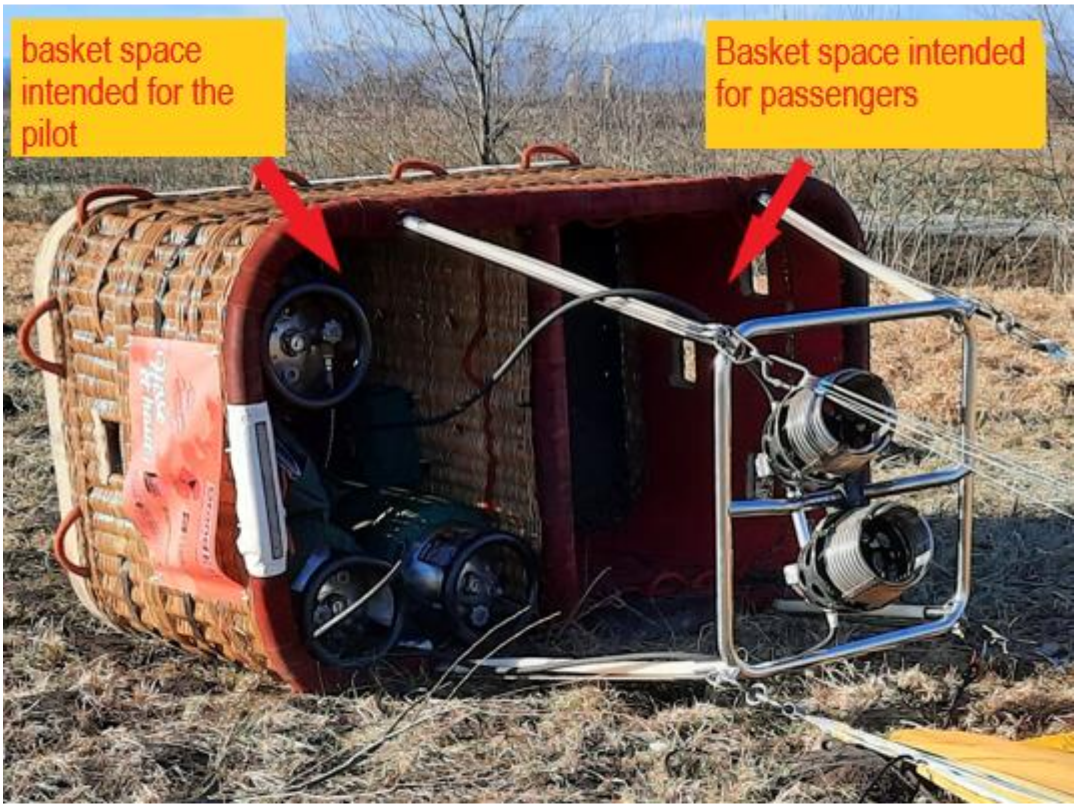


Figure 17: Basket of the OO-BDI balloon at the stopping point

2.2 Weather analysis

2.2.1 General

Weather data for the preparation and execution of flights in the airspace of the Republic of Slovenia is provided by the competent agency of the Republic of Slovenia for the environment - ARSO[6], as stipulated in the Act on the Provision of Air Traffic Navigation Services and the Act on the State Meteorological, Hydrological, and Oceanographic Service. In the field of aviation meteorology, the information is published in the AIP Compendium of Aeronautical Information[7]. Personal advice and support for flight crew members is offered at LJLJ International Airport. For all other users, advice from a meteorologist or forecaster is available free of charge and around the clock (24/7). Unlike other national providers within the EU, access to aviation weather data does not require prior registration on the ARSO website (link to EASA information[8]).

Meteorological information for general aviation is usually provided at the request of the pilot or his organisation by telephone or as a briefing directly from the ARSO weather service. At the time of the event, the subpage http://www.meteo.si/met/sl/aviation/ was dedicated to aviation,

[6] https://meteo.arso.gov.si/met/sl/aviation/ Access to weather data for aviation

[7] The AIP is a fundamental document for aviation that primarily serves to fulfil the international requirements for the exchange of permanent aeronautical information and temporary changes that are essential for aviation. In the field of meteorological data, the information available to users of the airspace of the Republic of Slovenia is provided on the AIP website – https://www.sloveniacontrol.si/acrobat/aip/Operations/2024-01-26/html/index.html

[8] EASA list - information of national providers of aviation meteorological data: file:///C:/Users/mzip182/Downloads/NMS%20aviation%20weather%20contact%20details%20v1.1%2023%20Jul%202019.pdf

where specific information for aviation users was collected. Specific forecasts and measurements were also available on this page.

2.2.2 *Analysis of weather data during the event*

Based on the data obtained and publicly available information, the ARSO weather service forecast suitable conditions for flying to VFR on the day of the accident for the wider area of the Ljubljana Marshes:

- suitable conditions for flying under VFR rules;
- the presence of individual stratocumulus clouds with a base at 6000 FT AMSL;
- local presence of moderate turbulence above 3000 FT AMSL;
- increased wind in the central part of Slovenia with an average speed between 36 km/h and 50 km/h at an altitude of about 2500 FT AMSL (Figures 7 and 8).

Otherwise, different wind conditions prevailed in the area of the LJLJ airport, which is about 25 km from the accident site. In the TAF weather forecast data for LJLJ Airport, there was data for the wind, which was expected to be 2 kt when the flight was prepared.

TAF LJLJ 220500Z 2206/2306 VRB02KT 9999 FEW033 PROB40 2222/2224 3000
PROB40 2300/2306 0600 FZFG VV001=

This shows that the TAF LJLJ and METAR LJLJ wind forecast and data differed significantly from the actual wind strength data at the same time in the Ljubljana Marshes area. The use of TAF and METAR forecast and data is not representative, as they do not provide a realistic weather situation for a planned flight with hot air balloons in the Ljubljana Marshes area.

Based on measurements and records, the Commission estimates that at the time of the hot air balloon accident:

- in the Ljubljana Marsh area, a strong west-to-south-west wind was blowing at an average speed of around 40 km/h at an altitude of 300 m above the terrain, and at altitudes of around 500 m above the terrain, the wind was even stronger at over 50 km/h (Figure 11);
- at the Vrhnika meteorological station, a gust of wind with a speed of up to 45 km/h was recorded (Figure 12);
- the atmosphere was turbulent at higher altitudes due to the stronger wind and the negative temperature gradient;
- the air temperature at the Vrhnika station increased, which is an indicator that no pronounced temperature inversion has formed near the ground. According to an analysis by ARSO, the reason for this is the presence of wind and the subsequent mixing of the lower layers of the atmosphere, which thus prevents the formation of an inversion;

- The wind forecast contained a suitable mean wind component with positional and vertical display accuracy. The official wind forecast is based on the ALADIN model[9].

From the analysis of the ARSO weather data available prior to the accident, it appears that the weather conditions at the take-off location were suitable and:

(a) at or above the applicable operating minima for VFR flights; and

(b) within the meteorological limits specified in the AFM Operations Manual.

The Commission concludes that the use of METAR and TAF weather forecasts and data for LJLJ and the use of weather data from the nearest automatic stations, Ljubljana and Vrhnika, are not meaningful for the preparation of flights in the Ljubljana Marshes area, especially when it comes to specific weather situations when flying in winter, and also because of insufficient data on the strength of the wind on the ground in the Ljubljana Marshes area. The data from the aforementioned measuring points is accessible in practice, but the quality is questionable, mainly due to the distance from the landing site and also due to the physical geographical characteristics of the terrain, which is around 160 square kilometres in size. There is no automatic weather station in this area.

2.3 Analysis of the operation of the OO-BDI hot air balloon

The ARC[10] documentation on the airworthiness[11] of the balloon was checked in relation to the type certificate valid at the time of the accident. When the functioning of the gas system was checked, it was found that both gas burners were working properly. The amount of gas in the gas cylinders enabled the planned flight to be carried out. The basket of the balloon and the balloon dome complied with the specifications in the manufacturer's manual and the issued EASA type certificates.

The take-off weight of the balloon was calculated to be about 20% below the maximum permissible take-off weight (MTOM 1450 kg) specified in the balloon manual (taking into account the data from the pilot's operational plan and the MLM (Minimum Landing Mass) value from the EASA TCDS type certificate[12]). The number of passengers in the basket was within the written limits for this type of balloon. During the investigation, the pilot attached documentation on the meteorological and operational preparations for the flight, which included the operational flight plan (Figure 19).

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[9] Calculation forecast of the meteorological model ALADIN/SI (Aire Limitee Adaptation Dynamic Development International—an international model over a limited area with the method of dynamic adaptation). The forecast time ranges from 00 or 12 UTC up to 72 hours in advance.
[10] Airworthiness review certificate issued by the Belgian authorised organisation Step In Balloons BV No. BE.CAO.0124
[11] TCDA EASA: file:///C:/Users/mzip182/Downloads/03-TCDS%20EASA_BA_021%20issue9.pdf
[12] Appendix no. 2

Figure 18: No irregularities were found when checking the operation of the burners

Operational flight plan

OOBDI

Laadrapport en passagierslijst

	Passagier	Gewicht (kg)	kledij +4 kg	bagage + 3 kg
1.	[redacted]	84	4	3
2.	[redacted]	85	4	3
3.	[redacted]	82	4	3
4.	[redacted]	85	4	3
5.	[redacted]	110	4	3
6.				
7.				
8.				
9.				
10.	Piloot	85	4	3
	Menselijk gewicht	531	24	18

Operator	[redacted]	
Immatriculatie	OOBDI	
Type	Lindstrand A 150	
Piloot	[redacted]	
Datum	22/01/2022	
Omgevingstemp.	-4	°C
Luchtdruk		HPa
Opstijghoogte	300	m
Max vlieghoogte	750	m
Draagvermogen	1450	kg
Handtekening		

Ballon		
Omhulsel	167	kg
Brander	23	kg
Mand	169	kg
Gasflessen : 80 + 80 + 80	[illegible]	kg
Ballon gewicht	**545**	**kg**

Brandstofberekening		
Geplande vliegtijd	1	uur
Reserve	0,5	uur
Nodige brandstof	192	liter
Handtekening		

Totaal gewicht	1118	kg
Meteo voorspelling	Zie bijlage	
Na vaart	Handtekening	

	Plaats	tijdstip
Opstijgen	Borovnici	9:30
Landen	IG	10:00

	Waargenomen defecten		Neen	Ondernomen actie
1				
2				
3				

Figure 19: Part of the pilot's operational plan for the execution of the flight

3 CONCLUSIONS

In accordance with the objectives of the investigation with respect to civil aviation safety and the prevention of the recurrence of such accidents and incidents in the future, the findings presented in this report do not constitute a determination of fault or responsibility. The use of this report for purposes other than improving aviation safety may lead to misinterpretation.

The conclusions of the investigation are based on the analysis of the information obtained from the pilot, passengers, and witnesses who were in the immediate vicinity of the accident site on the day of the accident. During the investigation, the investigating commission obtained the necessary information from the competent aeronautical meteorological service. During the investigation, data was obtained from the organisations responsible for the design, manufacture, maintenance, and buoyancy of the balloon and for the operation of the equipment. During the investigation, the Commission received radar data and a transcript of voice communications from the responsible air traffic control organisation - KZPS. Documents were obtained from the police, the medical facility that provided medical care to the injured, as well as information from other national and foreign authorities involved in the investigation.

3.1 Findings

3.1.1 Pilot

- The pilot had a valid hot-air balloon licence and permit. He had many years of experience in flying hot-air balloons, which he maintained continuously and without major interruptions;
- The pilot held a valid Medical Certificate Class 2 and an LAPL valid until June 12, 2022. The pilot's medical condition had no influence on the accident;
- The pilot carried out the pre-flight preparation in the presence of a local pilot, who ensured radio communication with the responsible ATC;
- For the meteorological preparation of the flight, the pilot used TAF forecast data for LJLJ and data from an unknown application that did not contain sufficiently accurate weather data for the area of the planned landing;
- In the pre-landing phase, the pilot correctly assessed the strength of the wind, warned the passengers and carried out hard landing procedures;
- The pilots of both balloons exchanged information prior to landing and were aware of significant changes in wind strength. In communication with the ATC controller, they did not report the deterioration in weather conditions and did not declare an emergency landing;
- The OO-BDI pilot provided assistance to the injured after landing.

3.1.2 Balloon

- At the time of the accident, the balloon was technically flawless and ready to fly in accordance with the manufacturer's instructions. A permit for navigation was issued by the authorised organisation and was valid at the time of the accident;
- There were no signs of malfunctions, faults or defects in the operation of the balloon, its parts or equipment;
- The take-off mass of the balloon was below the maximum authorised take-off mass (MTOM), which allowed a safe take-off, flight, and landing in accordance with the operations manual.

3.1.3 Other

- Due to the strong wind in the landing area, the gusts of which exceeded the limits for a safe landing specified in the operating manual, the balloon collided several times with the lower part of the basket on the icy grass field. As a result, some of the passengers fell out of the balloon basket and were injured, including three passengers with serious injuries;
- The basket of the smaller OO-BLM balloon tipped onto its front during landing and came to a halt after a few metres at a point about 200 m away from the OO-BDI balloon. Nobody was injured when the smaller balloon landed;
- The wind speed in the landing area at the time of the incident was significantly higher than the expected or predicted values that the pilot had determined during the preparations prior to landing. The wind speed in the landing area exceeded the limits specified in the manufacturer's operating manual for a safe landing;
- The meteorological conditions at the time of the accident and the particularly strong wind near the ground in the landing area had an influence on the accident;
- The fire and rescue services reacted in good time and provided assistance to the injured at the scene of the accident;
- The passengers involved in the accident were experienced in handling hot air balloons and had suitable clothing and footwear for the flight;

The availability of data on wind gusts is essential for flight planning in general aviation for flying at low altitudes as well as for balloonists, hang gliders, and paragliders. For the area of the Ljubljana Marshes, where commercial flights with hot air balloons are also carried out, there is not enough accurate data on the weather and especially wind forecasts on the ground, such as those available for other areas in Slovenia, where data from automatic meteorological stations is in practice more useful for balloon flight operators (the area around Bled, Celje, Maribor, and Murska Sobota). The METAR and TAF weather data and forecasts for Ljubljana Airport LJLJ and the data from the nearest automatic stations, Ljubljana Bežigrad and Vrhnika, do not provide sufficiently accurate data to assess the current wind speed when it comes to planning and conducting hot air balloon flights in the Ljubljana Marshes area.

In the course of the investigation, certain findings were presented to the representatives of the ARSO in the field of aeronautical meteorology from the analysis of the scope and usefulness of the available weather data for the preparation and execution of hot-air balloon flights. ARSO representatives set up a dedicated application during the investigation to provide hot air balloon operators with better-quality weather data (Appendix No. 5). In addition, during the investigation, ARSO provided data to forecast the maximum wind gusts at a height of 10 metres above the ground from the ALADIN/SI model for 72 hours in advance in 3-hour increments with a description of the model fields. During the investigation process, the hot air balloon pilot representatives outlined their expectations regarding wind sounding data, the availability of data from the Sodar, more detailed data on the wind below 3000 m, etc. For this purpose, ARSO provided the Sodar measurement data in real time (see figure below).

Opis meritev SODAR

Slika prikazuje meritve smeri in hitrosti vetra nad Ljubljanskim barjem z merilnikom SODAR do višine največ 600 m nad tlemi za zadnjih 24 ur. Slike se osvežujejo na vsakih 10 min. Smer vetra in hitrost vetra sta prikazana z zastavico. Veter piha v smeri od repkov proti začetku puščice. Kratek repek pomeni hitrost 5 vozlov, dolgi repek 10 vozlov, trikotnik 50 vozlov. Posamezni repki na puščici se seštevajo, tako dobimo izrisano predvideno hitrosti vetra v določeni točki. Z barvno lestvico je prikazana hitrost vetra znotraj določenega intervala. Čas na sliki je UTC. Pri izvajanju meritev SODAR lahko prihaja tudi do napak, zato so lahko na slikah prikazane netočne vrednosti smeri in hitrosti vetra.

Figure 20: Description of SODAR measurements

The Hot Air Balloon Operations manual states that during a fast landing, mainly due to the acceleration of the surface wind speed, the basket may tip over on impact, with the risk of passengers being ejected or falling out of the basket. Passengers should get into a low position (knees strongly bent), lean against the basket wall with their backs or shoulders, with their backs facing the direction of landing if possible, with their heads not sticking out over the edge of the basket, and with a firm grip on the rope. When analysing the size of the space for the passengers in the basket of the OO-BDI balloon, the Commission assumes that most likely not all passengers were able to ensure the correct position with bent knees and an adequate grip on the handles before hitting the ground. In the basket of the balloon intended for passengers, the Commission estimated that a maximum of four people could be placed in the correct position to minimise the risk of falling from the basket. In the case of OO-BDI, this created a greater risk, resulting in passengers falling out of the basket, three of whom suffered serious injuries.

3.2 Conclusion

3.2.1 Immediate cause

Hard landing and the resulting fall of the passengers from the balloon basket during a landing attempt in unexpectedly strong wind that exceeded the maximum speeds permitted for a safe landing.

3.2.2 Indirect cause

Insufficient weather information available about the wind forecast in the area of the intended landing led to the pilot's inadequate meteorological preparation.

4 SAFETY RECOMMENDATION

As part of the investigation, prior to the publication of the final report, the Commission assessed the progress made in the area of ARSO services in terms of access, scope, and quality of weather data intended for hot-air balloon flights in the Republic of Slovenia. In the following, prior to the publication of the final report, the Commission assesses:

- that in the Ljubljana Marshes area, where commercial flights with hot air balloons can be carried out, there is sufficient reliable data on the wind on the ground;
- hot air balloon flight operators in the Republic of Slovenia are not sufficiently familiar with the innovations offered by the ARSO for flight preparation and obtaining meteorological data in the area of the planned landing in order to assess the performance of the flight. Meteorological conditions (according to Regulation (EU) 2020/357 – BOP.BAS.145, Meteorological Conditions[13]), Annex II – Air operations with balloons (part BOP).

The Commission makes the following safety recommendations to improve safety in the category of flying with hot air balloons in the Republic of Slovenia:

SI-SR004-2024
In the current year, the CAA, in cooperation with ARSO, should organise and conduct a workshop in the form of training and education of hot air balloon flight operators in the Republic of Slovenia with the aim of promoting and using the new ARSO weather application for the balloon flight sector. The focus of the training will be on the accessibility, quality, interpretation, evaluation, and handling of weather data in order to carry out high-quality weather preparation before flight in accordance with the provisions of EASA Part-BOP - BOP.BAS.145 Meteorological Conditions.

SI-SR005-2024
CAA should consider this report as part of the programme to promote aviation safety and, within 12 months of the publication of the final report, organise and promote the implementation of a seminar in the form of regular training and education for operators of hot air balloon flights in the Republic of Slovenia with a focus on the topic of risk management in emergency procedures such as hard landing.

During the investigation, safety issues were identified with regard to the maximum number of passengers in relation to the available space in the balloon basket, which is divided into space for the pilot and the equipment with gas cylinders and, on the other hand, space for the

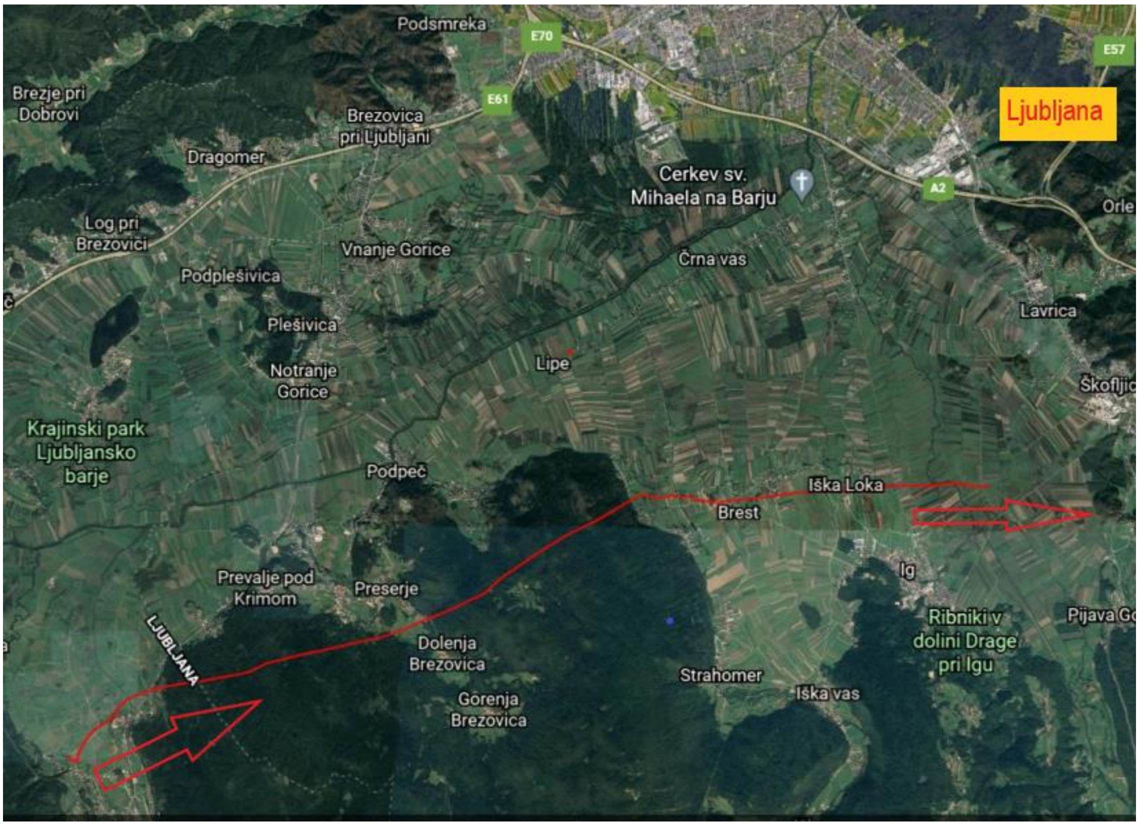
[13] https://www.easa.europa.eu/en/document-library/easy-access-rules/online-publications/easy-access-rules-balloons?page=5

passengers and their personal luggage. In aviation practice, such instructions are well known and are processed in operating documents defined by the manufacturers and also by the aircraft operators, owners, and users of balloons. The investigation body therefore has no safety recommendations with regard to the above points but expects operators, owners, CAMO organisations, and users to take safety measures to reduce their own safety risks as part of the internal inspection.

Toni Stojčevski
IIC

ATTACHMENTS

Attachment 1 – Area and trajectory of the OO-BDI balloon



Attachment 2 – EASA type certificat LBL 150A

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SECTION 2: Lindstrand A Type (42 000 – 500 000 ft3)

CAA UK Type Certificate Data Sheet reference: BB2

Manned free hot air balloon of natural shape with multiple gores between 24 and 32 flying wires. The balloon general assembly is defined by drawing EA-001-A-001. The definition of all variants (models) is listed in Table1.

Table 1: Models, Definitions, Limitations and Eligible Equipment

Model	Vol [ft³]	Vol [m³]	Dwg	MTOM [kg]	MLM [kg]	Burner	Baskets	Approval Date
LBL 150A	150 000	4 250	EA-150-A-001	1 450	652	02, 03, 04, 05, 08, 10	11, 12, 13, 14, 15, 16, 20, 31, 34, 35, 36, 40, 41, 263, 264	11.08.1993 ■

Attachment 3 – Restrictions from the manufacturer's Flight Operation Manual

Hot Air Balloon Flight Manual Approved by EASA under Approval Number EASA.BA.A.01000 on 10 April 2006, SECTION 2: Lindstrand A Type (42 000 – 500 000 ft3), 2.2 WEATHER:

2.1 INTRODUCTION

Section 2 details the operating limitations for the balloon and its standard equipment.

The limitations included in this Section and in Section 8 have been approved by EASA.

WARNING: The balloon must not be flown into contact with powerlines.

2.2 WEATHER

1. The balloon must not be flown free, if the surface wind at the time and place of take-off is greater than:

   Balloons ≤ 600,000 ft^3 (16992 m^3) : 15 knots (7.7 m/sec)

   Balloons > 600,000 ft^3 (16992 m^3) : 12 knots (6.2 m/sec)

2. The balloon must not be flown free if the forecast for the planned time and place of landing indicates a significant probability of the surface wind exceeding the limitations in paragraph **1.** above.
3. The balloon must not be flown if there is extensive thermal activity, any cumulonimbus (thunderstorm) activity in the vicinity of the flight path, or any turbulence which is giving rise to gusts of 10 knots (5.1m/sec) above mean wind speed.

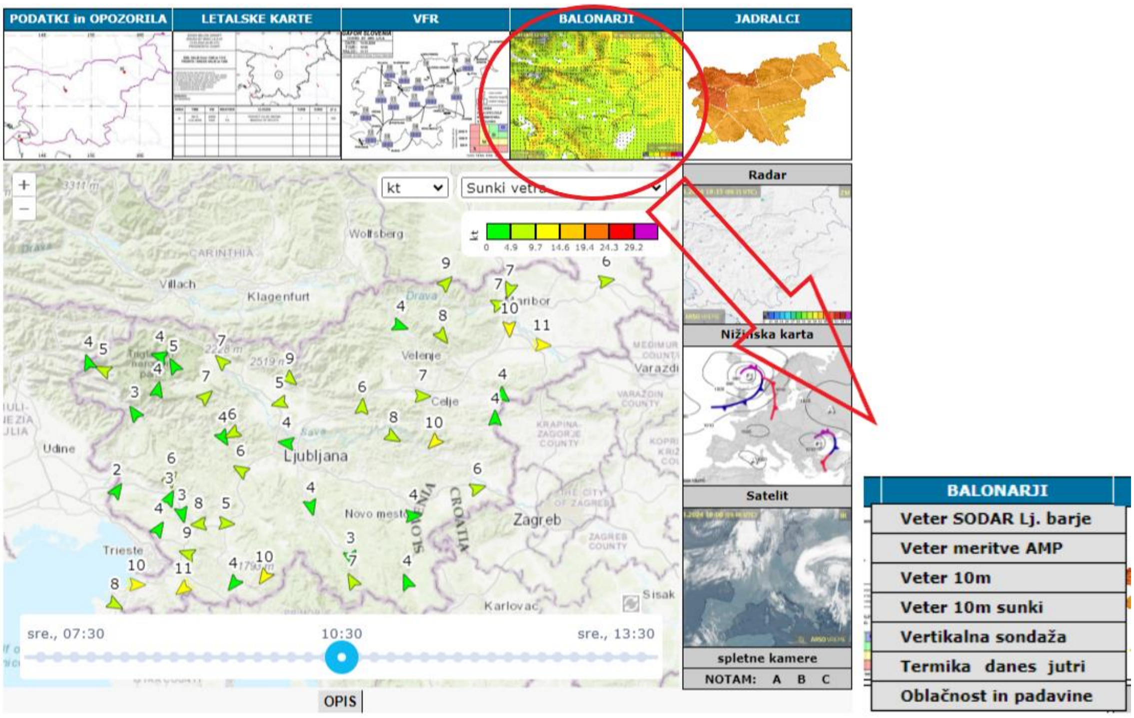
Flight Manual is approved by EASA under the approval number 10074820.

Revisions to the manual are published on the Cameron Balloons Limited website at www.cameronballoons.co.uk.

Attachment 4 – landing route OO-BDI

Attachment 5 – the position of the basket at the stopping point

Attachment 6 – ARSO new application for ballooning



Attachment 7 – EASA list of national meteo data providers in the EU

file:///C:/Users/mzip182/Downloads/NMS%20aviation%20weather%20contact%20details%20v1.1%2023%20Jul%202019.pdf

EASA
European Union Aviation Safety Agency

Aviation Weather Information from National Meteorological Service providers

The links below provide access to weather information services from National Meteorological Service providers. Telephone contact numbers are also provided.
The details have been provided by the National Meteorological Service provider of the State concerned.

Please note: The 'charges' indicated below relate to additional charges, if any, for telephone briefings. Normal telephone charges may apply depending on the user's telephone contract.

State	Link(s)/Contact numbers	Notes
Slovenia	http://www.meteo.si/met/en/aviation/ Briefings with forecasters available from the link above, select 'Manual' at the bottom of the page (not the 'Manual [pdf]' link) General 5 day outlook forecasts from: "Interactive weather" http://www.meteo.si/met/en/app/webmet/ or "user responsive" design suitable for mobile devices for general public http://www.vreme.si	Web information is free of charge without requirement for log in. We provide satellite data, weather radar data, on line webcams at major airports, forecast W + T aloft, night/day duration calculation for VFR planning, thermal straight forecast for soaring.